The Archaeologist’s Field Handbook
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Since the first edition of this handbook was published in 2004 many aspects of Australian archaeological practice have changed. In many respects, this edition presents a new snapshot of the field, reflecting improved methods, changing legislation, new capacities in digital data capture, management and archiving, and more readily affordable technologies for surveying and photography. The archaeological employment landscape has also shifted radically over the past decade: as of 2013 more than half (52 per cent) of all archaeologists in Australia were working in the private sector as consultants, a quarter (25.3 per cent) were employed in universities, approximately 16 per cent occupied positions in government departments, and only 4 per cent worked in museums (Ulm et al. 2013: 37). More importantly, 59 per cent of professional archaeologists who responded to Ulm et al.’s survey reported that they spent at least half their time engaged in cultural heritage management activities—the ‘business’ of archaeology that is covered by this book.

 Accordingly, we have almost completely rewritten this edition. One major change has been to restructure the chapters to focus on the different scales of recording and data management that are necessary across the life of a project, from the ethical and legal framework in which contemporary archaeological practice is set and the initial design and planning stages of a project, to the collection of landscape-, site- and artefact-level data. Thus, there is a greater focus on the management of a project from its inception, particularly in terms of data that are created digitally with no previous paper incarnation (‘born-digital’ data). Ten years ago born-digital data collection and management was only on the horizon of our concerns, but concepts of digital data and workflows and the importance of planning them from inception are becoming increasingly central to the operation of an effective project. The restructure of this book also has
meant a greater focus on data with a spatial dimension, including both locational data (i.e. where things are) and spatial relationships between things (i.e. where something is in relation to something else). For example, an artefact has a spatial location that can be allocated a set of coordinates, but it also has a spatial relationship with other artefacts at that site; depending on that relationship it may be isolated from other artefacts or part of a cluster. At a broader level, that site’s location has relationships with other sites, as well as other features in the physical environment. A considerable proportion of this book explains how to identify, record and analyse these kinds of spatial relationships.

A second major change in this volume has been to remove any explicit maritime archaeology content. We did this for several reasons: first, the highly technical and specialist aspects of underwater archaeology cannot be represented adequately in a wide ranging handbook such as this, and—like rock art dating, geochronology or geophysics—should only be undertaken by specialists with the appropriate training. Second, the theory and techniques used to map, plan or sample maritime archaeological sites—both those on land and underwater—are the same as those used for terrestrial sites. Third, while the specific repositories for information may differ, the research process for investigating maritime archaeological sites is the same as that used for any other type of site, so we have chosen to emphasise the commonalities rather than the differences. In other words, we have envisaged this to be an *archaeological* field handbook, and have therefore focused on the main methods and techniques that are common to all archaeological projects, regardless of sub-discipline. Our focus on terrestrial sites and techniques is simply a convenient way to capture the majority of archaeological work that is undertaken every day in Australia.

As with the previous edition, one of the main aims of this handbook is to argue for a minimum set of standards for archaeological field projects that can help to achieve comparability between researchers, projects and data. We think
this is particularly important for the future of Australian archaeology, since the work of Ross et al. (2013) has demonstrated how problematic the comparability of archaeological data is generally. This means that there is still very little scope for new syntheses of data to shift the parameters of archaeological research in new directions.

The essential caveats still hold true. First, there is no hard and fast ‘recipe’ for being a responsible archaeologist. Every site is different, and to some extent the field methods employed in each situation will be different. The key is to be flexible: while there are basic principles and methods, each field project will present its own challenges and inspire its own solutions. The methods and guidelines in this book outline thresholds for professional practice rather than the only methods that can be used in a given situation.

Second, while this book is intended primarily for archaeologists, you don’t need to be one to use it. This handbook has been designed for undergraduate and postgraduate students, as well as members of the general public (particularly those working as volunteers within heritage organisations), with the aim of providing the basic tools needed to plan and undertake fieldwork in a wide range of field situations. The structure of this book follows the pattern of a typical archaeological field project: first a site has to be located, then recorded and interpreted, and the results properly documented. Each chapter deals with different segments of this process and covers the various methods which can be employed to achieve this (see Figure P.1 for an overview). While each chapter can stand alone, there are also many overlaps, so information has been cross-referenced to help you locate related ideas. Specialist terms are flagged throughout the text in bold and explained in the text rather than in a separate glossary. Our intention has always been to make people aware of the legal and ethical obligations inherent in documenting and recording cultural heritage sites responsibly and well. To this end, some methods have been omitted from this
manual because they should not be undertaken by non-specialists. In particular, sampling rock art motifs for dating, or any restoration or conservation work, should only be done by trained professionals.

