Historic England

Understanding the Archaeology of Landscapes

A Guide to Good Recording Practice (Second Edition)

Summary

This guidance provides practical advice on the recording, analysis and understanding of earthworks and other historic landscape features using non-intrusive archaeological field survey and investigation techniques. It describes and illustrates approaches to archaeological field survey, drawing conventions and Levels of Survey for record creators and users. The guidance also draws from the experience of Historic England field teams, exploring different aspects of landscape investigation and analysis through a series of case studies.

This revised version of the 2007 edition is one of several pieces of Historic England guidance available from the Historic England website, including:

With Alidade and Tape: Graphical and Plane Table Survey of Archaeological Earthworks

Traversing the Past: The Total Station Theodolite in Archaeological Landscape Survey

Understanding Historic Buildings: a Guide to Good Recording Practice

Where on Earth Are We? The Role of Global Navigation Satellite Systems (GNSS) in Archaeological Field Survey

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Front cover:
Examining the landscape at Snodhill, Herefordshire.

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1 Why Record?

The land, both urban and rural, is a document recording the lives of countless past generations. Existing route ways, buildings and boundaries, trees and hedges, as well as structures now reduced to earthworks, are all part of the beauty and fascination of the landscape. They can also be analysed to tell the story of the past – economic, social, aesthetic and religious. Analytical survey is a powerful tool that can help unravel the stories embedded in the landscape record. It involves the keen observation, careful recording and thoughtful analysis of visible archaeological remains. The analytical survey of earthworks and landscapes is a particularly valuable contribution to archaeology, and to related disciplines such as historical geography and local history. It is a tradition spanning 300 years in Britain and is the oldest of archaeological techniques.

Analytical earthwork survey of sites and landscapes is generally undertaken for one or more of the following reasons:

- to promote the understanding and appreciation of archaeological sites and landscapes
- to inform academic research across a range of disciplines
- to establish proper curatorial concern for what are often fragile remains
- to generate appropriate processes of conservation and management through improved analysis and understanding
- to assess rates of attrition and threats to the historic environment
- to assess significance and provide a basis for strategic heritage management
- to provide a firm foundation for thematic, topographic or period-specific works of synthesis
- to deposit a permanent record in an established archive

The first edition of this guidance was produced in response to a clear need for wider dissemination of the fieldwork approaches to investigating and interpreting archaeological sites and landscapes developed through the work of the Ordnance Survey Archaeology Division, the Royal Commissions on (Ancient and) Historical Monuments in Scotland, Wales and England, English Heritage and Historic England. There is great demand for fieldwork skills that can be brought to bear on the analysis of historic sites and landscapes, and this has been addressed in a number of guidance documents available from the Historic England website. This guidance builds on those documents and stands alongside *Understanding Historic Buildings: a guide to good recording practice*.

The demand comes from:

- Local Authority Archaeologists, National Park Archaeologists and Consultants setting briefs and conducting assessments of archaeological landscapes
- Commercial archaeological organisations conducting fieldwork
- Universities, colleges and schools conducting research and training
- Voluntary and community groups planning and conducting fieldwork

Analytical field survey is ideal for the latter, being non-intrusive, requiring little equipment or back-up and producing worthwhile results as it progresses. In the commercial sector, time and resources will be limited and a brief set by a curator or consultant will necessarily be followed exactly by a contractor. In the academic and voluntary sector there may be much more flexibility, and the original ‘brief’ may be considerably modified in the course of the work. This guide attempts to cover all such eventualities.

There is much to be gained from the non-intrusive techniques described here (and the related remote sensing tools such as aerial photography, airborne laser scanning and geophysical survey, as well as techniques of building investigation and surface artefact collection), at a time when it is increasingly important to emphasise that archaeology is much more than merely excavation.

Figure 1: Skipsea Castle, East Yorkshire.
The landscape represents a living record of the past, with analytical survey a powerful tool that can help unravel the stories embedded within it.
© Elaine Jamieson, University of Reading.

2 Approaches

An analytical field survey of upstanding archaeological remains can be undertaken by an individual or a team, does not necessarily require expensive equipment and is, therefore, an economical means of analysing archaeological sites and landscapes, providing much new knowledge for a small outlay (for examples see Historic England's research reports).

Analytical earthwork survey provides useful information on the form and condition of earthworks; it is also extremely good at identifying the chronological relationships of the elements of the landscape to one another. By interrogating these relationships a relative chronology can be built up. Surface examination is less good at producing ideas on function (while some classes of earthworks are readily recognizable, the use that others were put to may remain obscure),

Figure 2: Ashenhill Bronze Age barrow group, Somerset.

Earthwork survey can provide useful information on the form and relative chronology of a monument, and usually provides a sufficiently clear picture for the interpretation of a site's history and development.

or on absolute dating. A feature may be of a type that, by analogy, is likely to be of a particular period, a Bronze Age round barrow for example, however, analytical survey cannot usually identify dates with any precision. Nevertheless, form and relative chronology are valuable indicators and usually provide a sufficiently clear picture for the interpretation of a site's history and development. This information can be used to frame further research, to inform site management or as the basis for public presentation.

The record resulting from an analytical earthwork survey must be appropriate to the original requirement, and will be dictated by the method selected. A rapid, extensive field survey of, say, all the surviving earthworks in a given area may result in summary information and a graphical record that is limited to a locating cross or a pecked line on a map (**Level 1**). At the other extreme, an intensive field survey of an individual earthwork will produce a detailed report and a plan that depicts every significant feature (**Level 3**).

No interpretation of the landscape, whether extensive or intensive, ever provides all the answers. Like any other method this is only a stepping-stone towards an understanding of former structures that can, at best, be only imperfectly known. However, we can come closer to the truth by using a variety of retrieval methods. This is an important consideration because a normal result of any landscape investigation is a host of new questions best addressed by other techniques, such as geophysical survey, environmental assessment and analysis, or selective excavation. If such needs can be identified at the outset this information should be included in the project design. At the very least they should be included in suggestions for further work.

In summary, the analytical investigation, interpretation and recording of extant earthworks are economical and inform a variety of needs at differing levels of detail. They are a key part of a longer process that will include preparation by searching existing records and that may end with recommendations for further investigations.

Every project should have clear objectives and targets that should be set out in a formal or informal project design. It is the aim of this guide to aid the articulation of those objectives and bringing them to fruition.

3 Preparation

Depending on circumstances, background research begins before or concurrently with field reconnaissance. At this stage all that may be necessary is a check of the standard archives and main published references. Detailed study of historic maps and documents is often better done at a later stage. The desire to know as much as possible in advance about the site or landscape to be surveyed, has to be balanced against the wish to see that site or landscape with fresh eyes and without prejudice.

Figure 3: Late 16th-century map of Compton Martin, Bath and North East Somerset.

Historic mapping can often provide valuable information on the changing nature of a site or landscape.
Somerset Heritage Services.

Archaeological archives and databases in Britain contain a wealth of existing records. These include antiquarian drawings, plans and accounts, Ordnance Survey Archaeology Division records, aerial photographs, surveys and records by the Royal Commissions, English Heritage/Historic England and commercial contractors, National Mapping Programme data (archaeological mapping from aerial photographs undertaken to the Historic England standard), Historic Landscape Characterisation and excavation records.

Although this record constitutes a rich resource, often containing valuable contextual information on landscapes and monuments, it is always important to critically assess existing datasets in the light of new research and modern archaeological approaches. Careful study may reap substantial rewards.

Some of the main sources of information include:

- the Historic England Archive (formerly English Heritage Archive or National Monuments Record)
- the National Record of the Historic Environment (NRHE) – available through PastScape and Heritage Gateway)
- local Historic Environment Records (HER) – approximately 60% of England's HER records are available through Heritage Gateway
- Archaeology Data Service
- Ordnance Survey (OS) plans: basic scale, derived and historical maps
- published sources (authoritative books and journals)
- County Records Offices, local libraries, private records collections and The National Archives
- other local or specialist data, such as museum, archaeological unit, university or local knowledge

See Where to Get Advice for a list of the main sources of information.

Figure 4: The Dove Valley, Derbyshire.

Identifying the most appropriate techniques and equipment to undertake survey work is a key task of the reconnaissance process, particularly in remote areas where mobile phone reception may be too poor to use real-time corrections to a GNSS rover.

4 Analytical Earthwork Survey

Archaeological earthwork and landscape survey, however achieved, is a means to an end – interpretation and understanding. Survey plans and diagrams must depict matters of interpretation correctly and survey reports must include interpretation, not just description. The process of archaeological field surveying and plan production, at any scale, can be broken down into three tasks:

1. Reconnaissance
2. Observation and Measurement
3. Depiction

4.1 Reconnaissance

Reconnaissance ('recce') is the process of preliminary inspection and is critical to the success and cost-effectiveness of any survey. Thorough reconnaissance pays dividends in the long run by identifying problems at an early stage and allowing them to be quantified, rather than emerging as surprises later. Time spent on reconnaissance is rarely wasted, although it should be proportionate to the size and extent of the survey.

Although reconnaissance belongs within the earliest stages of a survey, before venturing into the field the fieldworker (or a colleague) should undertake some preliminary 'desk-top' appraisal so as to get the best value from the time spent on the reconnaissance. Armed with this material the fieldworker can assess the quality of information for any site or landscape and thus identify gaps or weaknesses in the record; reconnaissance time can then be targeted at specific sites or questions, as necessary.

Perceptions of a site or landscape acquired through the desk-top assessment are often radically altered once the ground evidence is examined. During the reconnaissance itself the fieldworker should address the site from three main perspectives:

1. Archaeological assessment
2. Survey strategy
3. Site logistics

4.1.1 Archaeological assessment

One objective of the reconnaissance might be to identify the archaeological significance of a site or landscape. This may result in identification of previously unrecognised earthworks, re-interpretation of known features or confirmation of existing knowledge. It is not, however, necessary to make detailed observations about archaeological interpretation at this stage; understanding of the archaeological remains may only come during, and because of, the survey.

It is good practice to walk over not only the site but the surrounding area; this will ensure that its full extent can be determined and its landscape context established. The archaeological hinterland can often reveal as much evidence for interpretation as the site itself. Modern land use, which may have influenced the physical form of a monument, needs to be considered as part of this process, as well as the historical and archaeological influences.

4.1.2 Survey strategy

The choice of survey strategy will then come into consideration. That choice can range from placing a line or dot on a map with the briefest of notes (**Level 1**), to a large-scale measured survey and detailed report (**Level 3**). A number of factors will have to be taken into account:

- **Purpose of the survey.** Is it a detail survey for management purposes or a rapid identification survey?

  The time and cost of large-scale surveys has to be justified. The level may have been specified by a client but flexibility of approach has to be built into the reconnaissance, as field observations may change the initial desk-based perception and lead to re-definition of the brief. In a commercial situation the brief will be prepared by a curator or consultant and they should satisfy themselves, through reconnaissance, that the level is correctly set; once the contract is awarded the contractor will not exceed the brief.

- **Size of the area.** This is often the biggest single influence on the choice of surveying methodology.

  If the area is large but adequately covered by large-scale Ordnance Survey mapping (for example the Ordnance Survey MasterMap Topography Layer) surveying within mapped detail, such as field boundaries, may be the most cost-effective method; any surveying technique can be applied to recording the archaeology within a map base.

  Where there is no large-scale map detail to work from, surveys of large areas become more demanding in terms of maintaining accuracy.

- **Survey methodology and equipment.** What are the most appropriate techniques and equipment to suit the proposed task?

  Methodology may be dictated by the available equipment but one of the tasks at the reconnaissance stage is to identify the most appropriate equipment to undertake the work. The choice could range from using **Global Navigation Satellite Systems (GNSS)** and **Total Station Theodolite (TST)** equipment to more traditional techniques of recording, such as using a plane-table and tape measures (see Survey Technology).

  Variables such as vegetation cover, purpose of the work and scale of the survey all need to be considered when deciding on the most appropriate methodology and equipment.

- **Scale of survey.** Scale will be influenced mostly by the purpose of the survey.

  If it is intended to be used as a management document and has to include fine detail of earthworks and structures, then the largest scale practical is required (1:500 or occasionally 1:250).

  A scale particularly suited to earthwork portrayal, showing detail and yet covering large areas reasonably quickly, is 1:1,000. If the purpose is less geared to detail and more to wide coverage, identification and basic interpretation, Ordnance Survey large-scale mapping at 1:2,500 or 1:1,250 offers a solution. Large areas can be covered at 1:2,500 while still allowing the key details of individual monuments to be portrayed. At these scales data can also be collected for use in a **Geographic Information System (GIS)**, by using recording forms uploaded onto a **GNSS** device for example (see Case Study 2).

Very large area landscape recording is best addressed at 1:10,000 scale, the most detailed map scale available in upland Britain. When covering large areas the value of survey based on the transcription and interpretation of aerial photographs and **Light Detection and Ranging (lidar)** should be seriously considered, at least as an initial project stage.

Doubling the scale may mean quadrupling the number of measurements needed, and therefore the time taken. As a rough guide, at 1:1,000 scale it is possible for an experienced team to survey 1ha of open ground in a day.

The use of electronic survey equipment does not absolve the surveyor from thinking about scale at the reconnaissance stage, because the scale of the final product dictates the level of detail to be recorded and therefore the number of measurements that must be taken.

- **Personnel.** Identification of the number and skills of people required for the survey, and any training requirements, is an important consideration (see Case Study 1). Most instrumental survey, optical or electronic, requires a team of two or sometimes three people. Tape-and-offset, **GNSS** and some **TST** equipment (with robotic or motorised capability) makes it possible for a single person to undertake survey but the advantages of working in teams must be considered; solving problems in survey and in archaeological interpretation benefits from dialogue, and working alone can be a health and safety risk.

- **Timescale.** Time limits, possibly subject to external factors over which the fieldworker has no control, can be a significant influence on the choice of methodology. It may be more efficient when dealing with large areas to undertake rapid surveys to identify the nature and extent of archaeological remains, followed by more detailed survey of specific areas, rather than attempting large-scale survey at the start.

4.1.3 Site logistics

Some of the unpredictability of fieldwork can be eliminated by assessing the following:

- Ownership and access

- Health-and-safety

- **Legal constraints.** Is the site a Scheduled Monument or a Site of Special Scientific Interest (SSSI) or is there any other constraint on the land which would require special permission from an authority other than the landowner/tenant? For example, access to certain areas may be prohibited at particular times of the year due to nesting birds or the presence of protected species; this must be taken into consideration when planning fieldwork.

- **The quality of mobile phone reception.** This is important if planning to use **GNSS** to fix the location of the base station(s) accurately or if intending to use real-time corrections to a **GNSS** rover (see *Where on Earth Are We?*). There are also health and safety implications if the mobile phone reception is poor on site.

- **Other potential problems.** Is the site frequently used by the general public? Will there be grazing animals on site? Will vegetation (trees, undergrowth, bracken etc) or the likelihood of flooding preclude survey at certain times of the year?

4.2 Observation and measurement

4.2.1 Principles of surveying

The main principles of survey must be applied to all surveys whatever the extent or final scale of plan:

1. Control
2. Economy of accuracy and consistency
3. The independent check
4. Revision and safeguarding

Work should always proceed from control to detail – making sure the whole framework is accurate before surveying individual components within that framework.

Control

Control is an accurate framework of carefully measured points within which the rest of the survey is fitted. It can take the form of a network of points placed by the surveyor, such as pegs, or existing features, such as telegraph poles, fence junctions, building corners, whose relative positions are carefully measured. The principle of control applies regardless of the scale of survey, although generally the larger the scale the more carefully control has to be measured. The accuracy of the finished plan is determined by how precisely this control is surveyed; the larger the scale, the more errors become identifiable.

Previously mapped features are a ready-made control framework to which archaeological detail can be related, but only at the scale at which they were originally surveyed; enlargement of a plan will enlarge any errors in the original. Control can also be established by using GNSS equipment, and tied to OS National Grid using OS Net in real time or using post-processing software. However, the accuracy of the control is dependent upon the grade of GNSS equipment used (see *Where on Earth are We?*). Problems may arise if using a control framework which combines points derived from GNSS equipment and previously mapped features, as inherent inaccuracies in the existing mapping may become apparent. In areas with a long mapping history like Great Britain, most current topographic maps are partial revisions of earlier maps and include unrevised data of varying age and accuracy.

Economy of accuracy and consistency

This applies to both linear and angular measurements; as a general rule, the higher the standard of metrical accuracy, the higher the cost in time and money. It is important therefore to decide at the planning stage what standards of accuracy are required. In determining accuracy requirements, the main considerations are: the best method of presenting the survey information, the scale of final plot or maps and possible re-use of data (such as coordinate values).

Accuracy is usually quoted as a representative fraction that shows the ratio of the magnitude of

Error	Measured distance	Accuracy	Level of accuracy	Achieved by
0.10m (10cm)	1,000m (1km)	1/10,000	High - the error would not show on most map and plan scales.	precise techniques and equipment
1m	1,000m (1km)	1/1,000	Lower but still acceptable for most archaeological surveys	careful tape measuring and basic equipment

Table 1
Levels of accuracy.

the error (the difference between true value and measured value of a quantity) to the magnitude of the measured quantity (see Table 1). Because accuracy is a relative term it is important to define the context of its use in relation to archaeological survey.

There are three areas of accuracy that the archaeological surveyor needs to be aware of:

- accuracy of measurement
  – governed by care and consistency in reading measurements
- accuracy of equipment
  – ensured by choosing appropriate equipment for the task
- accuracy of portrayal
  – equivalent care and precision is required in drawing technique and employing methods of depiction appropriate to the scale of survey, to ensure that the final plan reproduces the field observations faithfully

The archaeological surveyor should also be aware of three categories of error which are likely to affect accuracy:

a gross– eliminated by care in observing, measuring and drawing

b systematic – caused by a constant factor such as a stretched tape or a poorly calibrated TST; these errors are cumulative – their effect will increase throughout the survey

c random or accidental – less quantifiable errors can still occur, even if all effort has been made to eliminate **a** and **b**. Checking a finished survey 'by eye' is often the best way of identifying such errors (see Independent check, below).

The standard of accuracy can change with each stage of the survey but it can never be more accurate than the control. Standards at each stage of survey must be consistent. Therefore, economy dictates that accuracy at all stages is of the necessary standard to achieve consistency and that time and resources are not wasted trying to achieve a higher standard of accuracy than necessary.

Independent check

Checks should be undertaken at each stage, so that any errors or problems are solved before moving on to the next. Some methods are self-checking, such as mathematical solutions when computing coordinates; others may be more mechanical, such as checking regularly that a plane-table is correctly aligned; when verbally communicating coordinates it is always expedient get the person entering them to recite them back. Clearly it is important to ensure that the control is right before moving on to detail survey. At the end of the job, the surveyor should walk over the ground with the finished field plan in hand to see if it 'looks right' and to make sure that nothing has been missed.

Revision and safeguarding

It is usually possible to plan and execute a survey so that it can be added to or revised at a later date, thus increasing the value of the original investment in time and resources. This process can be aided by simple procedures, such as using witness diagrams to record the positions of ground markers (objects placed in the ground to mark fixed survey points) in relation to nearby permanent features, so that they can be found again and re-used (see *Traversing the Past*), or ensuring that topographical detail likely to have permanence, such as walls and buildings, forms part of the control and appears on the final plot.

4.2.2 The process of survey

At small to medium scales (1:10,000 to 1:2,500) archaeological detail can be added to existing map bases by taping or pacing and the use of simple angle-measuring instruments, such as optical squares and compasses (Farrer 1987). In remote areas, where local map detail is sparse, archaeological features can be supplied by resectioning or traversing (see *Traversing the Past*), although navigation and mapping-grade Global Navigation Satellite Systems are now frequently deployed (see *Where on Earth are We?*).

After reconnaissance, the process of measured survey at larger scales (1:2,500 and larger) can be broken down into two main tasks:

1 Control survey

2 Detail survey.

Control survey

Where the control framework is not provided by map detail it must be supplied from scratch. Factors identified at reconnaissance stage such as the size of the area, accuracy, scale and equipment required will all influence the most appropriate control methodology. There are two main types of survey control, regular grid and irregular grid. A rectangular grid of pegs as control for an excavation or geophysical survey is an example of a regular grid.

The irregular or mathematical grid is a scatter of detail control points observed from control stations and placed on or near to archaeological and topographic features at the will of the surveyor; the grid is invisible and exists only as a mathematical background when computing coordinates. This is the type of grid system used by most surveyors and mapping organisations.

The mathematical grid used by the Ordnance Survey is known as the National Grid. If an archaeological survey project utilises the same system of coordinated control points established by the Ordnance Survey this will ensure that it can be fitted to existing mapping. Accurate National Grid coordinates can be obtained in the field through the use of **GNSS** but they are not necessary for small, discrete archaeological sites surveyed by more traditional methods, provided sufficient permanent detail is surveyed to 'fix' the site so that the survey can later be related to Ordnance Survey mapping. These 'divorced surveys' can be referenced to a site grid with a false origin. Although convention expects surveys to be oriented to the north this is not necessary with divorced grids as the control is laid out to suit the site. To avoid any confusion north arrows should appear on all plots and drawings.

Most modern electronic survey tools have on-board coordinate displays and calculation facilities, which allow divorced grids to be defined, and most will accommodate Ordnance Survey National Grid calculations on site, or via computer software. Values read from any angle measuring instrument and any linear measurement technique (polar coordinates) can be converted to rectangular (cartesian) coordinates for plotting on a grid system with a calculator with trigonometric functions, or they can be plotted manually on graph paper; it is not necessary to have electronic instruments to establish this type of grid system for a site.

Control survey consists of two parts: **Control Stations** (where instruments are set up during control survey) and **Detail Control** (points from which the detail will be surveyed) is supplied. The control scheme should also include 'hard' detail.

Figure 5: Fountains Abbey, North Yorkshire.
A Trimble R10 GNSS receiver occupying a permanent control station.

‘Hard’ detail consists of objects where there is no question as to the point to be measured, including buildings, walls and telegraph poles, but also any masonry elements of archaeological interest. Many natural features, such as rock outcrops, boulders and cliffs can often be treated as ‘hard’ detail. ‘Soft’ detail includes all archaeological earthworks where the points to be measured are a matter for subjective judgement. Modern TST and GNSS equipment allows large numbers of points to be logged accurately and rapidly which can be plotted with different line and colour styles and text annotations. Therefore, ‘soft’ detail can also be recorded using electronic equipment and form part of the control scheme, although where this is complex it is best supplied by traditional methods, usually tape-and-offset or plane-table (see *With Alidade and Tape: Graphical and plane table survey of archaeological earthworks*).

Figure 6: Bramber Castle, West Sussex.

The process of measurement and drawing facilitates critical observation, a practice essential to developing an understanding of the function and chronology of earthwork remains.

However the control survey is undertaken the final result will be a control plot, on polyester film for stability and ease of use, showing all the positions of the stations, detail control and ‘hard’ and ‘soft’ detail. Because of the variety of printers and plotters, and rapid advances in technology, defining standards is difficult. However, the minimum recommended thickness for plotter film for use in the field is 100microns. As most plotter inks are not waterproof one solution is to print a reverse image of the plot and place this face-down on the drawing board to protect it from rain. This plot will then be taken into the field to form the basis of the detail survey. It is also advisable to mark Ordnance Survey National Grid coordinates onto the archived field plan to ensure it can be accurately georeferenced and revised in the future.

Detail survey

Having established the accurate framework of control the next stage is to survey the detail of archaeological features so that their morphology and relationships can be portrayed in plan form by conventions, such as hachures. This is the essence of analytical earthwork survey – using the measuring process to examine slopes and other features, their forms and patterns, and to examine relationships and compare them with analogous examples.

The detail control points that have been positioned close to archaeological features now become the points from which measurements are taken, so that earthwork remains are portrayed in their correct relationship to these points and to each other. If lines representing ‘soft’ detail were recorded using TST or GNSS equipment these are also used to accurately draw the earthwork remains. The process of measurement and drawing of each section of earthwork, as well as ensuring that a good and accurate plan is being made, also facilitates critical observation, so that surface stratigraphy is perceived, and the relationship and function of earthworks can be understood. If accurate control has been established, confidence can be placed in emerging patterns.

In the majority of cases the artificial slopes of archaeological earthworks are best represented by hachured plans. On many sites natural slopes are also of archaeological interest, revealing much about form and location, and must be included in the detail survey. In some cases depicting them with a 'natural hachure' is sufficient; for more complex inter-relationships contouring the natural topography may be necessary. In extreme cases even contours may not adequately represent very steep or complex slopes; where this occurs other methods of depiction, such as 3D representation, may be necessary.

Any decision to embark on contouring would normally have been made at the reconnaissance stage and therefore appropriate equipment and methodology would have been used. **GNSS** equipment and digital ground modelling software is an efficient way of gathering and processing large amounts of 3D coordinate data for depiction of contours and modelling (see *Where on Earth are We?*). Height data derived from **lidar** or **Structure-from-Motion (SfM)** and M**ulti-View Stereo (MVS)** applications can also be a useful way of generating contour information and modelling (Crutchley and Crow 2009; Historic England *forthcoming*).

The value of contouring archaeological earthworks for analytical purposes is extremely limited and best restricted to simple sites and low, spread monuments, such as ploughed-out barrows and single-phase earthworks (Bowden 1999, fig 28). Contour surveys are sometimes said to be 'objective' (although judgements have to be made, for instance, about horizontal and vertical intervals). The corresponding 'subjectivity' of hachured survey is its strength, because that is where the fieldworker's judgement, experience, knowledge and interpretative skill can be deployed. The advantages of hachured survey over contour survey for earthworks are that it can:

Figure 7: Snodhill, Herefordshire.
Once control is established it is used to accurately survey the detail of the earthwork remains so that their morphology and relationships can be portrayed in plan form. The tape-and-offset survey at Snodhill Castle provided context for conservation of the site's fragile masonry remains.

- distinguish between natural and artificial slopes
- show chronological relationships between features
- give a consistent depiction of features as they turn across or along slopes

The best solution is therefore to show archaeological earthworks by hachures and natural slopes by contours.

Electronic data (especially that derived from **GNSS**, **lidar** and **SfM**) can be used to generate 3D surface models for slope analysis, presentation and increasingly as an aid to interpretation (see below). Where these methods are not available, recording height values around a site in the form of spot heights at strategic points can also enhance the value of the detail survey. This can be particularly relevant on sites, for example, where water management is significant. Measured profiles across earthworks are an effective means of conveying changes in height where vertical differences are dramatic, and also help to illustrate interpretations (see *With Alidade and Tape*).

4.3 Depiction

The depiction of hard detail is subject to generally accepted cartographic systems – sets of symbols, lines and annotations known as conventions. The depiction of archaeological features is also subject to conventions, such as those used by the Royal Commission on the Ancient and Historical Monuments of Wales, Historic Environment Scotland, Historic England and the Ordnance Survey. Conventions such as those used by Historic England can form the core of any survey, and site-specific conventions can be added where necessary. Conventions vary according to the scale and purpose of the plan being drawn.

Any convention or symbol should look like what it is trying to portray. Some conventions can be used to convey a feeling of depth or height, and at large scales (1:2,500 and larger) conventions should allow accurate depiction of detail. For small-scale surveys (1:10,000 and smaller), a combination of lines, schematic symbols and colours is usually adequate. Conventions must be clear, unambiguous and consistent. Interpretation, analysis and presentation can be enhanced by the selective use of colour.

Most surveying software packages have a range of embedded line styles and symbol codes that can be used in the field to define different types of feature. Annotations and notes on the drawing can be used to good effect as an alternative to developing large numbers of conventions. However, drawings should always be kept as clean as possible and detail drawn clearly. Before leaving a site, check unclear elements, make any necessary notes and add a key to the drawing to explain the conventions used.

5 Survey Technology

Surveying is about measuring two components: angles and distances. All surveying equipment is designed to measure one or both of these. What usually differentiates equipment, and consequently cost, is the accuracy attainable. It is quite possible to produce surveys with basic equipment, although when the area is large and there is a requirement to preserve accuracy more sophisticated equipment may be necessary. Lack of access to modern electronic surveying equipment should be no barrier even to undertaking large surveys.

Before the 1970s all surveying was undertaken with manual theodolites, plane-tables and chains to very high accuracies; the principles never change, only the practice and level of technology. Surveys of almost any size can be achieved with a combination of a theodolite, plane-table and tape measures. Small to medium-sized areas can be recorded, even at large scales, using a plane-table, optical squares and tapes. Compass and pacing alone can be perfectly adequate for small-scale (1:10,000) surveys (Bowden 1999, 74), although navigation grade GNSS now offers a cheap solution and is increasingly being used for collecting small-scale survey data (see *Where on Earth Are We?*).

Surveying equipment and techniques of recording have become increasingly automated. The main advances have been in speed and accuracy of measurement, automated computation and drawing, as well as in coding and categorisation of information, so that it can be accessioned electronically into databases. However, no technology has yet been developed that can emulate the human skills of observation and analysis of archaeological earthworks.

5.1 Global Navigation Satellite Systems (GNSS, also known as GPS)

High-precision National Grid coordinates for control can be achieved with **GNSS** (see *Where on Earth Are We?*); either by transforming the survey onto the National Grid using post-processing software (the Ordnance Survey makes all the satellite data logged by **OS Net** available to download for a 30-day period from its website) or by fixing the survey directly to OS Net in real time using a mobile phone internet service. It must be borne in mind that linking a site or landscape survey accurately to the Ordnance Survey National Grid in this way can mean that its relationship to local map detail appears incorrect, as existing Ordnance Survey mapping may be less accurately georeferenced.

Besides being a powerful tool for providing survey control, GNSS can be used as a flexible, rapid way of planning archaeological features. A GNSS rover can be used to record the tops and bottoms of individual earthwork slopes, using different feature codes from a predetermined library to distinguish between the two. The feature-coding software will join the individual points with a choice of line styles, colours and thicknesses. Using this method, the surveyor is literally drawing the feature with the GNSS. As the survey progresses it is useful to display a zoomable map on the survey controller, showing in real time what has been recorded. This allows the accuracy of the depiction to be verified as work proceeds and can be used to ensure no parts of the site are omitted. Using survey grade GNSS in this way can produce a detailed plan at large scale, requiring only minimal field checking at the end (see Case Study 3).

Mapping grade GNSS is typically used where the emphasis is on creating a basic map depiction at 1:2,500 scale or smaller (see Case Study 2). However, recent developments have seen the introduction of receivers that can attain an accuracy of 0.1m (10cm) using OS Net, meaning they can be used for 1:1,000 scale surveys where there is a reliable mobile phone signal (see *Where on Earth Are We?*). Modern devices are also capable of displaying georeferenced digital files of lidar, rectified aerial photographs, historic and modern Ordnance Survey mapping, and other datasets. Recording forms can also be designed and uploaded onto the devices and used to capture attribute information about the features being recorded in the field for use in a **GIS**. Some navigation grade models have a similar functionality, but can vary considerably in the level of accuracy they achieve.

Survey grade GNSS also provides three dimensional information across an archaeological landscape which can be used to construct a **Digital Terrain Model (DTM)**. Large quantities of 3D points can be collected by walking with a rover receiver over a site (Figure 8) or by driving if the receiver is mounted on a vehicle. To represent earthworks accurately, points should be recorded along the absolute top and bottom of each earthwork and along any significant breaks of slope. The DTMs can be manipulated so that subtle features can be more easily seen; these digital models can be rendered to create a three-dimensional surface from which visualisations and animations can be built, or for analysis using GIS software.

Figure 8: Warbstow Bury, Cornwall.

Two Trimble R8 GNSS receivers used as rovers for detailed **Level 3** survey.

5.2 Total Station Theodolite (TST)

The use of **TSTs** in archaeology is well established (see *Traversing the Past*). Advances have been made with the interchangeability of TST and survey grade GNSS, allowing the seamless integration of datasets captured using the different technologies. For example, the position of two points on the boundary of a woodland, or in a clearing, can be fixed with GNSS, then a TST can be mounted on the tripod over one point and orientated on the second point as a backsight (Figure 4). Using the coordinates for both points as recorded by the GNSS receiver, on the same survey controller, allows the survey to be carried into areas without satellite reception.

Integrating survey data collected using GNSS and TST equipment can often greatly speed up the survey process. However, when integrating GNSS and TST data a scale factor needs to be applied to the TST readings so that they are projected correctly to match with the Ordnance Survey National Grid coordinates logged by the GNSS receiver (see *Traversing the Past* and *Where on Earth Are We?*). On the latest TSTs offering a direct interface with survey-grade GNSS receivers this scale factor can be applied automatically. Tablet computers can also be integrated with TSTs and have the benefit of a larger graphic display (Figure 10).

The development of robotic or motorised capability in TST equipment (where the instrument can be controlled remotely via a radio link) makes it possible for a single person to conduct a survey using a TST. That said, the use of 'robotic' mode can prove frustrating in challenging conditions (such as in woodland, in a built up area or in a confined space), and multiple station set ups can be laborious and time consuming for a single person to undertake.

Figure 9

A TST set up over a control station for detailed **Level 3** survey in woodland.

The creation of a DTM is usually done more quickly and efficiently using GNSS receivers rather than a TST. However, it is still worth considering using a TST to model sites in areas where satellite reception is too poor to use a GNSS receiver, such as in woodland, and where lidar data is not available or not of a suitable resolution; a combination of GNSS and TST survey may provide the best solution in certain circumstances.

5.3 Tablet computers

Rather than a keyboard with an attached screen, a pen computer places the emphasis on the screen and the software is controlled with a stylus. Software for tablet computers enables the surveyor to use digital maps in the field. Data can be collected electronically but the surveyor can see the survey developing and can adjust it graphically. This system combines the benefits of digital data recording with the immediacy of using a plane-table or other hand drawn method. Tablet computers can be linked to TSTs and GNSS receivers, so that when a point is recorded it appears as a point on the computer screen in real time (Figure 10). The surveyor can tag each surveyed point with textual information. Taped measurements can be incorporated and data can be organised by colour and layer for transfer to other software packages for finishing and plotting.

Figure 10
A tablet computer linked to a TST for in use in the field.

5.4 Laser scanners/lidar

Lidar provides a high-definition representation of the modern ground surface across a given area through the use of laser scanning equipment mounted in an aircraft (see *The Light Fantastic*). The quality of this data is dependent on flying height and the sensors used, and surveys at 0.5m and 0.25m resolution are now common, but surveys to centimetre accuracy from helicopters are also possible (although digital files at this resolution are extremely large). The three-dimensional information in the lidar scan provides a metrically accurate framework for survey work and also can be fed into surface modelling packages to produce a variety of visualisations of the surveyed area. Terrestrial laser scanning can also be used as a way of collecting similar data over smaller areas.

The use of lidar by archaeologists for interpreting and mapping earthwork sites and landscapes is developing rapidly, but already the main advantages are clear. Because the laser scanner can often penetrate the tree canopy it enables the mapping of features in woodland and undergrowth that are invisible to aerial photography and may be difficult to recognise on the ground. The ability of lidar to record large areas rapidly and in some detail enables ground survey teams to target specific areas for detailed investigation and interpretation. One disadvantage, as with all remotely collected datasets, is that the data is of limited value if not critically compared and analysed against other sources of information such as historic aerial photographs and the real landscape.

5.5 Photogrammetry/Structure from Motion (SfM) and Multi-View Stereo (MVS)

Structure from Motion and **Multi-View Stereo** applications use the principles of photogrammetry to create a highly accurate 3D digital model of a site or landscape using an overlapping series of low-level aerial photographs. Small Unmanned Aircraft (SUA), either fixed-wing or rotary, are used for image capture and have the advantage over manned aircraft in that they fly at lower altitudes and can provide higher resolution mapping (often between 0.02m and 0.1m resolution). SUAs are also a fast and flexible means of acquiring imagery over small areas, making data relatively inexpensive to obtain for individual sites or discrete areas of landscape (see Historic England *forthcoming*).

The use of SfM by archaeologists for survey and mapping is a relatively new development, but undoubtedly represents a technique with considerable potential. In a similar way to lidar, the digital models produced using SfM and MVS applications can provide a metrically accurate control framework on which to base archaeological survey and analysis. Although photogrammetry can produce high-resolution **DTM**s, it can only model the surfaces the camera can see at the image acquisition stage. The technique therefore has limited application in wooded areas where tree cover may block the view of the ground; similarly, in areas under

Figure 11: Tintagel, Cornwall.

This 3D model was produced using Structure from Motion technology, which uses the principles of photogrammetry to create a highly accurate 3D digital model of a site or landscape using an overlapping series of low-level aerial photographs.

agricultural cultivation the 3D model derived using photogrammetry will represent the tops of the crops planted and not the ground surface.

Although undoubtedly a valuable tool in archaeological survey, mass data-capture methods such as photogrammetry and **lidar** require informed analysis at the point of use. There is no doubt that 3D models derived from photogrammetric techniques represent a powerful visualisation tool which can supply a new perspective on sites or landscapes. However, in situations where detailed interpretation and understanding is required, a combination of techniques is essential to achieve the best results. If interpretations are to be robust, the mass capture data must be verified against the real landscape in the field. Refining survey results may require the augmentation of data with information derived using other survey methods, such as **GNSS**, and experienced analytical observation will also be necessary to ensure matters of interpretation are depicted correctly (see Bedford and Went 2015).

6 Photography

6.1 Making a photographic record

Photographs are taken to record specific features – such as buildings, architectural details or finds – or to illustrate the broader context of a site, aiding the visualisation of a site in its landscape setting by a record user. They can be used to illustrate publications, particularly where their use supplements the interpretation of significant visual aspects of a site. New photography can also reproduce an earlier viewpoint, such as a topographical drawing, showing how the drawing has emphasised certain features, or how the landscape has changed. Photographs can also provide an *aide memoire* for site notes and for preparing drawings.

The scope of subject matter in field archaeology offers the photographer a diverse and challenging role in record making. Earthwork sites are notoriously difficult to photograph on the ground however, and often require low, raking light conditions and a raised viewpoint to produce effective results (Figures 2 and 12).

For general advice on archaeological field photography see Bowden 1999, chapter 6, and for more detailed information see *Understanding Historic Buildings* section 4.4 and *Photographing Historic Buildings*.

Figure 12: Kirby Hall, Northamptonshire.
The photographer has made use of the low, raking light conditions to highlight the earthwork remains of a deserted farmstead.

6.2 Digital images

Digital technology has now largely superseded the silver-based emulsion and chemical process used for well over a century. The relative infancy of digital technology in relation to traditional techniques does, however, create uncertainty over the longevity and archival stability of digital images. (See our guidance on digital image capture and storage). That said, the advantages of digital image capture – in desk-top publishing and digital projection for example – far outweigh any perceived disadvantages.

Access to digital cameras is becoming more widespread as the cost of hardware falls and cameras have become commonplace in devices such as mobile phones. Although the quality of images captured using a mobile phone or a camera within a pad or tablet is not yet suitable for publication or archiving, they can provide useful georeferenced images for use in reconnaissance work and site notes. Some mapping grade **GNSS** units have the capability of capturing georeferenced digital images that can be linked to features surveyed in the field and then downloaded into a **GIS** back in the office (see *Where on Earth are We?*).

6.3 Making notes

The most brilliant photograph is useless without a record of where and what the image is. The best time to make this record is at the time of exposure on site. The information must be written down or recorded electronically. Any caption should record at least:

- the subject matter
- its location (this may be the site itself or detail within the site)
- viewpoint (if building or landscape)
- date of photography

It must be emphasised that this represents a minimum requirement. Ideally the surveyor should relate the photographs more intimately to the other elements of the record, by making them physically part of 'component sheets' (see Bowden 1999, 154) or by marking the location and direction-of-view of the photographs on a version of the survey drawing as a key to the photography.