Third, we have kept key elements of the first edition, including boxed texts to highlight specific issues and lists of further readings and useful resources to cater for more detailed knowledge. We have also kept and expanded the range of sample recording forms—again, not because these are intended to cater for every archaeological situation, but merely to provide a minimum suite of variables that can be recorded routinely.

Finally, archaeologists seek to learn about people in the past through the objects that they made or used and left behind them. It is not just the objects (artefacts) themselves that are important, but also where they are found (the sites), and what other objects or traces of objects they are found with (their context). An artefact by itself can only tell us so much, and it is often the context which is most important for understanding the behaviour or activities which put the artefact there in the first place. The most important thing to learn about archaeological fieldwork is to pay as much attention to the context as to the artefact. In writing this book we have tried not to privilege the artefact over the context, or large or visually impressive sites over the ordinary. When conducting archaeological fieldwork, it is important to remember that all traces of past human behaviour are important, not just the most obvious or impressive ones.

[[INSERT FIGURE P.1]]

Figure P.1: Content overview
Acknowledgements

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CHAPTER ONE

THE CONTEXT OF ARCHAEOLOGICAL FIELDWORK

What you will learn from this chapter

- What it means to be a responsible archaeologist
- The legal requirements for conducting archaeological fieldwork in each state and territory
- The ethical responsibilities of working with others
- The kinds of insurance you need to manage professional risks

Archaeology is a complex task. Far from being a casual activity, it requires careful planning and a great deal of ‘behind the scenes’ work in order to be successful. This chapter deals with the broader contexts in which archaeology is set in contemporary Australia—the particular frameworks, sets of rules and regulatory frameworks that intersect with archaeology as a profession and that inform the way archaeologists work. The three chief contexts relate to ethics, legislation, and work health and safety practices.

Archaeologists and ethics

Ethics are an important part of archaeological practice today and govern much of what we do. The role of ethics within archaeology and more generally in any research setting is to help to protect others from potential harm that might arise through that research. Broadly speaking, ethics are differing ways of
understanding and examining moral life, and are concerned with perspectives on what is right and proper conduct (Israel and Hay 2006: 12). These moral principles reflect shared cultural norms and worldviews held by particular societies or cultures. As the discipline of archaeology has developed, so too have its shared cultural norms about what is right and proper conduct.

The context of contemporary archaeology has been produced by nearly a century of archaeological fieldwork. Over that time many aspects of archaeological practice have changed, both in response to particular criticisms of the way the discipline has operated and in line with broader shifts in the political and social contexts of how we understand heritage and therefore how we record and manage it. Probably the most noticeable shift over the last forty years has been the repositioning of Indigenous heritage as a living heritage (moving away from nineteenth and early twentieth century notions of ‘relics’). In many contexts, this has seen the centralising of Indigenous peoples’ rights to speak for (make decisions about) their heritage.

There are three specific ethical issues that are of particular relevance to archaeologists:

1. Ethics as the process of consultation, which is closely related to the field of cultural heritage management (CHM) and is therefore quite specifically laid out by regulatory bodies overseeing the process of CHM in some states. Consultation is also a general ethical requirement of all good research, however, so also applies to non-CHM projects.

2. Ethics as the general process of working with others. This will often be a case of having to manage different interests or opinions among stakeholders, and respecting those, even if you don’t necessarily agree with, or believe, them.

3. Ethics as the process of producing a thorough result that delivers what you have promised and that contributes something to the profession and
the community, even if it’s just the final report/paper and the site cards for the sites that you’ve recorded.

These three strands are essentially our responsibilities to others: those whose heritage we work on, or those we work with, working within the law, and ensuring that fieldwork is completed to a minimum standard and that our work makes a contribution. The World Archaeological Congress (WAC), the Australian Archaeological Association (AAA), the Australian Anthropological Society (AAS), the Australian Institute of Aboriginal and Torres Strait Islander Studies (AIATSIS), the Australian Institute of Maritime Archaeology (AIMA) and the Australian Association of Consulting Archaeologists Incorporated (AACAI) all have their own codes of ethics which clearly set out the ethical behaviours expected of archaeologists and researchers. When you join any of these organisations, you have to agree to abide by their codes of ethics—so it is important that you are aware of the different values enshrined in each of these frameworks.