7 Drawings and Reports

In archaeology, as in other field sciences, illustrations and written reports are two sides of the same coin; the text explains and qualifies the plan. For some projects the recording methodology may appropriately involve the use of a proforma recording form as an alternative to survey plans. Proforma data can be collected on a survey controller or similar device in the field for use in a **GIS**. The information recorded on such forms has to be tailored to the individual task (see Case Study 2).

7.1 Plans

Having applied best practice to the survey, it is essential that the same standards are achieved in drawing-up. The aim is to present the graphical results of a survey – whether hand-drawn or digital – as clearly as possible. The plans should carry forward the analytical processes of the survey itself, and clarify arguments put forward in the accompanying text.

At the completion of fieldwork the product should be a well-drawn and complete pencil field drawing or, if using digital methods, an annotated computer plot. Before commencing work on the final version, the illustrator should be satisfied that the drawing is complete and that no information is missing or unclear. Even if the draughtsman undertook the survey, a delay between fieldwork and drawing can result in some of the site's subtleties being forgotten if they were not recorded clearly.

Before beginning the drawing the objectives should be clear: publication, a working or management plan, or an archive drawing? There must always be an archive drawing, at full survey scale and including all survey information, whether the survey is to be published or not.

The finished plan (if not digitally generated – see below) is a fair-drawn version of the field drawing, and polyester drawing film is the best medium for this. It is easy to draw on with pens and pencil (see Table 2 for suggested lineweights). Alterations are made easily and the material itself is durable, maintaining its stability indefinitely. A suitable grade for penned drawings is 125micron and inks designed specifically for use on film must be used. Alterations may be made using a film ink eraser or a sharp blade. The only other drawing instruments and materials needed are standard technical drawing items.

Technical pen size/ digital lineweight	Used for
0.1mm or 0.13mm	small hachures
0.15mm or 0.18mm	hachures and linework
0.25mm	linework and stipple
0.35mm and 0.5mm	heavier lines

Table 2
Pen sizes and lineweights.

7.2 Illustrations

Further illustrations may be required for specific purposes, such as popular publication and presentation displays. These are all now routinely prepared with computer drawing software, which is flexible and easily obtainable. The possible requirements are too varied for standards to be set, although the draughtsman must always aim for clarity. Drawings can be printed or output in various digital formats. Computer drawing also enables a rapid trial-and-error approach – mistakes are easily corrected and colour options can be explored. Subsidiary illustrations can, of course, like the site plan, still be adequately produced by traditional methods.

7.3 Drawing techniques

7.3.1 Earthwork depiction – the hachured plan, basic techniques

The hachured plan remains the most effective means of depicting earthworks. Even if plans are simplified for wider dissemination, the hachured earthwork plan is still the basis for the archival record. Hachures are elongated triangular symbols which, when arranged in arrays, convey the positions of the top and bottom of a slope accurately, where the wide end (head) represents the top and the narrow end (tail) the bottom. Variations on this basic convention may be used to depict a diversity of subtle differences in earthwork forms and gradients (see Archaeological drawing conventions).

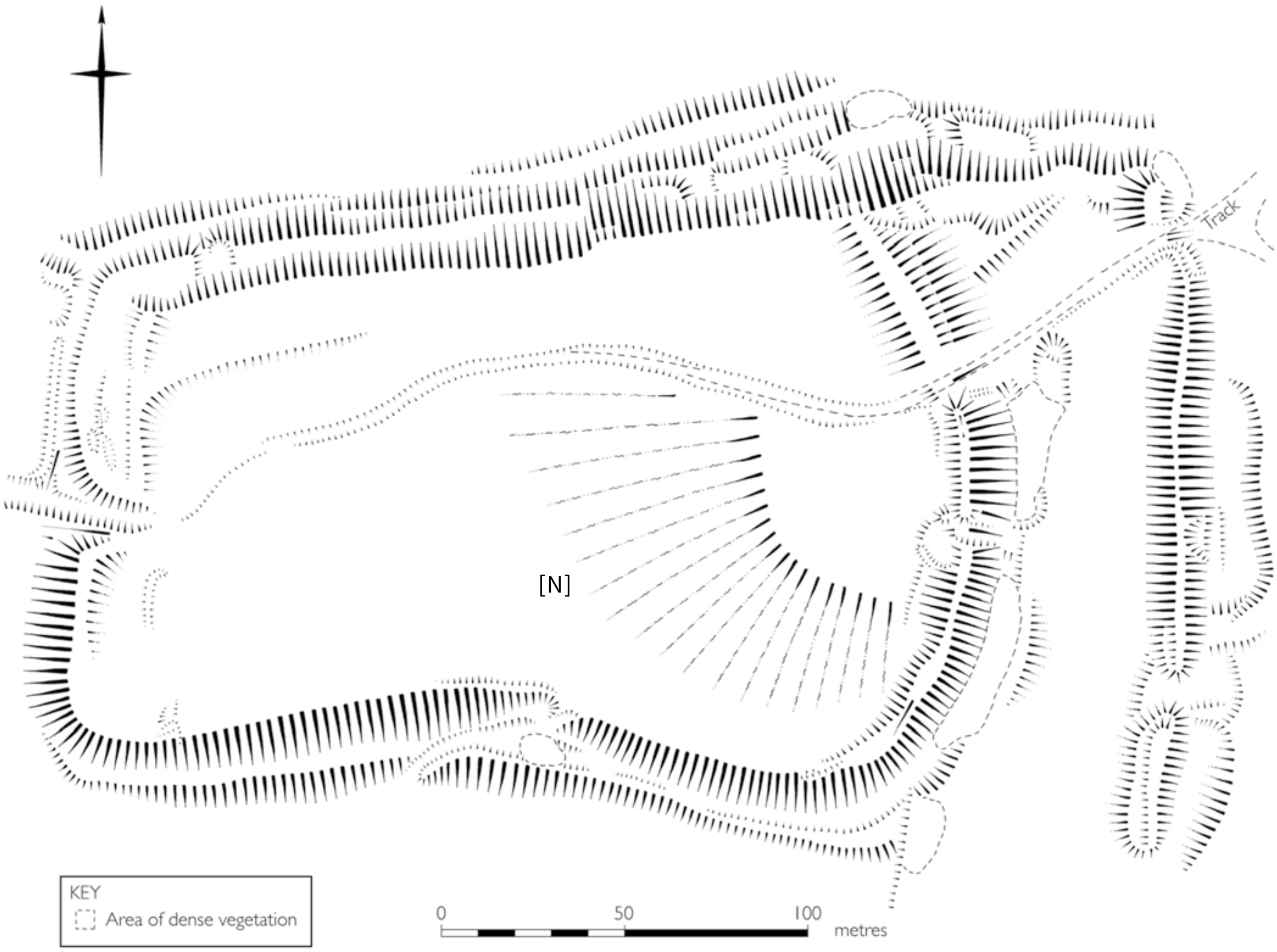


Figure 13: Burledge Hillfort, North Somerset.

On this hachured plan a balance between thickness and spacing of hachures is used to depicted the different gradients of slope across the site, with the natural slope depicted using the natural hachure convention [N].

The most important basic principle in drawing hachures is the uniformity of spacing, size and alignment within each array. Secondly, the different gradients or 'weights' of slopes must be shown and this is achieved by varying hachure thickness and spacing between arrays. Without this variation all slopes appear the same, giving a misleading impression.

Although steep slopes will have very closely spaced hachures, those for shallow slopes cannot be very widely spaced, as there is a limit at which too great a spacing will cause the form of the slope to be lost. A balance has to be drawn between thickness and spacing to achieve a visible variation in the depicted slope. It is important that the hachures of opposing sides of a linear feature are similarly spaced and opposite each other. Failure to do this results in an untidy plan, which is difficult to read. Similarly for curving or rounded features, any changes in spacing must be gradual, to maintain the continuity of the array.

Some slopes do not have even gradients and may steepen or flatten out gradually, to blend with the natural topography. If this is so pronounced that there is a break of slope, this should be surveyed and depicted by drawing the slope as two gradients, with the tails of the upper hachures touching the heads of the lower. The tail of the hachure can be broken to depict where a slope starts to level out and has no clearly defined base. Through a combination of all these effects, it is possible to depict subtle changes in gradient.

Where natural slopes form an important element of a site they should if possible be surveyed and depicted, using contours or the natural hachure convention. When using the latter technique, it is important that the plan does not become unduly cluttered with natural slopes, detracting from the archaeological detail.

7.4 Additional methods of depiction

Where contours are included they should not interfere with the hachured areas and they should, like the natural hachure, be used with caution, so as not to over-complicate parts of a drawing that are already heavily detailed with earthworks. A careful decision has to be made on the appropriate vertical interval, and contour heights must be clearly labelled at suitable intervals on the drawing.

Profiles are valuable to illustrate the shape of earthworks and to record current heights and angles of slopes where erosion is a problem. The positions of profiles should be accurately plotted on the plan, and the profile itself should adhere to standard conventions so that it is clear what features the section cuts through. It is sometimes necessary, where gradients are slight, to exaggerate the heights of a profile by varying the vertical/horizontal scale ratio. This scale difference must be clearly stated on the drawing.

7.5 Maps and smaller-scale plans

Large, dispersed sites such as field systems, or multi-period archaeological landscapes, need to be drawn at smaller scales if all relevant features are to be included on one plan. These plans can be surveyed at the intended scale or made up of several larger-scale plans accurately reduced, simplified and re-drawn. Often they are a combination of both. The most suitable scales to use are 1:2,500, 1:10,000 (Ordnance Survey basic scales) and occasionally 1:5,000, which is particularly useful when preparing maps digitally.

When using these scales, fine detail has to be omitted, although a 1:2,500 scale plan can still include a surprising amount of detail. Hachures may be used for larger features, with stony banks and cairns depicted using stipple. However, some features – such as leats – need to be conventionalised. At 1:10,000 scale the main aim is to show geographic location and site type, and nearly all features have to be conventionalised.

For large landscape surveys where data is compiled within a GIS environment, it is important to define from the outset a consistent standard of depiction.

7.6 Annotation

Annotation of illustrations should be neat, unobtrusive and minimal. All archive plans should contain a metric scale bar and a north point, as well as a title box containing essential information (see Archaeological drawing conventions). Publication drawings should, if possible, be oriented with north approximately to the top, and appropriate grid intersections should be shown where necessary. Where this is not practical the direction of north should be indicated clearly. A key must be included for any conventionalised features.

Text placed within the drawing should be kept to a minimum. For archive drawings of very complex detail, such as industrial landscapes, it is sometimes best to place annotations on a separate overlay, or a separate layer if the digital plan is archived.

7.7 Beyond the earthwork plan

While plans and maps remain the basic means of depicting and recording earthwork sites, it is often necessary to develop the ideas and interpretations that result from the survey into a form that will convey them more readily to others. By selective simplification and conventionalising of significant features it is possible to convey phases of activity or distinctly different types of evidence that have been brought to light as a result of survey.

The inclusion of colour is by far the best method of highlighting differing elements or phases of an earthwork plan. In some cases, several versions of the plan may be necessary, highlighting separate features. At smaller scales, such as 1:2,500, a multi-phase field system, for example, is understood at a glance when reproduced in colour. This technique is also useful for combining information from differing sources, such as earthwork survey, geophysical survey and air photographic transcription, where all three produced in monochrome on the same plan could be confusing, and if prepared separately the impact would be lost. Although colour is often available when producing one-off reports for limited circulation, archive plans and for exhibition or display work, its use in publications is sometimes restricted due to cost. Where this is the case the best alternative is the use of grey tones. Although more limiting than colour, grey shades can still effectively break down a site into its component parts. Line weight is another alternative, where different monuments or elements of a monument can be highlighted by a combination of heavier and lighter lines.

7.7.1 Computer graphics

The advantages of computer graphics are that data can be manipulated and assembled easily, and laborious hand drawing routines, such as hatching, stippling and shading, can be performed accurately and with speed. Drawings may be altered without difficulty, allowing many different versions of the same basic drawing to be produced. Computers also handle colour with much greater ease than is achievable using traditional drafting methods. The production of hachured plans to high standard using a computer is now becoming commonplace.

Hand-drawn images can be scanned and georeferenced for use in a GIS environment or to allow editing in a computer graphics package. It is possible to download digital field survey data for use in CAD or a GIS. Both enable data from differing accurately gathered sources to be combined into one map drawing, as long as proper provision has been made for its use at the survey stage and common points of reference are established within each dataset. Different types of information can be stored on separate layers and styled using different colours, symbols and line types; for example, a ground survey could be overlaid onto an aerial photo plot, together with geophysical, fieldwalking and excavation data; or for management plans the position of footpaths and erosion, vegetation and animal burrows, or planned future encroachments at the site.

Once prepared in this way a wide range of options are available for the finished product. The material may be retained in its digital format and viewed and contrasted with a vast array of other archaeological and geographical datasets. Alternatively, the data could be plotted onto paper or film for management and archive plans and for publication, although publication quality illustrations are often better produced by transferring the drawings into a graphics program. Within such software colour, grey shading, annotation and lettering can all be incorporated and reproduced to high standards.

Another visualisation option is the Digital Terrain Model (DTM), in which suitably surveyed topographical and archaeological features are presented as a 3-dimensional model. This is particularly useful where aerial photographs of a site are not available and a ground survey can provide the first 'view' of the earthwork features as a whole.

7.8 Reports

The principal written product resulting from a survey will be the archive report. This is distinct from the publication report (Bowden 1999, 186–8). Producing a coherent written description that integrates the available evidence is a particular skill. This description provides the communication of understanding by those involved in the fieldwork, who have had privileged access to the field remains, to their readers, now or in the future, who may not have that access. The final report should also contain a balanced selection of relevant illustrations, drawn to a consistent standard, which convey not only highly detailed plans of the archaeological features, but also the geographical context and relationships with the landscape and with other monuments.

Objectivity cannot be a valid aim in the light of the necessary choices about inclusion, order and weighting, and the imperative to allow the understanding resulting from fieldwork to be developed and conveyed must be the culmination of the process. Yet at the heart of the activity lies the observation and recording of field remains, and similarly at the heart of the resulting report must be a description of those remains, sometimes even a catalogue of features, including observations of relationships, out of which grows the interpretation and understanding. The inclusion of interpretative plans can, in addition, convey many of the thoughts and conclusions regarding the chronology and nature of the site that come about as a result of the survey.

Any report must also include a detailed section on survey methodology and the equipment employed, to enable the reader to gauge the reliance that can be placed on the survey results, as well as the usual apparatus of references, acknowledgements, and so on.

8 Dissemination

Archaeology depends upon a fragile and finite resource. It is the archaeologist's duty to conserve this resource and to make the results of a fieldwork project, including the original archive, available to the public. Archiving issues are covered by guidance notes, codes of conduct and standards.

8.1 Archiving principles

The archive should be deposited in an appropriate and accessible public record within a reasonable period of the end of the project, even if the project has been fully published (CIfA 2014). For non-destructive fieldwork, public access to the archive may not appear critical, but there are strong reasons for its public deposition:

- The archive created by a survey is a point-in-time record of condition. If the site is subsequently destroyed or eroded, or even restored for display, the archive remains an invaluable source of evidence for what has been lost.
- Publication media usually impose limitations of scale. A survey plan will often have to be reduced, with loss of detail. The full-size plan will only be available as archive.
- Public access to the archive will help disseminate any insight gained by the fieldwork – especially if the project remains unpublished, but true even after formal publication.
- Publication should be at a level appropriate to the importance of the results. Much detail will therefore remain unpublished and available only in the archive.

From the outset of a project, due consideration must be given to permanence (using the correct materials). Published guidance on the preparation of archaeological archives is available (Walker 1990; see also CIfA 2014). Long-term storage in the correct environment is the responsibility of the repository but the surveyor is responsible for ensuring that the correct materials are used and that the archive is maintained in good condition prior to its deposition (CIfA 2014, 3.4.2). This requires attention to some house-keeping issues:

- Masking tape must be peeled off drawing film as soon as possible.
- Do not store or use the archive in areas prone to damp, dust or dirt, or of fluctuating temperature or humidity.
- Do not leave the archive in strong light.
- Do not expose the archive to risk from food, drink or tobacco.
- Do not use steel paper-clips, staples, pressure-sensitive adhesive tape or rubber bands.
- Do not fold or roll the archive unnecessarily – where possible, store it flat.
- Always handle documents with care: wash and dry your hands before handling them.

8.2 Publication

Publication should be considered whenever a survey has produced significant new information or insights worthy of wider dissemination. Decisions have to be made as to what should be published, and although it is often tempting to describe everything that was found, this is usually quite unnecessary and can detract significantly from any insights gained from the survey. In the presentation of results the descriptive side may be largely dealt with through an archive report and by the publication of a plan or plans. The crucial element of any publication should always be the synthesis: the presentation of distilled conclusions which represent the concise expression of what was learnt and the context in which the information should be viewed.

The first step should always be to identify the most appropriate place for publication. This may be a local or regional journal, a website or web-based portal, or a national or international peer-reviewed journal, depending of the importance of the survey results. In exceptional cases the intrinsic interest of the site or landscape may justify publication in the form of a standalone publication. Further advice on the publication of survey projects can be found in Bowden 1999, 186-8.

8.3 Signposting

Record creators should signpost the existence of a record through OASIS - Online AccesS to the Index of archaeological investigationS. The OASIS data capture form has been designed to help in the flow of information from data producers, such as contracting units, community groups and academics, through to local and national data managers, such as Historic Environment Records (HERs) and national monument records. A copy of a report can be uploaded free of charge to aid in its wider dissemination and use. The resulting information is validated and passed onto the Archaeology Data Service (ADS) for inclusion in its online catalogue.

At the time of writing it is intended to replace OASIS with HERALD (Historic Environment Research Archives, Links and Data), during the course of the next two years. This will provide a similar service. Updates on the progress of this project will be available on the OASIS website.

9 Recording Levels: A Description

Levels of recording and analysis for archaeological survey define a common standard, making it possible to categorise, group and compare in broad terms records that may vary considerably in detail. They also provide those undertaking or commissioning work with an understanding of what should be included in the record of a site or landscape, and enable an estimate to be made of the resources required before a project or survey begins. By clearly defining recording levels, users of a completed record can appreciate the intensity of recording and understand the basis upon which conclusions have been reached.

All archaeological records generated as a result of field investigation must attain the following criteria:

- A record should aim to be accurate, clear and concise.
- A record should chart the historical development of an archaeological site or landscape and provide a clear statement of its significance.
- The scope or level of the record and its limitations should be stated.
- A record should include a methods statement.
- A record should make a clear distinction between observation and interpretation, thereby allowing data to be reinterpreted at a later date.
- Wherever practicable, a record should have regard to the context of the site, including its wider archaeology, known and potential, whether in terms of below-ground deposits or landscape archaeology.
- A record should describe past research at a site.
- A record should include an indication of any sources consulted.
- A record should identify the compilers and give the date of creation. Any subsequent amendments to the record should be similarly endorsed.
- The report and supporting material should be produced on a medium that can be copied easily and which ensures archival stability.
- A record should be made accessible through deposit in a permanent archive.

Those creating a record should be mindful at all times of the rights and sensitivities of owners and occupants, and of the health-and-safety implications of working in historic landscapes.

No fieldwork can be regarded as complete until all the necessary documentation has been entered in the appropriate database and archive. In addition, all records generated by survey should be indexed to a core data standard compatible with national and international standards for records, such as MIDAS Heritage – *the UK Historic Environment Data Standard* (2012) and CIDOC (1999). The Forum on Information Standards in Heritage (FISH) Thesauri should be used where appropriate to ensure standardisation of terminology.

Within Historic England the results of all survey work have been summarised in a Monument record entry (or multiple entries as appropriate) compiled to core data standards and held in the National Record of the Historic Environment (NRHE). An Event record (or records) for the survey is created to provide a digital link between the survey project, updated Monument records and any plans or reports deposited in the archive. In addition to the core data, most records of an archaeological monument will combine a written description and analysis, with a visual record made by a metrically accurate survey drawing.

Three levels of recording have been identified and are described below; they range from the least detailed (**Level 1**), comprising a basic map/plan depiction and brief annotation, to the most comprehensive (**Level 3**), which consists of the fullest combination of archaeological source material, surveys, descriptions, interpretations and contextual analyses. Table 3 provides an overview to when each level of survey is appropriate.

Archaeological survey and recording will normally correspond to one of these levels. However, it is not possible to be prescriptive about the levels of record for all circumstances – objectives, time and resources will vary from case to case.

Furthermore, initial aims must be flexible in practice; procedures adopted at the outset of a survey may require subsequent modification. The paramount considerations are accuracy and clarity. For example, more complex investigations will result in a number of other outputs including:

- large-scale survey of a particular monument
- a plan at 1:2,500 of its setting and context within the wider historic environment
- a landscape survey fitted on to the Ordnance Survey digital map base and with possible long-term further research through GIS
- establishment of permanent survey control to aid excavation, water flow monitoring, land use change, environmental impacts and similar studies
- a digital three-dimensional model of the monument

Each of the descriptions of the three levels of recording is followed by a specification of the recommended components (Items) that can be combined to make up an archaeological record to the standards set by Historic England. The individual Items are described further in Survey Products.

In any record where it is not appropriate to conform exactly to one of the three prescribed levels, components may be included or omitted but any substantial departure should be noted. Multiple-level recording of an archaeological field monument, using the appropriate level criteria, is permissible: **Level 1** verification of previously recorded **Level 2** and **Level 3** field investigations; **Level 3** investigation of previously recorded **Level 1** field inspections, etc. Fieldworkers are strongly urged to tailor the format of their records to the NRHE model or to that adopted by the relevant County HER.

9.1 Level 1

Level 1 is mainly a visual record, supplemented by the minimum of information needed to identify the archaeological site's location, possible date and type (Case Study 1). This is the least complex record, and will typically be undertaken when the aim is to provide essential core information to agreed standards, including structured indexes of the location, period, condition and type of the monument that, typically, would result from rapid field investigation (see The written account, Items 1–5). This would be accompanied by a simplified cartographic record, often at 1:10,000, of the location and extent of the site.

There should be basic consultation of easily available related information sets: these may include field surveys, records of buildings, archives, aerial and ground photography, geophysical survey, fieldwalking, excavation records and other local sources.

A **Level 1** record will typically consist of:

- The core monument record
- The written account: Items 1–5, and 12
- Survey drawings: an annotated 1:10,000 map (either digital or hardcopy), indicating location and extent (Item 13) and a cartographic record (Item 14)

9.2 Level 2

This is a descriptive record that provides qualitative information beyond the scope of **Level 1** inspection (Case Study 2). It may be made of an archaeological site that is judged not to require any fuller record, or it may serve to gather data for a wider project.

A **Level 2** record provides a basic descriptive and interpretive record of an archaeological monument or landscape, as a result of field investigation. It is both metrically accurate and analytical, depicting the real landscape context of the archaeological features. The examination of the site will have produced an analysis of its development and use, and the record will include the conclusions reached, but it will not discuss in detail the evidence on which this analysis is based.

This record must include the core monument data. Beyond that, the information provided at **Level 2** should be able to satisfy broad academic and management requirements. It will normally include a divorced (that is, non-map based) measured survey or an accurately located map-based survey at a scale that will represent the form of the monument. In addition, the location and extent will be indicated on a 1:10,000 index map to ensure consistency with other levels of recording. Some statement of method, accuracy, and of the quality of investigation and survey will normally be included. Related information sets consulted at this Level may include field surveys, records of buildings, archives, aerial and ground photography, geophysical survey, fieldwalking, excavation records and other local sources.

A **Level 2** record will typically consist of:

- the core monument record
- the written account: Items 1–5, 8–12
- survey drawings: accurate cartographic location and extent of the monument(s) at scales of 1:10,000 and 1:2,500; site plan at a scale of up to 1:2,500. Items 13–14 and 18 (and in exceptional cases Item 15)
- ground photography: as appropriate

9.3 Level 3

A **Level 3** record provides an enhanced and integrated, multi-disciplinary record of an archaeological field monument or landscape, resulting from the process of field investigation (Case Studies 3-7). This is often enhanced in one or more ways by additional specialist research or fieldwork such as geophysical survey; aerial survey; fieldwalking programmes; specialist assessment of artefacts; the analytical recording of standing structures; and excavation. In many cases such enhancements would result from contracted-out arrangements of negotiated partnerships. A distinguishing characteristic of this Level is that the enhancement will be included in the design of the project or task and will form an integrated part of the resulting record and analysis (rather than being simply an information set that has been consulted, or a separate event). Taken to its logical conclusion, this Level extends to an all-inclusive ideal of interdisciplinary investigation.

This record will provide a quality of description, interpretation, graphical depiction and analysis beyond the scope of a **Level 2** entry. It must include the core monument data. **Level 3** investigation will normally be used only for selected monuments, reflecting their importance, or where a specific management/client need has been identified that makes this level of detail appropriate (such as threat, Scheduling requirement, research, etc). An accurately located, measured survey (map-based or divorced) at an appropriate scale (at 1:1,250 or larger), designed to represent adequately the form and complexity of the monument, will always be part of the record; additional documentary and cartographic material may also be generated as part of the detailed recording and analysis.

To some extent, **Level 3** field investigation may be seen as being open ended, with specifications tailored individually to suit a variety of requirements, but it always demands a detailed descriptive and analytical approach, complemented by an accurate measured survey or surveys. A statement of method, of accuracy and of the quality of investigation and survey will always be included. All related and readily accessible information sets should be consulted at this Level. These may include field surveys, records of buildings, unpublished documents, aerial and ground photography, geophysical survey, fieldwalking, excavation records and other local sources.

A **Level 3** record will typically consist of:

- the core monument record
- the written account: Items 1–12
- survey drawings: accurate location of the monument(s) at scales of 1:10,000 and 1:2,500 Item 13
- site plan at a scale of 1:2,500 or larger. Item 14
- other drawings: as appropriate Items 15–21
- ground photography: as appropriate

Circumstance	Principal need	Level of record	Form of record
Strategic heritage planning at national, regional or local level; studies of landscapes, pilot projects	Information on the distribution, survival, variation and significance of archaeological sites, defined geographically, typologically or chronologically, and understanding of their evolution, to inform a range of national and local policy initiatives, to underpin heritage management decisions and as a contribution to academic knowledge	Generally low-level record – typically Level 1 or 2, but in selected cases 3). Map accuracy required is c 10m.	May make extensive use of external photography, supplemented by written accounts of individual sites and/or synthetic text. Drawn element may be omitted, simplified, limited to maps or restricted to key examples. Locations to be identified by a grid reference and plotted on a 1:10,000 base map
Management planning for individual sites or components within the landscape	Baseline information on the nature and significance of archaeological sites, providing a foundation for long-term decision-making, and identifying where further knowledge is required	Level 2 (or, on occasion 3), is required. Map accuracy required is c 1m.	Measured drawings may form an important and cost-effective component, meeting a range of non-historical as well as historical needs. Where sites form a tight geographical group, or belong to an historic estate, more extensive documentary research may be practical. Objects and monuments to be plotted against an 1:2500 map, or production of a plan of similar scale.
Full contextual assessment of an archaeological site and its landscape setting for research/academic and curatorial reasons	Understanding of the significance of the archaeological site and providing detailed analytical appraisal of its context, date and function	Always Level 3. Map accuracy required is c 0.10m	An account of the site and its landscape setting accompanied by a full range of measured and annotated drawings as well as photographs and reconstruction/ phased diagrams. An accurate, measured survey plan is essential, at a scale of 1:1,000 or larger, alongside three-dimensional data.
Rescue or remedial survey when rapid response is required	Proper contextual appraisal of damage or threat to monument or landscape	Dependent on scale of site/ landscape and the nature of response to the threat. This may well include all Levels of survey.	Could require the use of all available methods of analysis. Thoroughness of the resulting record is dependent upon the nature and extent of the threat but will include, as a minimum, a measured drawing and annotated text.

Table 3

A guide to potential uses of the different levels of survey.

10 Survey Products

10.1 The written account

Any written account (see List of Survey Products) should take into consideration factors including:

- existing practices and formats
- the circumstances that led to the generation of the record and the uses to which the information will be put
- the need to adopt common data standards and models
- whether information is presented as text or in tabular format

The introductory material in any written account should always include Items 1 to 3.

Item 4 may prove adequate for the description at **Level 1**, and Item 5 for **Level 2**. However, in **Level 3**, Item 6 is the mandatory minimum in order to give the much fuller description and analysis demanded. Exactly how this information is given may vary, depending on the type of field monument being investigated: accuracy and clarity are more important than rigid structure. Unnecessary descriptions, and measurements that can be obtained readily from the survey drawings, should be avoided. Where complex relationships exist, the use of interpretive drawings is to be encouraged. A clear and explicit distinction must always be made between the descriptive part of a report and the interpretation.

10.2 Survey drawings

The scale of a survey drawing must be appropriate to the level of recording, the nature and extent of the site, the amount of detail that is available and the use that will be made of the survey (see List of Survey Products). A **Level 1** survey will require little more than a location symbol on a map or a delineated area showing the approximate extent of the site. **Level 2** surveys will normally be drawn or designed at scales of up to 1:2,500, whereas surveys at **Level 3** will require plans at 1:1,250 scale or larger. The same scale should, so far as is possible, be adhered to throughout a project (especially a thematic one) in order to facilitate the comparison of different examples. To help make complicated remains comprehensible, interpretive diagrams or phase plans should be provided. Terrain modelling can be used very effectively to illustrate and explain the relationship between the site and its topography: in certain circumstances this may be preferable to contour modelling which is less easy to understand.

Particularly complex relationships within a site may need to be drawn at a larger scale than the rest of the survey; these may be shown as an insert or window. Profiles should be drawn where it is necessary or helpful to show the ground surface, especially that of a bank or ditch in section; these will normally be drawn at a much larger scale (such as 1:250) as appropriate. As a general rule, exaggeration of the vertical axis is to be discouraged, but is sometimes necessary to make a point. For both profiles and for detailed windows, the scale, position and orientation of the supplementary drawing must be shown clearly.

List of Survey Products

A **written account** may contain the following Items:

1 The type (classification) of the archaeological field monument being investigated, and its period; normally using the Monument Types, the FISH Thesauri should also be used.

2 The exact location of the site; the National Grid Reference (up to 8 figures, as appropriate) and the Civil Parish, District, and County or Unitary Authority; along with identification numbers (NRHE, HER, designation) for the site.

3 The name of the compiler, the date of the investigation and reason(s) for the survey, with details of site ownership and present land use.

4 The key source (for example an aerial photograph or principal publication).

5 A summary of the salient features – this is particularly important for monuments that have lengthy and complex descriptive reports.

6 A concise description of the site, including information on plan, form, dimensions and area, function, age, developmental sequence and past land use.

7 A detailed description of the site, including the same information as **Item 6** plus full analysis and interpretation with supporting evidence presented.

8 Consideration of the topographical setting of the monument and its relationship to other sites and landscapes, and to historic buildings in the immediate vicinity.

9 The potential for further investigation and for other forms of survey should be assessed and recommendations made. Any finds made during the investigation should be noted.

10 Relevant information from other sources, including published or unpublished accounts and oral information; the location of unpublished records must always be given. Relevant bibliographical references must be included, but an inclusive bibliography need not be assembled.

11 A brief assessment of the local, regional and national significance of the site or landscape with regard to its origin, purpose, form and status (that is, its academic context).

12 A brief Event Record: this is a succinct description of the activities that were necessary for the compilation of the monument record, which may be coupled with the information provided in **Item 3**.

A set of **drawings** may include the following Items:

13 A diagrammatic plan showing the location or extent of the monument or landscape.

14 A metrically accurate site plan, typically at 1:1,000 or 1:2,500, showing the form of the site or landscape. The plan should be related to topographical features and to modern detail (field boundaries etc), whether or not they are depicted on Ordnance Survey maps. The use of larger scales (such as 1:500 or 1:250) may occasionally be justified, where relatively intricate detail needs to be shown. The scale 1:1,250 may be justified in urban areas where this is the Ordnance Survey basic scale.

Note: As cartographic information in digital form is now the norm, the concept of basic scale weakens as the reproduction of maps at a greater range of scales becomes possible, however, the traditional suite of mapping scales remains a useful benchmark.

15 Profiles illustrating salient vertical and horizontal differences in the ground surface. Their position must be marked on the site plan and their orientation distinguished by means of a reference letter and arrow at each end of the section line.

16 Interpretive diagram(s) showing successive phases of development; phase plans must be accompanied by an unaltered copy of the survey from which the interpretation has been devised. Full cross-referencing must be included.

17 Reconstruction drawings may be particularly relevant. Such drawings must always be fully cross-referenced and must be accompanied in the record by copies of the survey plans on which they are based.

18 Copies of maps produced from the interpretation of aerial photographs and/or lidar, either undertaken as part of the National Mapping Programme or as specific larger-scale exercises.

19 Copies of plans that throw light on the history and interpretation of the monument. This includes any excavation plans which contribute to an understanding of the visible remains. The location of excavation trenches should be clearly shown on the new survey, with some indication of their accuracy. If a report is to be published, the copyright of any plan or photograph must be taken into account.

20 Copies of any plans derived from geophysical or geochemical investigation. The limits of survey or common points must be shown. An accessible presentation of the data should be superimposed on a second copy of the new survey.

21 Copies of gridded plans showing the location of archaeological objects and the extent of artefact spreads found by 'fieldwalking'.

All drawings (except those for publication) must be clearly labelled with the name of the site, the surveyor and the date of the survey. Drawings in a set must be cross-referenced to each other. Drawings may be executed by hand or computer generated: hand-drawn plans can be scanned into the digital environment to allow further manipulation. The growth and development of digital archives have led to an increasing requirement for the provision of survey information in a digital format to allow manipulation and interrogation within GIS. These developments have prompted the increasing use of CAD and other digital graphics software in the processing and presentation of survey data. This has made survey data more flexible and easier to manipulate into different formats than when drafted in traditional hand-drawn format.

The drawing conventions at each Level should follow standard Historic England practice as laid out in the Archaeological drawing conventions. Surveys should also contain the appropriate corporate logo. In order to record this, and other pertinent information, Historic England has devised a standardised information block, which must be included and completed on all survey drawings prepared for the Historic England Archive.

Records are now often produced wholly or partly in digital form, whether as a word-processed computer file, a TST or GNSS survey of a site, a CAD drawing or a digital photographic image. While in theory it is possible to store all such material in digital form in perpetuity, experience has shown that even the storage media themselves can be rapidly superseded by technical developments. It is necessary to distinguish in this area between data that is stored in an active computer system (on-line) and data that is stored on other media, such as external hard drives (off-line). In the case of on-line data, curation problems are reduced if the system is backed up regularly and the data adequately migrated when the system is itself upgraded, but it is important to appreciate that the advent of new software and hardware platforms may result in restricted access or functionality.

Where digital data is to be deposited as part of the archive record it is imperative that the intended repository is contacted as early in the recording process as possible. This will help to ensure that the repository is willing and able to accept and access the data in the hardware and software configurations used. While some national archive repositories can store data in on-line systems, most local repositories are likely to store material in off-line formats, at least in the short term.

Where records are written to off-line storage media it is recommended that at least two copies are created, preferably on different types of storage media, and that these are stored in different locations. The long-term storage of off-line data presents a number of problems in maintenance and curation. It requires stable storage conditions, regular copying to ensure that magnetic-based information is not lost, and regular up-grading to keep it accessible as software changes. Additionally, the pace of change in computer hardware means that some early storage formats have already become obsolete, and it may be necessary to transfer data between different types of media to ensure continued use.

At present, therefore, it is always advisable to hold a hard copy of all data deposited in digital form. While the digital record can provide information not susceptible of reproduction on paper (for example three-dimensional views, or the ability to examine minute areas of a drawing in close detail) the paper archive at least ensures the currency and accessibility of most of the information. Further guidance on digital data issues can be obtained from the Archaeology Data Service.

See Case Study 6.

11 Archaeological Drawing Conventions

The purpose of a set of drawing conventions is to provide consistency and clarity in the production of archive or publication plans, regardless of whether they are hand-drawn or produced digitally. Consistency is achieved through standardisation of symbols for the depiction of archaeological features (such as earthworks, cairns, ruined walls) and non-archaeological features (such as modern fences, roads and tracks). Clarity is achieved by adapting the conventions to the scale of the finished plan; by the selective use of annotation and by the provision of a key explaining the conventions used. As a minimum standard, all the plans within a project or publication must use the same conventions but the ultimate aim for an organisation is to have a single set of conventions for all its mapping output.

11.1 Objectives

Historic England uses a standard set of mapping conventions for the depiction of archaeological sites and landscapes. (It is acknowledged that special circumstances sometimes require additional or alternative conventions.) The aim in issuing the Historic England conventions is:

- to promote the use of a set of conventions across the profession adapted to the recording and interpretation of archaeological sites and landscapes
- to facilitate the comparison of plans of different archaeological sites and landscapes through the use of a standard set of conventions
- to facilitate the comparison of plans produced by different archaeological organisations by promoting the use of a standard set of conventions
- to provide guidance on the level of information and the preferred conventions for drawings acceptable to the HEA
- and to indicate a minimum level of information that should be included in archive and publication drawings

11.2 General points

As a minimum standard, all plans should include:

- a metric scale bar and, if appropriate, an imperial bar
- a north point. This should be annotated with MN if the direction relates to magnetic north (in which case the date should also be included); with GN to indicate direction related to the orientation of the national grid (Grid North); or with TN to indicate direction to True North calculated by reference to information on local Ordnance Survey map sheets.

- a key to illustrate the conventions used. To avoid repeating the key on each map or plan in a publication, the conventions used could form a separate figure that appears before the first of the illustrations to which it relates.

All archive plans should include an information block (see Table 4).

Where the plan is to be stored digitally, the information block need not appear on the drawing but could be embedded in the file as metadata.

All archive plans should have a grid, preferably depicted by means of marginal ticks, with numeric values qualified by a statement as to whether it is a local grid (that is, a site grid) or related to the National Grid. There is no need for a drawn grid on digital maps and plans where the base coordinates of the drawing relate either to a local grid or to the National Grid. However, the statement as to the origin of the grid still needs to appear as text on the drawing or stored as metadata.

11.3 Conventions for large-scale drawings (1:1,250; 1:1,000 and 1:500)

11.3.1 Archaeological features

Hachures are used to depict artificial slopes. They are an extremely versatile method of depicting the wide range of slopes encountered on an earthwork site (Figures 14-15; see also Bowden 2002, fig 20). Used with care, they can show a wide variety of earthworks ranging from very slight slopes shown by small-headed hachures with broken tails (A) to very steep, wide slopes shown by thick-headed hachures (B). As well as the shape of the hachure, the spacing along an earthwork also conveys much about the type of slope. Narrowly spaced hachures indicate a steeper slope than where they are drawn widely apart. Care is needed not to place hachures too closely together as there is a danger that the heads will coalesce into an unintelligible mass. Equally, if the hachures are too far apart they will not define either the shape or the alignment of an earthwork adequately. The most difficult slopes to define by hachures are those on tight curves, such as the edge of a circular pit or mound. To get

Historic England				
OFFICE OF ORIGIN	COUNTY	SCALE OF SURVEY	METHOD	OS MAP No.
PROJECT NAME	DISTRICT	DATE OF SURVEY	ASSOCIATED PLANS	NRHE No.
SITE NAME	PARISH	SURVEYOR(S)		SM No.
DOCUMENT STATUS	NGR	© HISTORIC ENGLAND	SHEET	CATALOGUE No.