Archaeologists and stakeholders

Contrary to the stereotype of an archaeologist working alone in a laboratory or library, working with others is one of the main tasks of our profession. People skills are an essential skill for all archaeologists, as it is regularly the case that we need to liaise and negotiate with a wide range of stakeholders. A stakeholder is anyone with an interest or concern in archaeological work, or who can affect, or is affected by, such work. Because archaeologists are almost always dealing with the physical remains of someone else’s past, archaeologists have ethical responsibilities to many different groups. These can be broadly summarised as:
• Government agencies. This involves working with, and understanding, the various forms of cultural heritage legislation that are current across Australia and your ethical responsibilities according to the practices of the administering authority (see ‘Working with the legislation’ on page ##).
• Indigenous people, who will often have widely varying views on archaeology, its usefulness and its purpose.
• Local non-Indigenous community groups and organisations, who are often very interested in the ways that archaeology can connect them to the recent past and who, in a sense, ‘pay’ for archaeological work through their taxes.
• Landowners and tenants, who own, or are responsible for, sites.
• Developers or other heritage clients (see Chapter 10: Cultural heritage values and significance), who need the professional advice of an archaeologist to help them make decisions about what is important, what should be saved and how. If you are being contracted to undertake development-related work, you must also bear in mind the legal right of the client to have full access to information about the site (see ‘Archaeological data and intellectual property’ on page ##).
• Other archaeologists, who may work in the same area or with the same stakeholders, or who may want to compare their data to yours, or use your research as part of their background research.

As an archaeologist, when conducting fieldwork, you need to think about how your work is likely to affect each of these interest groups. Do you need to ask any of them for their support or permission? Will your work promote positive change? Is it collaborative? Is it thorough? Are there measures you can take to ensure that the people you are working with will get some benefits from the
Thinking through, and acting on, these kinds of questions can make the difference between ethical and unethical research.

**Working with Indigenous communities**

Gaining the support and consent of Indigenous community members is a basic ethical principle of many professional archaeological organisations. For this reason, it is imperative that you provide every opportunity for Indigenous people to be genuinely involved in the research process—from project conception through to fieldwork and final publication.

The key ethical principles for working on archaeological projects with Indigenous people usually derive from the foundational notion that Indigenous people are the custodians of particular tracts of land, often referred to as their Country. This means that certain families are recognised within their communities as having unique rights and interests in specific tracts of land (or sea). In practice, this means that custodians or Traditional Owners have inherited rights to ‘speak’ for Country about its stewardship or management. These rights are inalienable, that is, they can generally not be acquired in any way other than through descent, and cannot be taken or given away (Sutton 2003: 4; see also Bird Rose 1996). Secondary, or contingent rights, are those that ‘flow from something else’ (Sutton 2003: 12), such as a relationship to someone with primary rights (e.g. by marriage), or long-term historical links to a particular place (e.g. when people came into missions from other places). Importantly, people with contingent rights often have less authority to speak about heritage matters. Understanding these two forms of Indigenous peoples’ connection to Country is very important in Australia, since it can help to ensure that you are negotiating with the correct people about your work from the outset. Furthermore, these rights are enshrined in various ways within several
pieces of heritage legislation, to the effect that consent is required from the correct custodians well ahead of a field-based project commencing.

In practice, this means that Indigenous custodians are required to fulfil certain obligations when archaeologists propose to work with them, to ensure that the work is done in an appropriate way and that locally-specific cultural protocols are followed. For archaeologists seeking to work with Indigenous communities, there are certain obligations they must try to fulfil. This includes recognition that Indigenous custodians:

- Must be in control of the cultural knowledge that relates to their heritage, including what knowledge is shared and with whom, and the way that knowledge is used in the research and any publications or other outcomes deriving from it.
- Need to be consulted with early in a project and this must be ongoing throughout the life of the project. Ideally, one of the first steps in a research or heritage management project is to discuss the work with the community, or to go one step further and seek their guidance on the kinds of research or management work they would like to see undertaken.
- Must have an active role in CHM, including how sites or objects may best be protected and conserved (DECCW 2010a: 2).

One of the main areas of ethical responsibility is in the use of information provided by Indigenous people: in Indigenous knowledge systems, knowledge is rarely ‘open’ in the sense that all people have an equal right to it. Indigenous knowledge is rarely definitive (in the sense that there is only one ‘right’ answer) and it is often restricted. Access to important or restricted knowledge is frequently mediated by people with the appropriate qualifications, usually based on age seniority or gender. Furthermore, such individuals are often deferred to within the community when it comes to speaking about heritage or land
management issues. In terms of archaeological fieldwork, this means that it is essential you work closely with more senior people out of respect for customary protocols around knowledge and cultural seniority.