Table 4
An example information block.

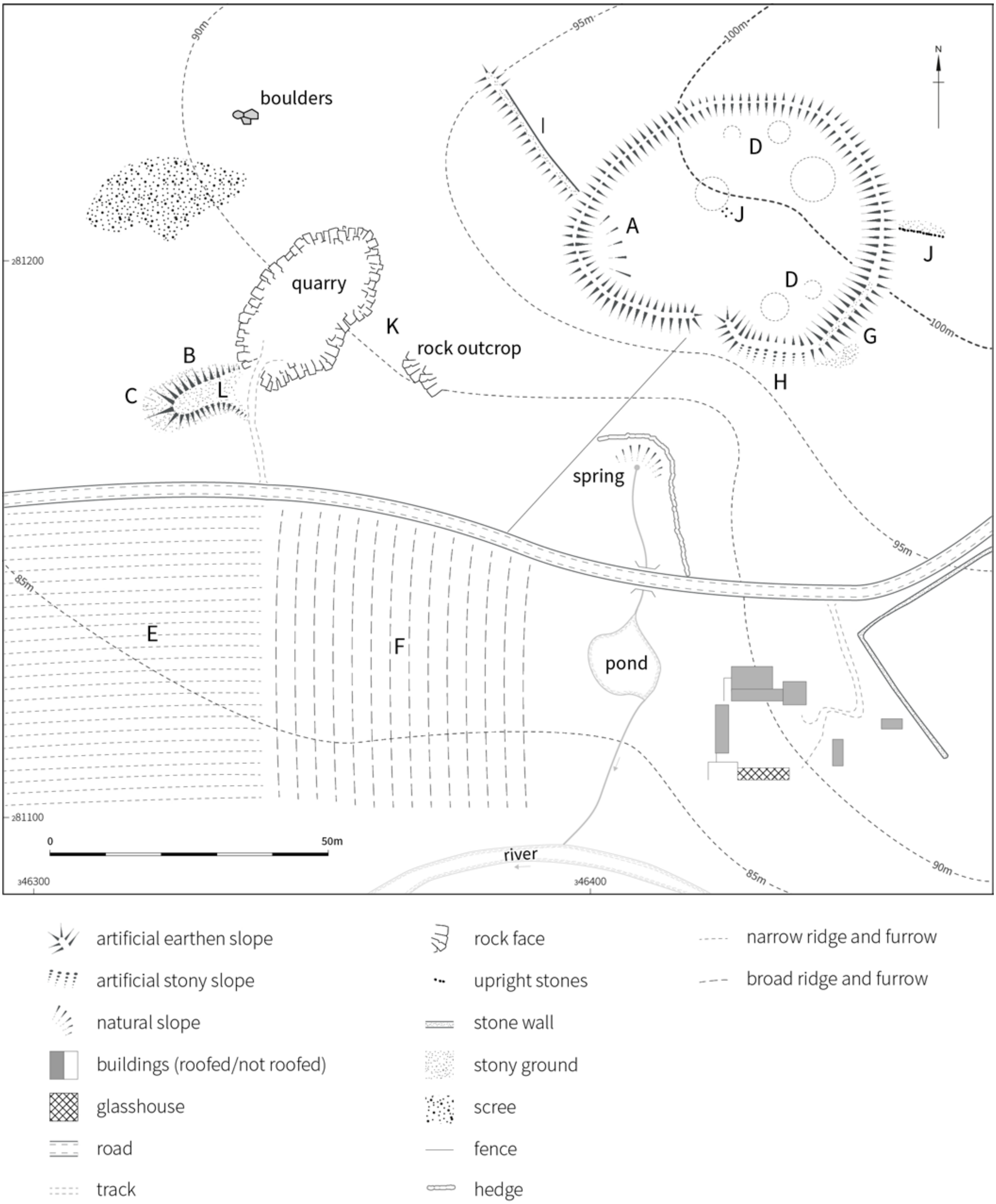


Figure 14: Conventions for large-scale drawings – greyscale

When printed at actual size on A4 this example is at a scale of 1:1,000

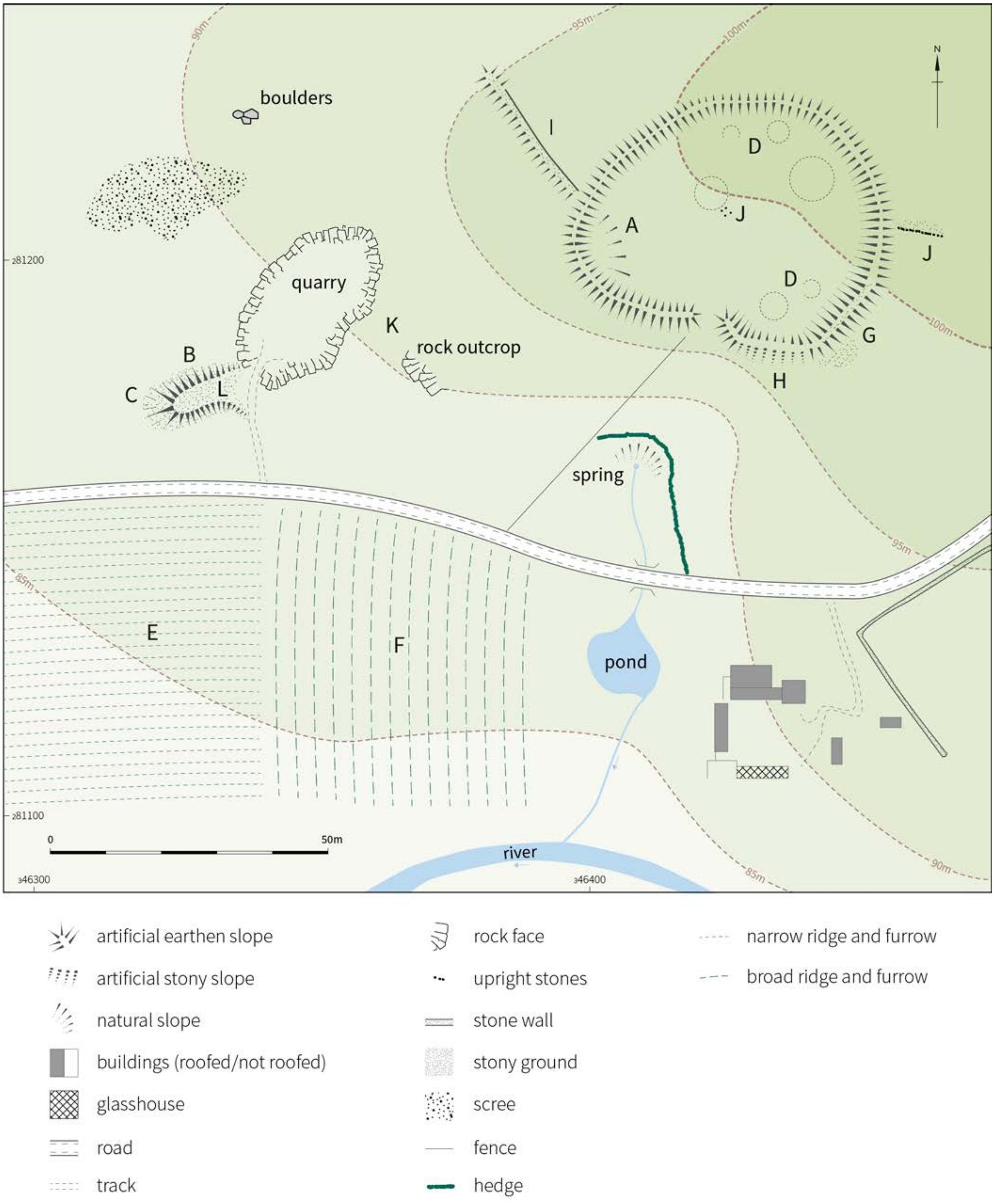


Figure 15: Conventions for large-scale drawings – colour

When using colour accepted conventions are that water is blue and the terrain greens/browns, getting darker as the data unit, in this case the elevation, increases. When printed at actual size on A4 this example is at a scale of 1:1,000 an accurate depiction it is sometimes necessary to add short lines in between the tails of hachures to maintain the uniform representation of a slope **(C)**. Where a feature is too narrow to be shown by hachures, such as the groove left by a timber roundhouse **(D)**, a single dashed line can be used.

Irrespective of age, it is not usual to depict the earthwork remains left by ploughing as hachured slopes. A line convention is generally used as an alternative to hachures, with the line following the furrow rather than the ridge. Narrow ridge-and-furrow ploughing (which typically results in straight, closely-spaced furrows) is shown by short dashes **(E)**, while long dashes are used to show broad ridge-and-furrow **(F)**.

Stipple can be used in among hachures to indicate earthworks with a high stone content, such as stony banks, or used without hachures where the feature is comparatively flat **(G)**. Where major slopes are formed entirely of stone, such as the collapsed stone rampart of a prehistoric hillfort, the hachures are drawn as strings of dots with larger dots used to define the head of the hachure **(H)**. Wall faces are indicated by a continuous solid line **(I)** or, if the scale allows, by showing the individual stones as filled shapes **(J)**. Standing stones and orthostats are also shown in this way.

Quarried faces are depicted in the same way as natural rock edges **(K)**. Annotation should be used to distinguish quarries from natural rock exposures when both occur on the same plan. Dumps of quarry spoil are shown by hachures with stippling to indicate stony material **(L)**.

11.3.2 Natural Features

Contours depicting the natural terrain should be unobtrusive in the drawing. This can be achieved by means of a thin, dashed or dotted line, with slightly thicker lines to emphasise major contours (for example every 25m where contours are at 5m intervals). To preserve clarity, contour lines should not cross other drawn features, such as earthworks. Contours must be labelled selectively so as to make the direction of the natural slope intelligible without cluttering the drawing and the unit of height, feet or metres, made clear.

Natural hachures can be used instead of contours to emphasise or precisely depict the shape of a particular slope. Natural hachures are drawn without heads and with broken, wavy tails to distinguish them from hachures representing artificial slopes.

A stream may be too narrow to show both sides, in which case it is shown as a single line representing the centre of the watercourse. Use an arrow to indicate the direction of flow for all types of watercourse. Wider stretches of water, such as a pond or a river, can be shown as a solid area in colour, or by a continuous outline with offset wavy broken lines, simulating water, in greyscale.

Outcrops are shown by a combination of long and short lines at right angles to the rock edge, with the length of the longest lines determined by the width of the exposed face, similar to large-scale Ordnance Survey mapping. Large rocks and boulders are shown in outline, but where they form part of a structure they can be filled in for emphasis. Spreads of rocks, such as scree, are shown by stippling with a varied dot size to suggest a mixture of rock and smaller stones.

11.3.3 The modern landscape

Standing buildings are shown shaded and outlined to show the party wall. Cross-hatching is used to show glass structures. Roofless buildings and free-standing walls are shown in outline. Where of archaeological significance buildings and structures can be emphasised with a darker shade or bolder colour.

Stone walls are shown by two parallel lines, while fences are shown by a single continuous line. Hedges are shown by a wavy line to give the impression of vegetation.

The sides of a metalled road are shown by a solid line, with a dashed line to indicate the edge of the metalling. The edges of an un-metalled track are shown by a dashed line.

11.4 Conventions for small-scale drawings (1:2,500 and 1:5,000)

11.4.1 Archaeological features

The capacity to show small detail is restricted on maps at smaller scales. Instead, greater use can be made of symbols, tone and (where possible) colour, giving the freedom to develop conventions specific to a particular map or project.

11.4.2 Natural features and the modern landscape

The conventions used are based on the large-scale mapping conventions described above, but simplified to accommodate the reduced scale. For example, stone walls should be shown by single, rather than double lines.

12 Case Studies

CS1: Recording rock art

The rock art recording pilot project, Northumberland and County Durham: a Level 1 survey focussed on demonstrating best practice for the creation of a national database.

The rock art pilot project was conducted as a methodological trial for a national project. It was supported by English Heritage in partnership with Northumberland and Durham County Councils and had four main aims:

- to record all rock art sites to a common standard
- to ensure that the locations of all the sites are recorded as accurately as hand-held navigation-grade GNSS sets and/or simple graphical survey techniques allow
- to report briefly on the present condition of known examples
- to develop a Web-based database that could form the basis of an accessible national archive.

Following recruitment and training of local volunteers at the end of 2004, more than 50 people worked in small teams to review the extensive records of rock art sites compiled by local enthusiasts. As a pilot project, it was important to develop a consistent, repeatable and user-friendly recording system that could be applied by anyone, with a minimum of training.

The methodology was refined in the course of the fieldwork, taking on board specialist advice and feedback from the volunteers themselves. To ensure that there was negligible impact on the rock surfaces and fragile motifs, the recording methods employed were non-invasive. For each engraved panel, the volunteers took high-resolution digital photographs and panoramas. They also completed a specially designed recording form, covering various categories of information, mostly in the form of tick lists, including the content of the motif, its immediate context, present condition and any identifiable threats. In addition, the volunteers experimented with low-cost photogrammetry to capture 3D imagery of the motifs. This innovative approach proved successful and extremely cost-effective: it could potentially replace traditional recording techniques such as tracing and rubbing, which can be inaccurate and harmful to the rock surface.

For the purposes of determining the Ordnance Survey National Grid Reference of each site, the volunteers primarily used navigation-grade GNSS satellite mapping sets. Rock art commonly survives in open moorland, which is often completely devoid of mapped features, making GNSS the ideal surveying tool for this purpose. The project particularly attracted walkers and other outdoor enthusiasts, so many of the volunteers proved to be already familiar with the operation of the GNSS sets, or to own one themselves. All the same, to ensure consistency, training was provided by English Heritage field surveyors. The volunteers, even those with long experience of using hand-held GNSS, were generally surprised to learn that their navigation-grade sets could not be relied upon for accuracy of better than 10m (see *Where on Earth Are We?*). It came as a real shock to hear that better accuracy could often be achieved using simple, old-fashioned taped survey, in conjunction with Ordnance Survey maps at 1:2,500 or 1:10,000 scale. Wherever convenient (or necessary, for example due to overhanging trees or rock outcrops obscuring the reception of the satellites), the volunteers were encouraged to qualify the GNSS readings they obtained by using 30m tapes to plot the sites graphically against a map background. Where rock art survives within enclosed fields, and especially where rocks bearing motifs have been incorporated into post-medieval field walls, it is neither difficult nor time-consuming to determine locations, sometimes with map accuracy as good as ±2m. The recording form required the volunteers to state which survey technique(s) they had used and to draw sketch plans if appropriate.

In addition to describing the topographic setting of each site, volunteers were also asked to record briefly their comments on any other features in the environs which they considered might be of relevance to the survival or condition of the rock art. For example, prehistoric field clearance cairns or post-medieval quarrying in the environs of a rock art panel might well shed a very different light on the distribution pattern of sites. However, there was no expectation that these written observations would approach the detailed, contextual study that a **Level 3** survey should constitute.

As a pilot, the project was expected to be a learning process for professionals and amateurs alike, and so it proved. The digital archive of recording forms and photographs resulting from the project will be invaluable in helping to inform conservation and management decisions about the sites that have been examined. It will improve access to the sites, both physically and through remote research. Above all, perhaps, the pilot has created a pool of enthusiastic and skilled volunteers, who have subsequently turned their attention to other fieldwork.

Figure CS1.1

Volunteers recording rock art at Gled Law in Northumberland.
© Tertia Barnett.

CS2: Miner-Farmer landscapes

Miner-Farmer Landscapes of the North Pennines Area of Outstanding Natural Beauty (AONB): a multi-disciplinary survey of an upland landscape

In 2008, English Heritage initiated a multi-disciplinary landscape project aimed at investigating the interwoven influences of medieval and post-medieval industry and agriculture on the development of the landscape of the North Pennines AONB. The project was undertaken in partnership with the AONB and other stakeholders, and the findings of the work continue to inform the conservation, protection and management of not just the historic environment, but also of the perceived 'natural' environment, much of which has been profoundly shaped by past human activity.

The project focussed on the historical manor of Alston Moor: a remote upland massif spanning the Cumbrian-Northumberland border and including a small part of County Durham. The survey and investigation work was undertaken by a number of specialists from English Heritage and beyond, and employed a range of non-intrusive survey techniques including:

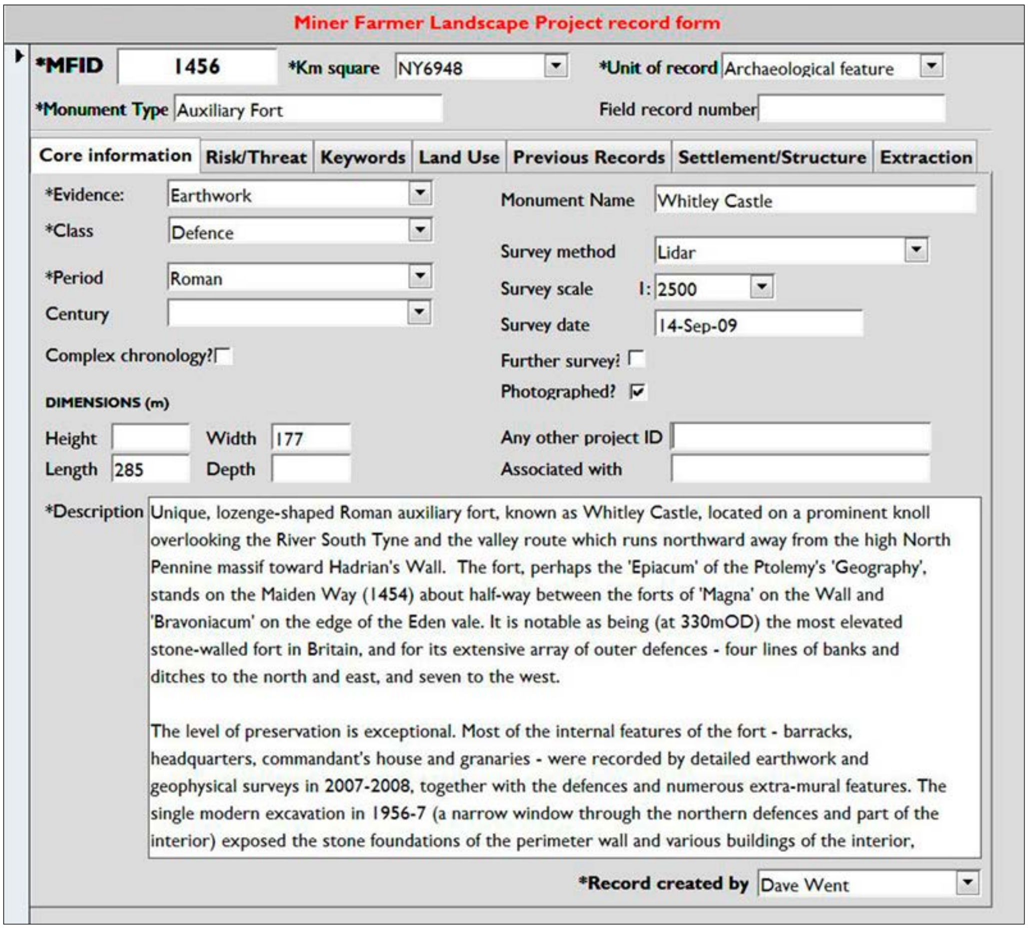
- Aerial mapping and analysis
- Ground-based rapid survey (**Level 2**) of a sample area
- Detailed analytical earthwork surveys (**Level 3**) of selected sites
- Geophysical surveys of selected sites
- Environmental research using remote sensing and soil chemistry
- Palaeo-environmental evidence review
- AONB-wide historic farmstead characterisation
- Historic Area Assessment of the built environment.
- Detailed measured surveys of selected historic buildings.

The most comprehensive element of the archaeological survey was the desk-based analysis of aerial photographs which covered the whole of the historic manor, 234 square kilometres, using techniques developed by English Heritage for the National Mapping Programme. Pre-existing aerial photographs were used for the whole area, but for a 96 kilometre square transect along the valleys of the rivers South Tyne and Nent true colour and infra-red orthophotography and 50cm lidar data was specially commissioned for the project from Infoterra Global Ltd in 2008-9. The aerial mapping produced 15 AutoCAD® drawing files, one for each partial or complete Ordnance Survey 1:10,000 quarter sheet, depicting all the archaeological features visible on remotely captured datasets. In all some 2,370 NHLE records were created or modified by this work. Nearly 68 per cent of these relate to some form of industrial activity, principally the legacy of the lead-mining from the later 18th and early 19th centuries. However, the mapping also revealed a great deal of prehistoric evidence new to the archaeological record, including some 25 enclosed or scooped hut settlements, numerous barrows and even a solitary henge.

Within the enhanced aerial transect a smaller core research area, centred on the confluence of the two rivers at Alston was selected for more detailed Level 2 archaeological survey. This had two principal aims: the development of a methodology for using digital aerial imagery as a tool for ground-based investigation, and the further enhancement of the archaeological record. The core area was divided into two fieldwork zones: 20 square kilometres allocated to English Heritage archaeologists, and 18 square kilometres to North Pennines Archaeology Ltd, who successfully tendered for the work. Based on early trials the initial approach was to load the digital aerial imagery (that is, hill-shaded surface and terrain lidar models and orthophotography) on portable mapping-grade GNSS receivers, along with base maps and other useful historical map layers. The GNSS equipment would then assist with the location of features on the ground and enable the archaeologist to map the feature either by overwriting the image with points, lines or polygons, or by directly surveying details seen only on the ground. Each entry would be accompanied by a free text description and other prescribed database fields for period, condition, etc.

In practice the limitations of the portable GNSS devices of the time (Trimble GeoXT) meant that lower-tech alternatives were often adopted, reserving the GNSS function for primary mapping of features not visible on the aerial imagery. A 1km square of hill-shaded lidar, printed on waterproof film at 1:2,500 scale was easily carried and annotated, and a waterproof notebook was often easier to use to than a small touch-screen, especially in bright sunshine or driving rain. Irrespective of how it was captured, the field data was subsequently loaded into the project GIS, with each unique feature number relating to a multi-field database entry.

Work continues to bring all the various strands of the project together and compare the effectiveness of the different methods employed. At face value c 6,500 records created by ground survey over 38 square kilometres shows a marked improvement in data capture compared to 2,370 records arising from the aerial mapping of 234 square kilometres; but there are factors in the ‘scale and grain’ of the two landscape surveys to consider, as well as issues about the larger


Miner Farmer Landscape Project record form

*MFID 1456 *Km square NY6948 *Unit of record Archaeological feature

*Monument Type Auxiliary Fort Field record number

Core information | Risk/Threat | Keywords | Land Use | Previous Records | Settlement/Structure | Extraction

*Evidence: Earthwork
*Class Defence
*Period Roman
Century
Complex chronology?
DIMENSIONS (m)
Height Width 177
Length 285 Depth

Monument Name Whitley Castle
Survey method Lidar
Survey scale 1: 2500
Survey date 14-Sep-09
Further survey?
Photographed?
Any other project ID
Associated with

*Description Unique, lozenge-shaped Roman auxiliary fort, known as Whitley Castle, located on a prominent knoll overlooking the River South Tyne and the valley route which runs northward away from the high North Pennine massif toward Hadrian's Wall. The fort, perhaps the 'Epiacum' of the Ptolemy's 'Geography', stands on the Maiden Way (1454) about half-way between the forts of 'Magna' on the Wall and 'Bravoniacum' on the edge of the Eden vale. It is notable as being (at 330mOD) the most elevated stone-walled fort in Britain, and for its extensive array of outer defences - four lines of banks and ditches to the north and east, and seven to the west.

The level of preservation is exceptional. Most of the internal features of the fort - barracks, headquarters, commandant's house and granaries - were recorded by detailed earthwork and geophysical surveys in 2007-2008, together with the defences and numerous extra-mural features. The single modern excavation in 1956-7 (a narrow window through the northern defences and part of the interior) exposed the stone foundations of the perimeter wall and various buildings of the interior,

*Record created by Dave Went

Figure CS2.1

Initial page for the Whitley Castle Roman fort entry in the project database. Subsequent pages/fields cover a wide range of information including date, aspect, condition, forms of erosion, access, recommendations for further study, survey metadata, etc. The database is linked to a unique feature number attached to the survey data.

investment of time necessary to undertake ground survey work. Aerial mapping is the most efficient way to record archaeology over a large open landscape, but more detailed ground-based work will always add a greater depth of understanding when applied to a sample area or an individual site.

CS3: The Pleasance, Kenilworth,

A heritage protection led Level 3 analytical earthwork survey

In 2012, English Heritage Assessment Team was asked by English Heritage National Planning team to undertake an earthwork survey of The Pleasance, a substantial earthwork enclosure which formed part of the medieval pleasure grounds that once surrounded Kenilworth Castle, Warwickshire. The request was in response to concerns over damage to the Scheduled Monument by badgers, and was intended to help improve on-going management. Analytical earthwork survey was considered the best means of establishing a detailed record of the site and improving understanding of its form and function.

The Pleasance lies a kilometre to the west of Kenilworth Castle, in a location that was formerly on the edge of the castle's Great Mere (an artificial lake created by damming the valley west of the castle). It was built by Henry V in the early 15th century and is widely accepted to have comprised a detached garden and banqueting house. Previous research has largely focussed on the documentary history of the site, with contemporary chronicles and household accounts providing evidence for a substantial medieval building, at least two towers and extensive gardens.

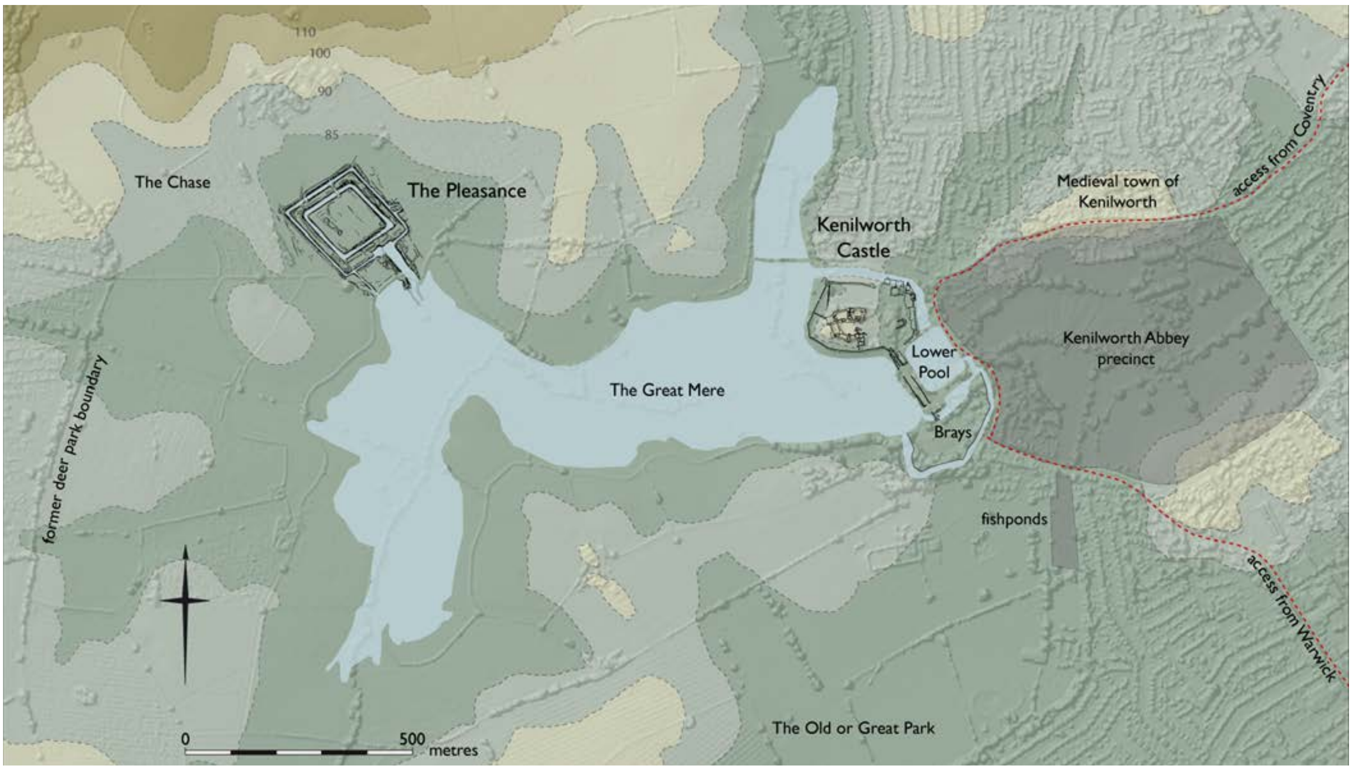


Figure CS3.1

Reconstruction of the medieval landscape surrounding The Pleasance. A hillshade image of the unfiltered DTM along with contour data was transferred from the GIS to a graphics programme to produce the finished illustration.

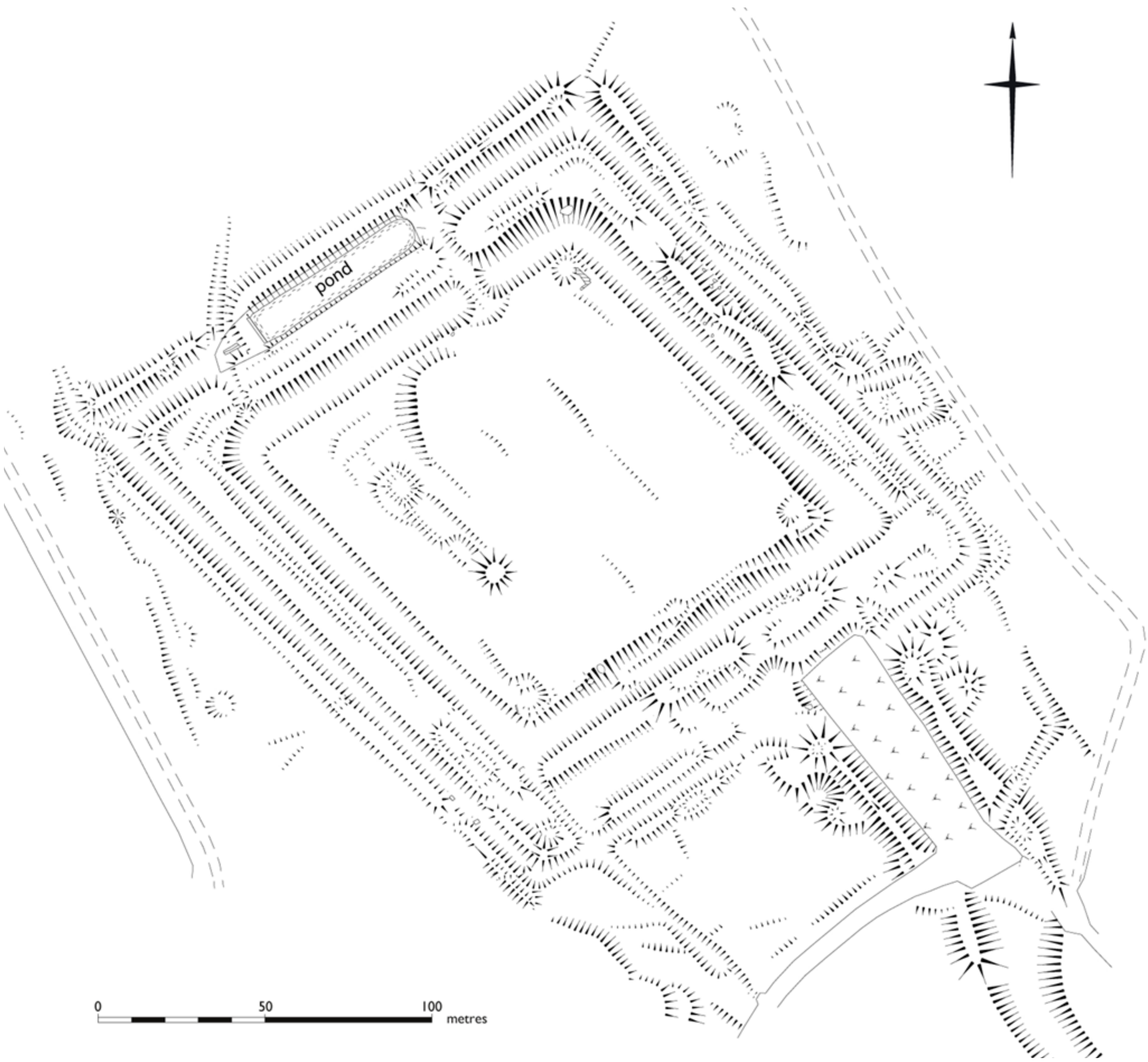


Figure CS3.2

Earthwork survey of The Pleasance: 1:1,000 scale (reduced). The survey was drawn digitally in AutoCAD® then transferred to a graphics programme to create the finished illustration for publication.

Despite the survival of well-preserved earthwork remains the monument as a whole had not previously been examined in detail, other than by geophysical survey. The earthwork survey was undertaken using differential survey-grade GNSS equipment and 1:1,000 scale was selected for the work, enabling the accurate plotting of even the most subtle of earthwork features. As mobile phone reception in the area was very poor real-time connections to OS Net for differential corrections could not be relied upon, so an on-site base station was established. The survey was transformed to fit accurately on to the OS grid using post-processing software in the office. The base station was positioned to ensure good radio links across the entire site, and a marker was embedded in the ground so the receiver could be set up in exactly the same place for the duration of the survey.

A team of two surveyors worked independently with two GNSS rover receivers. These were used to plot the tops and bottoms of individual earthwork slopes, using red lines for tops and green for bottoms. The emerging plan viewed on the screen of the data logger of each receiver ensured that no part of the site was missed and that each earthwork feature was mapped accurately. Other codes were used to survey 'hard' details such as tracks, fences and masonry remains, and to set out an irregular grid of control points. The post-processed survey data was subsequently transferred into AutoCAD® software, edited and a plan generated that was taken out into the field and drawn up by hand on polyester film. Subtle detail that had been missed was added by tape-and-offset survey using the GNSS control points as a framework. The hand-drawn plan was later digitised to produce a hachured plan of the site in AutoCAD®, then transferred to Adobe Illustrator® to create the finished illustration for the written report.

A key aspect of interpretation was understanding the relationship between The Pleasance, Kenilworth Castle and the wider landscape. The digital information from the new survey work was therefore combined with historic and modern mapping, NRHE data, topographic information, and other archaeological survey data in a GIS environment to enhance the value of the survey. A DTM was generated using 1m resolution lidar data downloaded from Next Perspectives®, and the extent of the former Great Mere was estimated by combining height data from the model with information from the new earthwork survey. The degree to which the site could be seen from different locations within the castle was estimated by performing viewshed analysis in ArcGIS® software and through on-the-ground investigations. A hillshade image of the unfiltered DTM was also created and transferred to a graphics programme to produce an illustration showing the site and its wider landscape setting. The results of this work formed an internal report for the National Planning team and were published as a journal article (Jamieson & Lane 2015); the survey plan was deposited in the Historic England Archive.

CS4: Tintagel Island

A Level 3 survey of a landscape managed by the English Heritage Trust and the National Trust.

In 1984 a fire severely damaged the surface at Tintagel and exposed previously unknown archaeological remains across a large area of the Island. The opportunity was taken by the Royal Commission on the Historic Monuments England to survey the whole Island at 1:1,000 using the best technology then available, which in this case was a manual theodolite and tapes. So accurate and complete was this survey that 30 years later, in an age when much more sophisticated electronic survey equipment is available, very little work was required to update the survey for current purposes.

Tintagel has a remarkable settlement of the 5th-7th centuries, visible as a spread of small sub-rectangular building platforms across the Island; a 13th-century castle; and post-medieval military and industrial remains. It is also a place imbued with legend.

In 2014 the English Heritage Trust started an ambitious programme of improvements to the visitor experience at this iconic Cornish coastal site, including new archaeological research. At an early stage in this process they asked Historic England to re-visit and update the 1984 survey. A few days' work in the field was enough to convince that the original survey needed very little revision; all that was required was the addition of a very small number of features not observed in 1984 (probably accounted for by local changes in the vegetation cover), a small structure built since the 1980s, and areas of recent footpath erosion. These additions were rapidly made with a hand-held mapping-grade GNSS receiver, with a stated accuracy of +/- 10cm. An additional outcome of this exercise was a check on the accuracy of the original survey, which was deemed to be well within acceptable tolerances.

The new investigation, informed by discussion with English Heritage Trusts' Property Historian, led to considerable re-interpretations of several features. Ditches previously accepted as remains

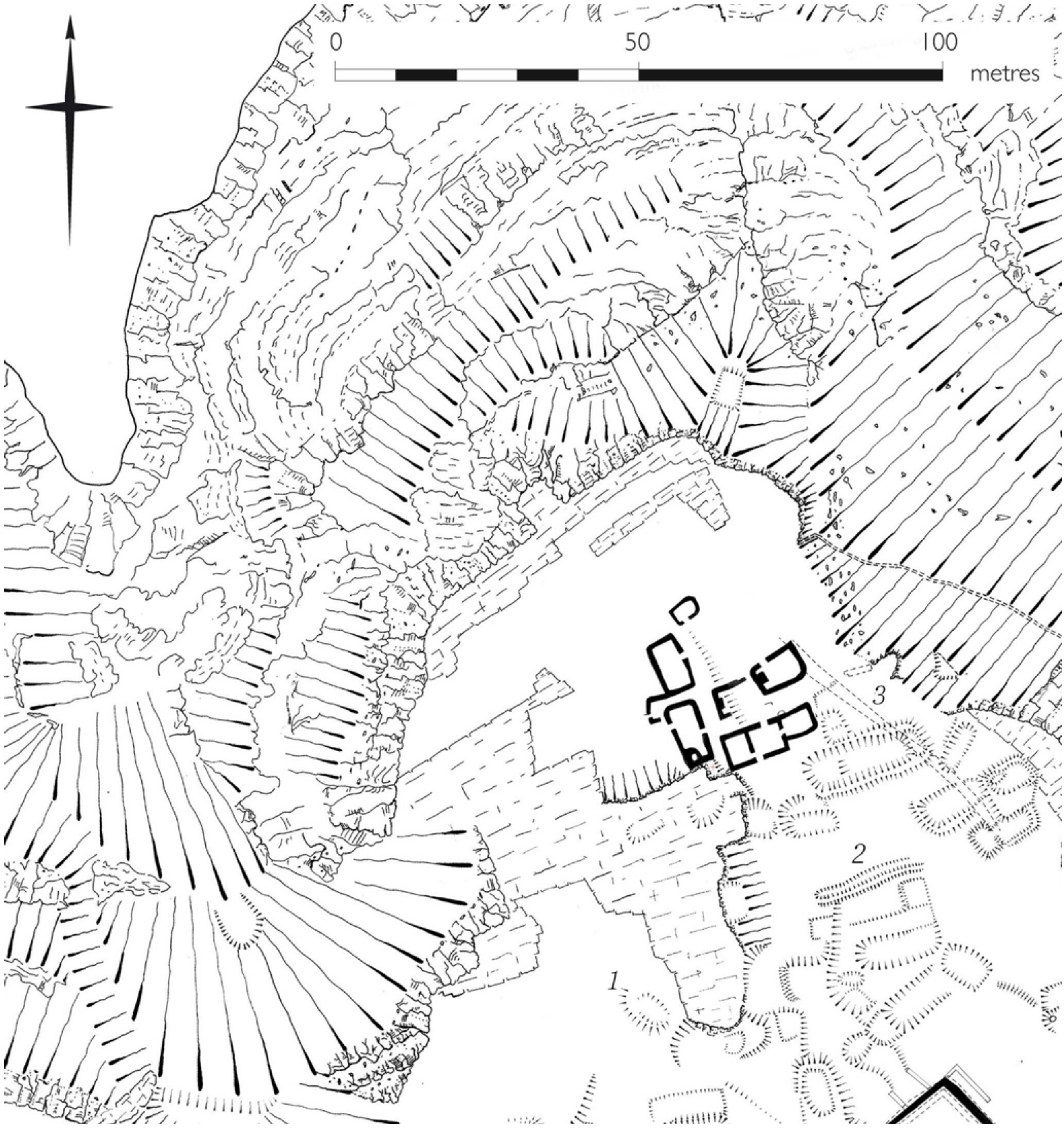


Figure CS 4.1

Extract of the resulting survey plan:
1) a newly recorded building
2) one of the ditches re-interpreted as a miners' prospecting trench
3) recent visitor erosion mapped as broken lines

of cultivation or garden plots were now seen to be prospecting trenches, adding to understanding of Tintagel's considerable history of mineral extraction. The enigmatic chapel, garden and 'tunnel' were linked for the first time as part of a coherent scheme of 13th-century landscape design, reflecting a concern with the legend of Tristran and Iseult (Bowden and Jamieson 2016) – previously this link had only been made for the garden. This has implications for our knowledge of Richard, Earl of Cornwall and his household; it also forms another significant example in the newly recognised category of designed medieval landscapes, which is transforming views of the sophistication of an elite society often seen as brutal and ignorant. Tintagel is a relatively early example of this phenomenon, others – such as Dunstanburgh and Bodiam (Oswald *et al*; Everson 1996) – belonging to the 14th century.