Bear in mind that, even if you are working on historical sites, you may still need to consult with the senior custodians of the people on whose land the sites are located. This is particularly so of historical places that Indigenous people may have historical associations with. Indeed, some of the most significant heritage places for Indigenous groups are those that are associated with a community’s experience of colonialism—places such as mission settlements, pastoral stations, or government settlements and institutions.

Good ethical practice also means that you have a commensurate responsibility to ensure that the information shared with you is used correctly. What one scientist may view dispassionately as ‘data’, a senior custodian may view as highly sensitive secret/sacred information, and part of their cultural patrimony. Sometimes Indigenous people will share restricted information with you; it then becomes your continuing responsibility to ensure that information is not seen or heard by an inappropriate audience. Maintaining continuing consultation is a long-term (but often unforeseen) aspect of a working relationship, particularly when it comes to the publication of your results, or their return in other formats to the community. If you intend to publish your fieldwork, you should return to the community to show them what it is you wish to publish and how you will present the information. It is your duty to make sure that the publication does not contain information or images that the senior custodians require to be kept restricted. Permission is not given forever, and you will probably need to get separate permission each time you wish to publish. If your fieldwork involves artefact collection or excavation, you may also be required to return the material to the Indigenous community after the completion of the project. In fact, it is good ethical practice always to return the
results of your research in some way to the community, whether that be telling them about what you found, supplying a copy of the digital data or hard copies of your reports, or providing other outcomes, such as Plain English reports, interpretive materials or audio or visual recordings of oral histories collected as part of your project. Ideally, these community outcomes should be discussed and agreed upon at the beginning of a project rather than decided upon by the researcher in isolation, once the project is nearing completion.

Ethical practice during an Indigenous archaeological project also means that you remain receptive and open to hearing opinions that may challenge you personally, or that may not necessarily be compatible with the more scientific dictates of archaeology. For example, a senior custodian stipulating that artefacts must not be interfered with, or that people of a particular gender are not permitted to visit a place, can be confronting. This can be confronting for some, but keep in mind that you are working in a cross-cultural setting and that ethical practice requires a preparedness to accept different understandings and practices to those that you may be more comfortable with as an academically trained archaeologist. It is just as likely that, in working with you, custodians are themselves making many quiet concessions about your work or tolerating cultural transgressions that you are not necessarily aware of. Keep in mind that the people who are working with you will have a lifetime of experience and knowledge about the Country within which you are working, about local cultural protocols and expectations and ‘ways of knowing’. This means that, at times, you may need to vary your methods or reflect on the purpose and direction of the project. It is for these reasons that working in dialogue with communities from the very beginning is the most productive path, both for the custodians and you.

Any involvement of Indigenous people in a heritage project will generally require payment for their time in recognition of the fact that you are engaging people with expertise that is critical to your project. It is now standard practice
for senior custodians to have a role as advisors in order to oversee the work being undertaken and the methods being applied. Other community members are also frequently employed as field assistants during fieldwork, or are formally interviewed during site visits or oral history research. Ensuring that Indigenous people are employed in meaningful roles through a project also helps to ensure immediate, local accountability to custodians. It also represents an excellent opportunity for all parties to develop a deeper appreciation of each other’s viewpoints on heritage, archaeology and the research process. Fees for involvement of Indigenous people do vary and many Indigenous organisations may have set their own schedules of fees according to age and seniority. The appropriate rates of pay, as well as information about when or how often payments will be received, should of course always be discussed with relevant communities ahead of any planned work.