Another unexpected outcome of the new survey was the discovery of previously unrecognised remains of a 16th-century harbour in Tintagel Haven and elucidation of the complex network of tracks and paths linking Tintagel valley with the shore (Herring 2016). Elements of this maritime aspect of Tintagel had been seen before but the totality had neither been appreciated nor recorded. Such re-interpretations emphasise that, regardless of the technical functionality of electronic survey equipment, the entirely human skills of observation and analysis remain fundamental to good archaeological landscape investigation.

Figure CS 4.2

Hand-held GNSS receivers can simplify survey in even the most challenging situations; recording the remains of the 16th-century quay in Tintagel Haven.

CS5: The Mendip Hills Project

A Level 3 survey of a deserted farmstead.

In 2006, English Heritage embarked on a three year landscape-based research project examining the archaeology and built heritage of the Mendip Hills Area of Outstanding Natural Beauty (AONB), a gently undulating Carboniferous Limestone plateau located to the south of Bristol. The work was carried out in partnership with the Mendip Hills AONB service, local authority heritage teams and local history groups. The key driver for the work came from the recognition that the sustainable management and conservation of the historic landscape could only be achieved through a sound understanding of the historic resource.

From the outset an inter-disciplinary approach was adopted, with the entire area subjected to a desk-based assessment using aerial survey techniques as part of the National Mapping Programme (NMP). A vital component of the desk-based work was also to bring together existing information on the historic landscape, using historic documents and maps, antiquarian excavations, recent archaeological research, and data from the NRHE and relevant HERs. An extensive programme of new fieldwork was also undertaken, including the detailed survey and investigation of a wide range of archaeological sites and monuments. Alongside this, a programme of architectural investigation and recording examined a wide range of building types, ranging from farmhouses to health institutions, was undertaken.

Although there was architectural evidence for numerous farmhouses dating from the 16th and 17th centuries remaining in the survey area, it was recognised that few upstanding farm buildings of the period survived as they had been altered significantly or entirely replaced as a consequence of agricultural change. The clearest evidence for the form and layout of 16th- and 17th-century farmsteads, therefore, came from holdings which had been completely abandoned prior to agricultural improvement. A number of abandoned farmsteads were identified during the course of the project, including a site named Ellick, near Burrington Combe. Initial reconnaissance indicated that the well-defined earthworks represented the remains of at least four buildings with attached yards and closes, and highlighted the site as one of the best preserved of its type in the region. It was clear that analytical survey of Ellick would significantly increase our understanding of pre-improvement farmsteads on Mendip.

The survey was undertaken using differential survey-grade GNSS equipment, at 1: 500 scale, appropriate for the complexity of the earthworks. An on-site base station was established, fixed relative to OS Net using a mobile phone service. Once the base station point was accurately recorded, the rover data linked to the base station was then precisely fixed on to the OS National Grid. A team of two surveyors worked with two rover receivers plotting the individual earthwork slopes and setting out a network of control points using the feature code library. The survey data was then transferred into AutoCAD® software and the plot drawn up by hand in the field on polyester film. The finished survey was drawn using traditional pen and ink techniques, then digitised and transferred to Adobe Illustrator® to create the illustration for publication.

By combining analysis of the earthwork remains with historic photographs and the architectural evidence from surviving structures, the form and layout of the farmstead could be interpreted with some accuracy. The survey revealed a rather complex arrangement of buildings, with the barn and dwelling house positioned on opposing sides of a central yard, a layout common to the area. A small structure was attached to the north-side of the barn, with an outhouse to the west forming an L-shaped range which faced onto a second yard. To the south of the farmhouse was a further outhouse, possibly a wainhouse as the single-bay building appears to have been open on one side. This information was subsequently used to produce a reconstruction drawing of how the farmstead might have looked at the beginning of the 17th century. The results of this work, and of the wider Mendip project, have been

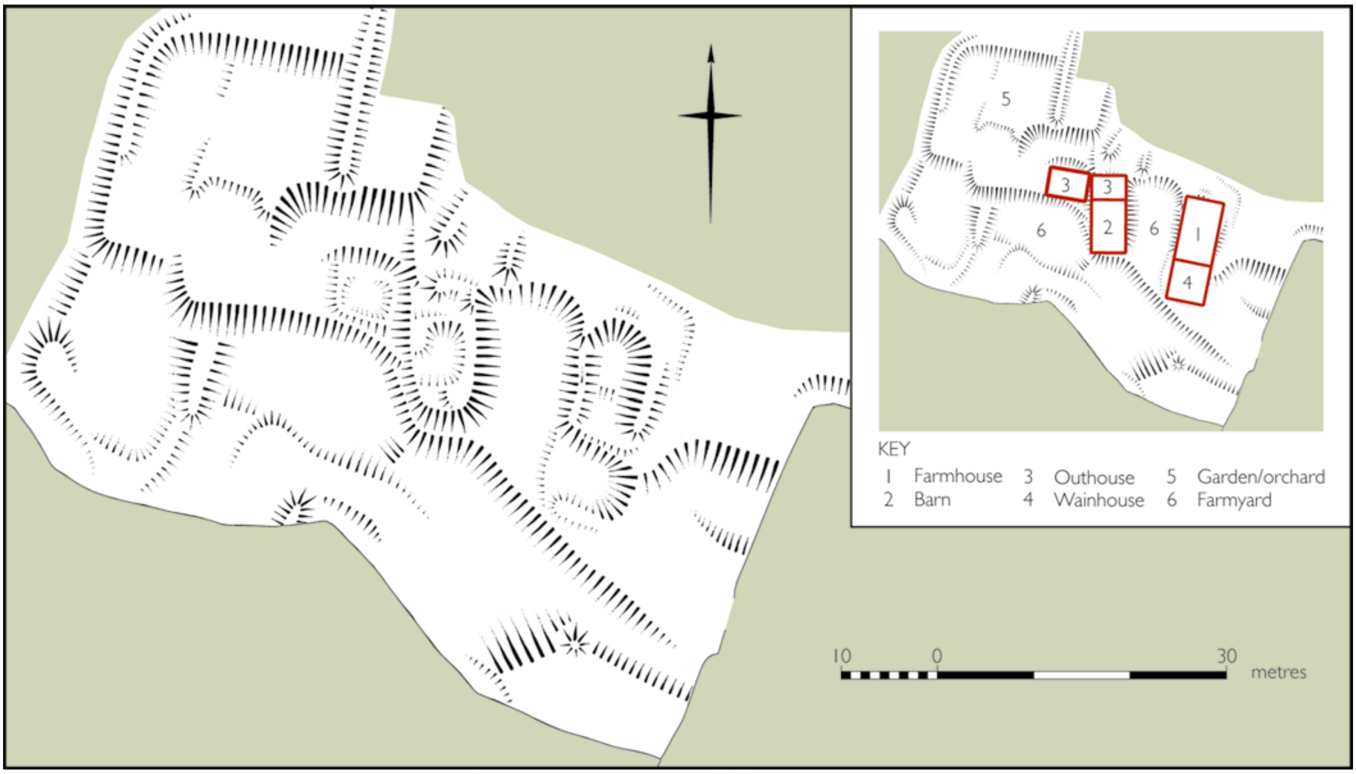


Figure CS5.1 (top)
Earthwork survey of Ellick, near Blagdon. The survey was drawn using traditional pen and ink techniques then transferred to a graphics package to create the finished illustration for publication.

Figure CS5.2 (bottom)
Reconstruction drawing showing how the farmstead at Ellick may have looked around 1600. This illustration was produced by Allan Adams using graphite pencil.

published as a series of Research Reports, and by Historic England as an academic but accessible monograph (Jamieson 2015).

CS6: The Cumbrian Gunpowder project

Level 3 surveys of industrial remains.

The Cumbrian Gunpowder Industry Project was undertaken by English Heritage as a follow up to the Monuments Protection Programme, which studied the gunpowder industry nationally. Several of the Cumbrian works were recommended for scheduling but required survey in order to understand the remains so that essential information for site management and conservation could be provided. Previous researchers have concentrated on the documentary evidence relating to these sites and there has been little formal recording and analysis of the surviving physical remains. In order to rectify this situation, this project considered all seven of the Cumbrian sites, irrespective of their current designation, in order to enhance overall understanding of this once important regional industry and to contribute to knowledge about the gunpowder industry at a national level.

The remains of this industry survive as a combination of extant buildings and earthworks. The former tend to be the buildings connected with the storage and processing of raw materials, and houses for the site managers, together with ancillary buildings such as stables, saw mills and cooperages. The actual buildings connected with gunpowder manufacture had by law to be demolished or burnt down when a works closed, so that there was no danger of any residual gunpowder adhering to their fabric accidentally igniting and causing explosions. Low platforms and ruined walls sometimes mark the sites of these deliberately destroyed buildings. Other archaeological remains include weirs, leats, waterwheel pits, blast walls/ banks together with the track beds of the former tramways that served the works.

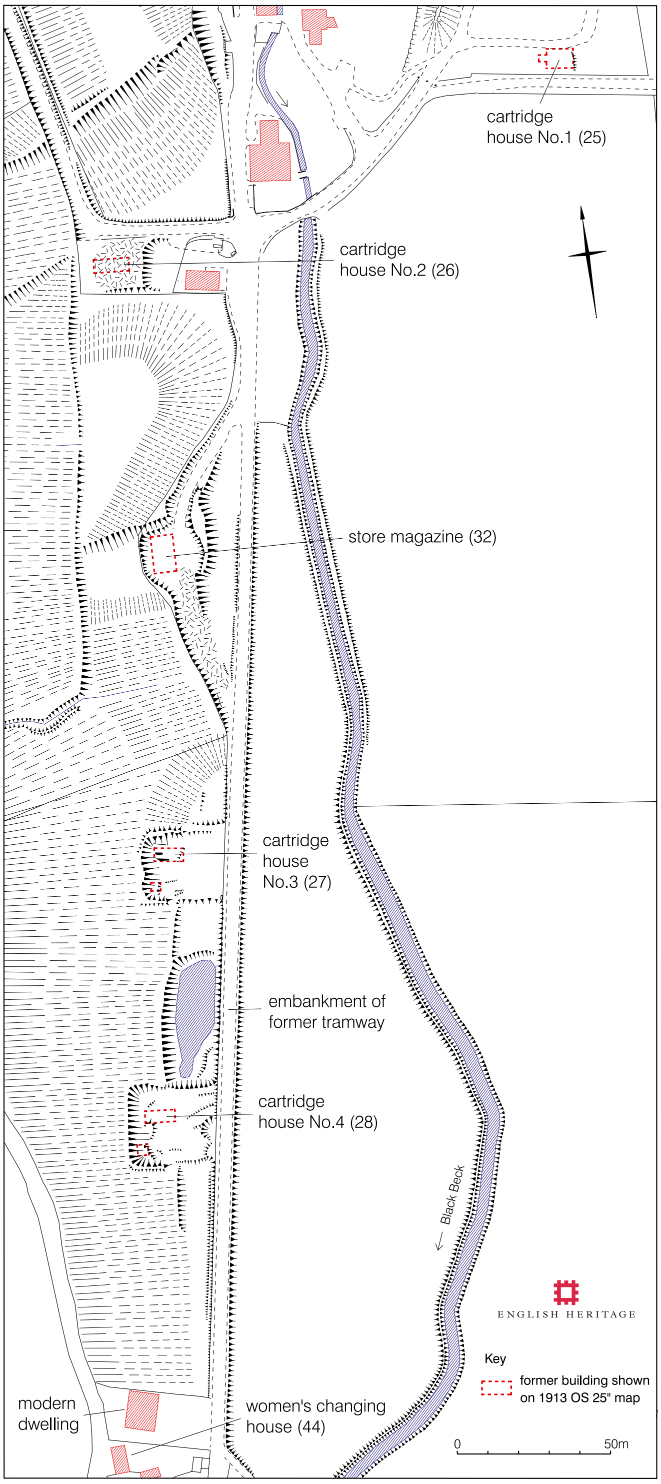


Figure CS6.1

Reduced extract from the 1:1,000 scale survey plan of the Blackbeck Gunpowder Works showing the earthwork remains of the store magazine and blasting cartridge house sites. The outlines of the former buildings that were depicted on the 1913 Ordnance Survey 1:2,500 map have been superimposed. The entire drawing (including hachures) was produced using AutoCAD ® software.

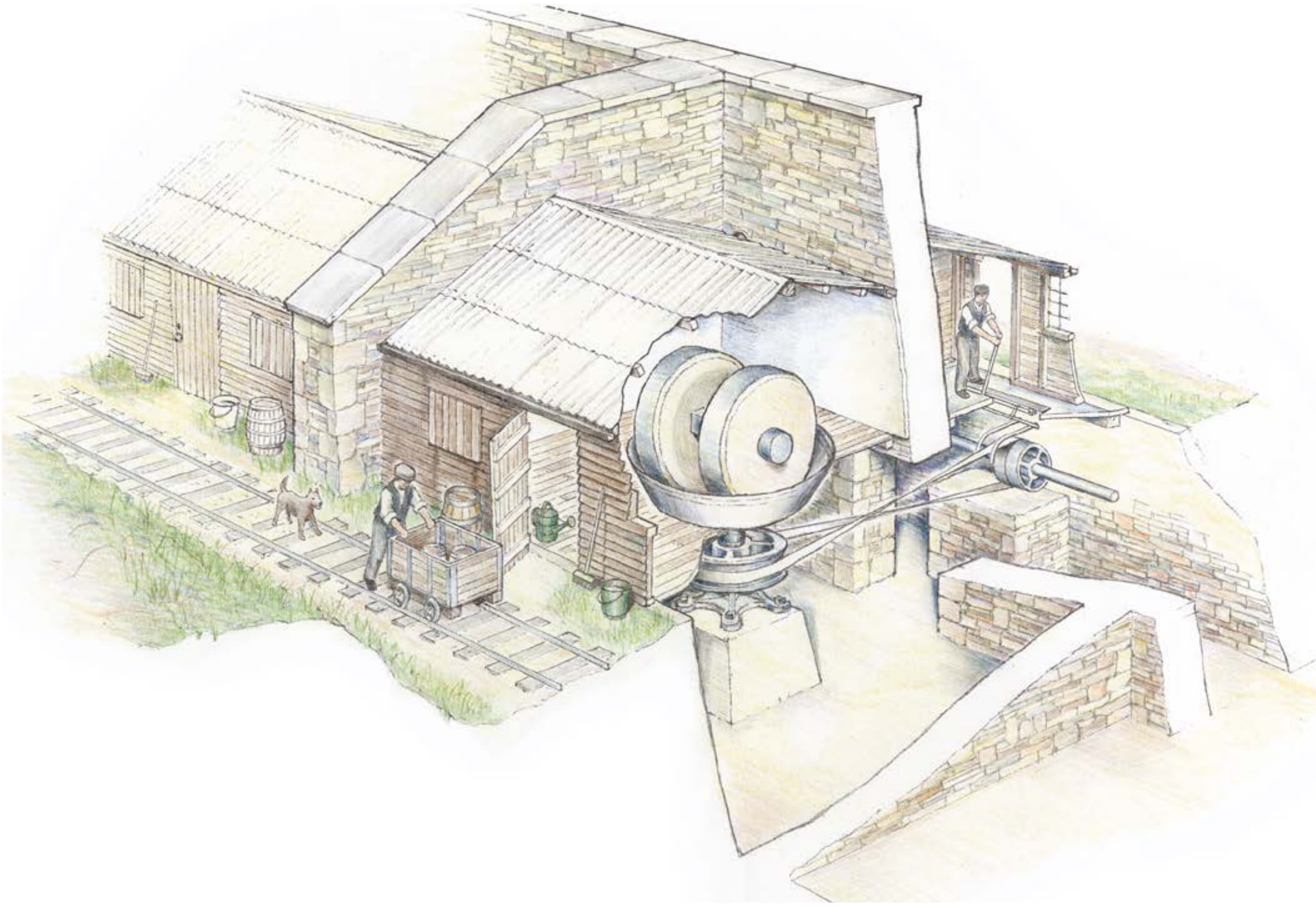


Figure CS6.2

Hand-drawn reconstruction of the incorporating mills at the Blackbeck Gunpowder Works. Reconstruction diagrams such as this can help clarify how the surviving ground remains, which are often incomplete, relate to the original industrial process. This drawing was produced by Tony Berry using coloured pencils.

The sites are often complex and occupy a considerable area because individual process buildings were widely separated, to reduce the likelihood of an accidental explosion at one building spreading to others. The majority of the sites are in woodland; survey has to be undertaken chiefly in the winter months and it is impossible to use GNSS, so survey was carried out using a TST to create a series of interlinked traverses. Much of the archaeological detail, together with buildings and walls, was recorded electronically at this stage but temporary points were also established for the recording of those parts that are either difficult to reach or where the remains require more time to understand. Once the electronically captured data was processed and a plan generated, these temporary points were used as the framework for tape and offset survey plotted directly on to the plan by hand. The hand-drawn material was later digitised to produce a digital plan of the whole site at a scale of 1:1,000. Where insufficient survives to warrant large scale survey, the Ordnance Survey I:2,500 map was used as a base on which any surviving remains were either annotated or added. The buildings were measured with hand tapes, but where parts are either inaccessible or dangerous, a reflectorless TST was used.

Documentary research also formed a vital component of the methodology. Gunpowder processing buildings were subject to government legislation, changes of function, and to explosions that resulted in rebuilding, sometimes at a new location. The only way to understand how a site evolved and what the surviving remains actually represent is through the study of a variety of sources including early Ordnance Survey maps, historic site plans, the reports of the Explosives Inspectorate, local newspaper accounts of gunpowder explosions and inquests, and the manufacturing method books. The latter were produced for each site by the Imperial Chemical Industries (ICI) who owned the Cumbrian gunpowder works in their final years. Early photographs, often in private collections, of the sites when still in operation and verbal testimonies from some of the last surviving gunpowder workers also contribute an important element to the story.

A detailed report for each site has been produced containing, where appropriate, a copy of the survey plan at a scale of 1:1,000 (for example Dunn *et al* 2004). Copies of the electronic survey plans and the analytical reports were deposited in the Historic England Archive, Swindon, on completion.

CS7: Spadeadam Rocket Establishment, Cumbria

A Level 3 survey of a technological landscape.

Spadeadam Waste lies between the border towns of Brampton, Cumbria and Haltwhistle, Northumberland. In the late 1950s this high desolate moorland was chosen as the site for the testing of Britain's indigenous, intermediate range ballistic missile known as 'Blue Streak'. The construction of the rocket establishment transformed the moorland into a complex technological landscape, inter-connected by roads, electric transmission lines, water pipes and more specialised linkages, such as high pressure nitrogen pipe lines, and command and control cables. From 1976 this 3,000hectare area was used by the RAF as an electronic warfare tactics range.

Figure CS7.1
Greymare Missile Test Area, low level oblique air photographs enable the relationships between the natural landscape and manmade features to be quickly appreciated.

As part of continuing improvements to the management of its estate the Ministry of Defence, through the RAF and Defence Estates, produced Integrated Rural Management Plans (IRMPs). The primary aim of the investigation was to identify and record the remains of the rocket establishment to aid their future management.

The starting point for the investigation was a topographic survey of the main rocket test areas. These were open and ideally suited to recording using differential survey-grade GNSS equipment. The use of GNSS equipment allowed widely-spaced locations to be easily positioned on the same grid and produced an electronic data set that could be plotted at a variety of scales.

Some original site drawings did survive but their coverage was patchy and for some areas non-existent. They also often represented the engineers' intentions (rather than as-built plans) and in some locations omitted modifications made during construction. They also did not show many significant features associated with the site's construction, including a temporary navvy camp, building workers' huts and the foundations of a concrete mixing plant. Also absent from the original drawings were features associated with the site's use in the 1960s by the European Launcher Development Organisation (ELDO) and later by the RAF.

The new survey provided a point in time record that could be used to produce a detailed analysis of the development sequence of each area, but also provided the estate's managers with precise identifications of all the Rocket Establishment's buildings and ancillary features.

Architectural drawings were also prepared for some of the key installations, including the main rocket stands and the heavily protected block houses from where the tests were controlled and monitored. These were recorded by a combination of a TST, hand measuring and booking techniques. The resulting drawings were prepared using AutoCAD® software. In addition to the drawn record an inventory was made of all the Rocket Establishment's buildings and key features, using a standardised form and cross-referenced by number to the drawings. Information on the sheets included grid references, and notes of documentary sources confirming construction dates and former functions. In nearly all instances a photograph was attached to the forms.

The forms provide a record of the different features and are an important source of data for the management of the range's historic

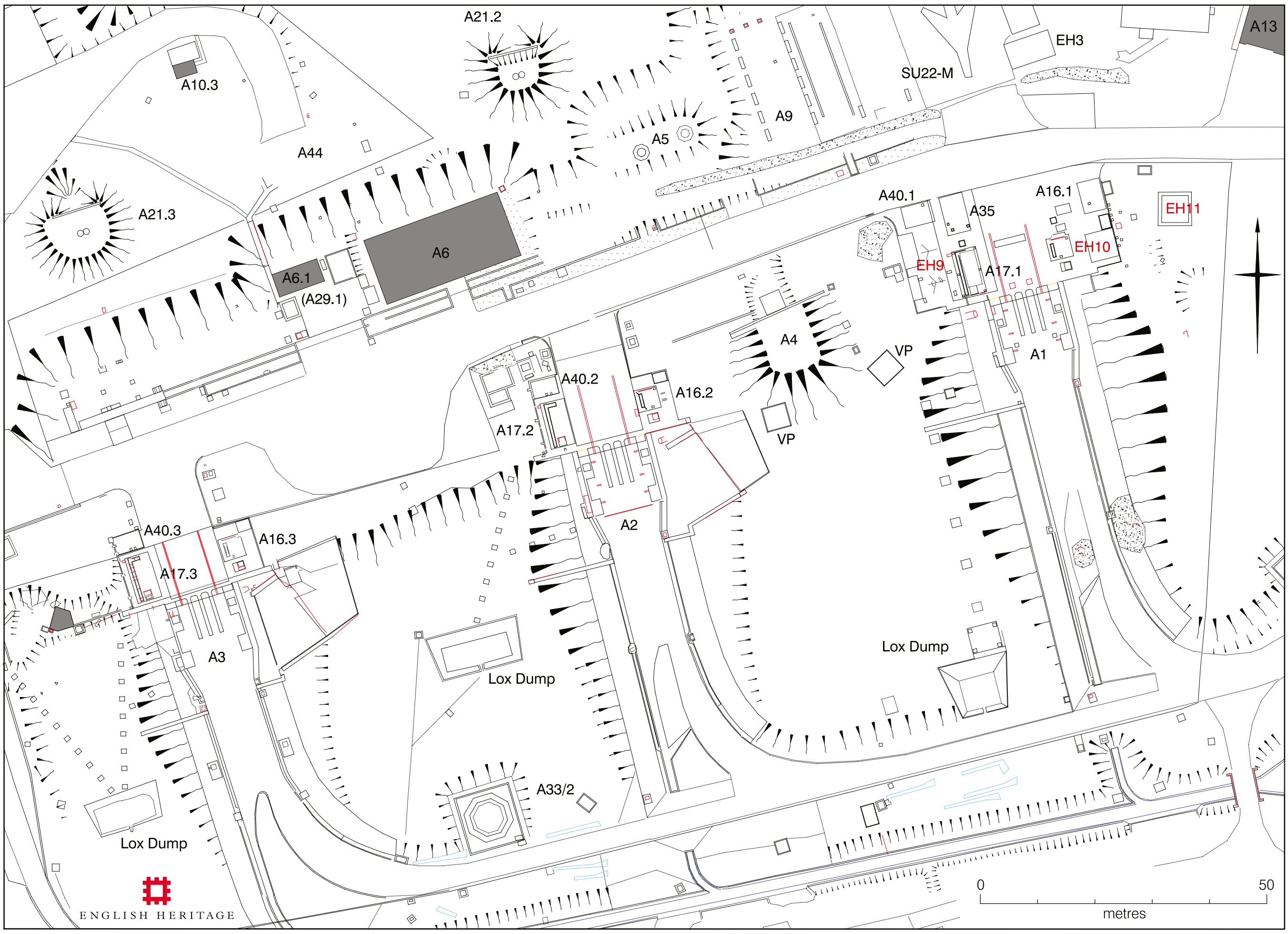


Figure CS7.2

An extract of the survey of the Priorlancy Engine Test Area. The numbers on the diagram are cross referenced to individual recording forms. The drawing was produced using AutoCAD® software.

assets. They allow the significance of different structures to be quickly appreciated, so that, for example, training activities may be modified to avoid damage.

Even on a recent site as comparatively well-documented as Spadeadam, aspects of the site's history remained poorly understood and the archaeological remains of those activities are the only substantial confirmation of their existence. One persistent rumour was that work had started on an experimental underground launcher facility, or silo, for the Blue Streak missile.

Contemporary air photographs revealed disturbed ground in an area where it was suggested that the silo excavation might lie. Earthworks in the area revealed a roughly circular hole with traces of a concrete lining around its lip and a by-pass channel with sluices to divert water around the excavations (Cocroft 2006).

An important aspect of this project was the collaboration with an oral history project run by Tullie House Art Gallery and Museum, Carlisle, and the video installation artist Louise K Wilson. The oral history project had many benefits: the stories told by the veterans were a significant contribution to the social history of the establishment and helped to clarify aspects of the site's operation and history. Another valuable gain was the unearthing of many contemporary photographs. Louise's film was important in exploring the character of the range and what it meant to different groups of people.

The archaeological survey was presented as an illustrated, hardcopy report setting the site in its historical context and describing its development. This was supported by drawings and a separate volume containing the forms with the descriptions of the individual features. It was also converted to pdf format for supply on compact disc. The work of the oral history project was presented by an exhibition of images and artefacts, supported by an archive of recordings, photographs and other documents. Louise K Wilson's film was shown at exhibition and conferences elsewhere. Less tangible is the increased local awareness of the work that had gone at Spadeadam. Now technology not only offers the possibilities of presenting such projects on a single CD or USB stick, but also offers a means for the electronic interactive exploration of an historic environment and what it means to different groups of people.

This project illustrates how an archaeological survey of a recent defence site may act as a catalyst for other forms of research and activities, and through which a local community can appreciate the significance of historic landscapes where physical access may be barred. The survey archive has been deposited with the Historic England Archive in Swindon.

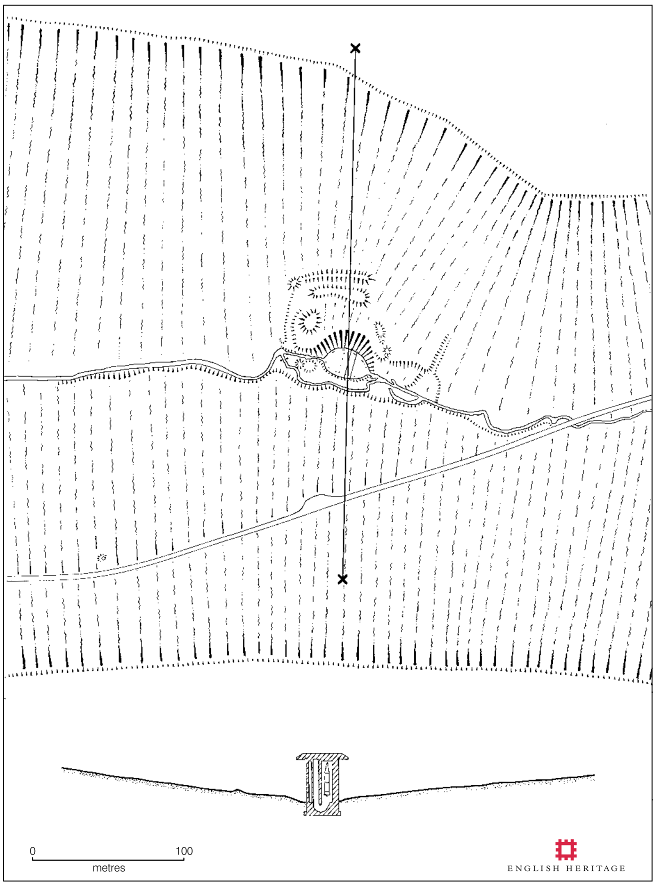


Figure CS7.3

Survey of the earthworks associated with the abandoned 1959 underground launching facility project. This drawing was produced using traditional pen and ink techniques.

13 References

Ainsworth, S, Bowden, M, McOmish, D and Pearson, T 2007 *Understanding the Archaeology of Landscapes: A Guide to Good Recording Practice*. Swindon: English Heritage.

Bedford, J and Went, D 2015 'Using drones for field survey' *Historic England Research* **1**, 20-4 HistoricEngland.org.uk/images-books/publications/historic-england-research1/)

Bowden, M (ed) 1999 *Unravelling the Landscape: An Inquisitive Approach to Archaeology*. Stroud: Royal Commission on the Historical Monuments of England (RCHME)/Tempus.

Bowden, M 2002 *With Alidade and Tape: Graphical and Plane Table Survey of Archaeological Earthworks*. Swindon: English Heritage. HistoricEngland.org.uk/images-books/publications/with-alidade-and-tape/)

Bowden, M and Jamieson, E 2016 *Tintagel Castle and Island, Cornwall: survey enhancement project* Swindon: Historic England. Research Report Series RRS 33-2016 See research.historicengland.org.uk

CIfA 2014 *Standard and guidance for the creation, compilation, transfer and deposition of archaeological archives.* Reading: CIfA. www.archaeologists.net/sites/default/files/CIFAS&GArchives_2.pdf

Cocroft, W D 2006 'The Spadeadam Blue Streak Underground Launcher Facility U1' *Prospero: the Journal of British Rocketry and Nuclear History* **3**, 7-14

Cole, S 2017 *Photographing Historic Buildings*. Swindon: Historic England. HistoricEngland.org.uk/images-books/publications/photographing-historic-buildings/

Crutchley, S and Crow P 2010 *The Light Fantastic: Using airborne laser scanning in archaeological survey.* Swindon: English Heritage. HistoricEngland.org.uk/images-books/publications/light-fantastic/

Dunn, C J, Hunt, A, Goodall, I and Berry, T 2004 *Blackbeck Gunpowder Works, Cumbria: an archaeological and architectural survey*. English Heritage Survey Report AI/32/2004. See research.historicengland.org.uk

Everson, P 1996 'Bodiam Castle, East Sussex: castle and its designed landscape' *Chateau Gaillard* **17**. 79-84

FISH 2012 *Midas Heritage: the UK Historic Environment Data Standard.* HistoricEngland.org.uk/images-books/publications/midas-heritage/

Herring, P 2016 *Tintagel, Cornwall: Tudor harbour and early trackways* Historic England. Research Report Series RRS 34-2016

Historic England 2015 *Digital Image Capture and File Storage: Guidelines for Best Practice.* Swindon: Historic England. HistoricEngland.org.uk/images-books/publications/digital-image-capture-and-file-storage/

Historic England 2015 *Management of Research Projects in the Historic Environment: the MoRPHE Project Manager's Guide*. Swindon: Historic England. HistoricEngland.org.uk/images-books/publications/morphe-project-managers-guide/

Historic England 2015 *Where on Earth are We? The Role of Global Navigation Satellite Systems (GNSS) in Archaeological Field Survey.* Swindon: Historic England. HistoricEngland.org.uk/images-books/publications/where-on-earth-gnss-archaeological-field-survey/

Historic England 2016 *Traversing the Past: The Total Station Theodolite in Archaeological Landscape Survey*. Swindon: Historic England. HistoricEngland.org.uk/images-books/publications/traversingthepast/

Historic England 2016 *Understanding Historic Buildings: a guide to good recording practice.* Swindon: Historic England. HistoricEngland.org.uk/images-books/publications/understanding-historic-buildings/

Historic England forthcoming *Photogrammetric Applications for Cultural Heritage*. *Guidance for good practice.* Swindon: Historic England

Jamieson, E 2015 *The Historic Landscape of the Mendip Hills.* Swindon: English Heritage.

Jamieson, E & Lane, R 2015 'Monuments, Mobility and Medieval Perceptions of Designed Landscapes: The Pleasance, Kenilworth'. *Medieval Archaeology* **59 (1)**, 255-271

Oswald, A, Ashbee, J, Porteous, K and Huntley, J 2006 *Dunstanburgh Castle, Northumberland: archaeological, architectural and historical investigations* English Heritage Research Department Report Series RDRS 26-2006 See research.historicengland.org.uk

Rippon, S 2012 *Historic Landscape Analysis: Deciphering the Countryside.* Council for British Archaeology Practical Handbook 16. York: CBA www.oxbowbooks.com/oxbow/historic-landscape-analysis.html

Walker, K 1990 *Guidelines for the Preparation of Excavation Archives for Long-term Storage.* London: UKIC Archaeology Section

14 Glossary

CAD – Computer-aided drawing/design. A term used to describe graphics packages used primarily in engineering and design. As these disciplines require a high degree of precision, they are also ideal for survey applications.

Coordinate system. A pre-defined framework on to which coordinates can be related.

DTM – Digital Terrain Model. A digital elevation model of the bare earth topography, without buildings or vegetation

EDM – Electromagnetic Distance Measurement. This involves evaluating the signal returned from the target of a light beam emitted by the EDM unit. EDM is also applied colloquially to any survey instrument using this method of distance measurement.

GIS – Geographical Information system. A system for capturing, storing, checking, integrating, analysing and displaying data that are spatially referenced to the Earth. This normally comprises a spatially referenced computer database and application software.

GNSS – Global Navigation Satellite System (often referred to as GPS). The generic term for satellite navigation systems, including the American Global Positioning System (GPS), Russian GLONASS and other satellite constellations.

Lidar – Light detection and ranging. A system that uses laser pulses to measure the distance to an object or surface, typically determining the distance by measuring the time dealy between transmission of a pulse and detection of the reflected signal. Lidar is frequently deployed from a plane or helicopter to create 3-D models of the ground surface rapidly and accurately to varying degrees of resolution, depending on post spacing.

MVS – Multi-view stereo. A photogrammetric process using multiple convergent images to create a stereo view.

NMP – National Mapping Programme. A national programme of archaeological mapping using aerial photographs and more recently, lidar data.

OS Net® A network of reference stations throughout Great Britain maintained by Ordnance Survey. It consists of more than 100 base stations. This network allows users of GNSS to carry out precise positioning within the National Grid. www.ordnancesurvey.co.uk/business-and-government/products/os-net/

SfM – Structure from-Motion. A photogrammetric process of estimating the 3-D structure of a scene from a set of overlapping 2-D images taken from different positions.

TST – Total Station Theodolite. A tripod-mounted calibrated optical instrument used to measure horizontal and vertical angles in order to determine relative position. On a TST the angles and distance to surveyed points are recorded digitally.

15 Where to Get Advice

15.1 Sources of information

Historic England

Historic England Archive:
archive.historicengland.org.uk/ enables anyone interested in England's historic buildings and archaeological sites to search – free of charge – catalogue entries for the survey plans and accompanying reports, photographs and other documents held in our public archive. Most are not digitised – please contact the Historic England Archive:

Archive Services
Historic England
The Engine House
Fire Fly Avenue
Swindon SN2 2EH
archive@HistoricEngland.org.uk
01793 414600

Historic England maintains the **National Record of the Historic Environment (NRHE),** which contains over 420,000 records of England's archaeological and architectural sites, providing basic information about each site together with sources, archive and investigation details as appropriate. It includes archaeological, architectural and historical sites from earliest times to the present day, covering England and its territorial waters (the 12 mile limit).

Information from the **NRHE** is accessible through PastScape (www.pastscape.org.uk/) and the Heritage Gateway (www.heritagegateway.org.uk/) although the NHRE database holds more detail and can be consulted via the **Historic England Archive**.

Historic England curates the National Heritage List for England (NHLE) - The List for the Department for Culture, Media and Sport (DCMS). Drawing together all scheduled monuments, listed buildings, registered landscapes and battlefields, and protected wrecks, The List now holds almost 400,000 entries and can be searched online.

Historic England has published a series of *Introductions to Heritage Assets,* particularly in respect of scheduled monuments (see HistoricEngland.org.uk/listing/selection-criteria/scheduling-selection/ihas-archaeology/).

Historic Environment Records (HERs)

HERs contain a wide range of information about the historic environment in a local area, including information about sites, previous surveys and recording activity. They hold a wide range of source material including:

- Archaeological reports
- Aerial photographs
- Maps
- Journals
- Historic Landscape Characterisation data

HERs are maintained by Local Authorities and contact details can be accessed online through Heritage Gateway or through individual websites.

Other resources

A number of organisations compile indexes to sites and other information that might be relevant in the planning stages of a survey project. The addresses of these organisations (in Britain) can be found in resource hubs and directories published by the Council for British Archaeology (CBA) and by the Chartered Institute for Archaeologists (CIfA).

Archaeology Data Service (ADS)
http://archaeologydataservice.ac.uk/

British Geological Survey maps at 1:50,000 and 1:10,000 scales (1:50,000 scale available through the iGeology App)

County Records Offices, local libraries, private records collections and **The National Archives** (http://www.nationalarchives.gov.uk/)

- Other published sources (authoritative books and journals)
- historic maps (pre-Ordnance Survey): tithe maps, estate maps, enclosure awards, etc
- other local or specialist data, such as museums, local studies libraries, archaeological units, university or local knowledge

FISH Thesauri covering monument and evidence types (http://thesaurus.historicengland.org.uk/)

Lidar: open data available to download from the Environment Agency through the Survey Open Data Catalogue (http://environment.data.gov.uk/ds/survey/index.jsp#/survey)

Ordnance Survey
plans: basic scale, derived and historical maps

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Images

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