Archaeologists’ ethical responsibilities in Indigenous research are not restricted to field-based projects. In most states, access to non-confidential Indigenous material (whether photographs, artefacts or documents) held in government collections (such as the South Australian Museum, or AIATSIS) can only be obtained with written approval from the custodians of the region under study. Typically, institutions that hold such materials have established guidelines and procedures and it is important that you make sure you understand these prior to requesting access. Often, Indigenous communities are very interested in accessing such materials themselves, so it may well be the case that gaining access to important collections can help to fulfil both your goals as a researcher and the community’s goals. If you are affiliated to a university, all research to do with Indigenous Australians will have to be approved by a university ethics committee. The thinking behind this is that all research on humans has a potential to cause harm, and that preventing or mitigating this harm requires careful planning and independent review.
While sometimes processes for contacting and working with Indigenous communities are clearly outlined in state legislative regimes (see ‘Working with the legislation’ on page ##), this is not always the case, and some regimes fall well short of the ethical standards required for Indigenous research more broadly. In these cases, you need to understand how the choices you make in particular contexts reflect wider standards. *Ask First: A Guide to Respecting Indigenous Heritage Places and Values*, a booklet produced by the Australian Heritage Commission (AHC 2002), outlines the general steps involved in best practice for contacting and consulting with Indigenous communities throughout Australia and contains tips on how to resolve conflict where this emerges. For further information about ethics processes, we recommend the detailed *Guidelines for Ethical Research in Australian Indigenous Studies* (GERAIS) produced by AIATSIS. These should be consulted for all Indigenous research projects. AIATSIS also provide a research ethics review process, which can ensure that your project meets the best standards for ethical research involving Indigenous communities.

**Working with non-Indigenous communities**

If you are conducting historical heritage fieldwork, you are likely to be working with a range of non-Indigenous interest groups, such as the local branch of the National Trust, or members of the local historical society. While it is not usually considered mandatory (i.e. it is not a legislative requirement) to consult with local communities in the same way as for Indigenous groups, such collaboration can have many benefits, such as access to sites or information. Indeed, the Society for Historical Archaeology (USA) code of ethics mandates that members ‘strive to engage citizens in the research process and publicly disseminate the major findings of their research’ (see https://sha.org/about-us/ethics-statement/). ‘Community’ includes all the people who live in the area in which an
archaeological project is being undertaken, or who are affiliated with the site, even if they live some distance from it, and includes a wide range of people, each of whom will bring particular desires, skills or agendas to a project.

Approaching landowners or tenants for permission to access their land is a mandatory aspect of consultation, however, both as a matter of politeness and privacy, and of good ethical practice. In some states, obtaining this permission is an essential prerequisite to undertaking fieldwork—in Queensland, for example, you need written permission to prove you may enter land before you can obtain a permit to survey and to obtain an excavation permit in many states you will need the written permission of the landowner. The simple rule of thumb is ‘if in doubt, consult’—and certainly the more you undertake, the less likely you are to alienate anyone, the fewer problems you should encounter in the course of your project and the more information and assistance will be available to you. It is both good manners and good judgement to consult with the community with whom you are working and to make sure they benefit from the research you are undertaking.

This, in turn, raises another ethical responsibility: communicating your results to the wider public. Public excavations and site tours, school talks, public lectures, a project website and popular publications, guidebooks and interpretive materials are all excellent ways to make your project and its findings accessible. While this seems easy in theory, in fact it takes a great deal of time and commitment and is not always possible. It is important to remember that the public are interested not only in the results, but also in the process of archaeology. Site tours and public excavations are popular because they teach people about what has been found and about how we go about ‘doing’ archaeology. Several state government agencies who administer non-Indigenous heritage legislation around Australia (notably Victoria, New South Wales and Tasmania) often place a strong ethical and practical obligation on archaeologists
to contribute, wherever possible, to community involvement in archaeological work and to provide interpretive materials or source material that can be used to create interpretation at sites, so that clear public benefits can be derived from all archaeological work.

Planning and achieving effective community engagement and consultation

Given the wide range of stakeholders with whom archaeologists customarily work, effective community engagement requires careful planning and the development of skills in liaising and communicating with diverse audiences. Communication is the first step in any consultative process, but it can be one-way or two-way. Examples of one-way communication are posters, pamphlets or brochures—information which is passive and ‘delivered’—while two-way communication involves seeking community views and input, even though this may not always be positive. The next step is engagement: making the community response an active part of the overall process and involving stakeholders in decision making throughout. Good community engagement is hard work and requires skills in building and maintaining relationships, facilitating group communication, resolving conflict, and speaking to large and small groups effectively. Being able to reflect on what went well and what didn’t will also be a useful talent that will help you to build your skills in this domain. General principles are:

- Know who you’re trying to reach and understand how they are likely to access the information you want to give them and how best they will understand it. Your materials must be clear and easily understood by your audience.
- Design engagement processes for times and places that are comfortable to the community.
- Make sure you select the right consultation method or strategy for different groups or sections of the community.
• Plan community consultation so that it is inclusive, yet recognises difference. This may mean interacting with diverse groups in parallel if they are not comfortable talking together.

• Make sure that communication is open and ongoing and that you have some strategies for recognising and valuing community contributions and for receiving and using that information.

Adapted from: DECCW 2010a: 6; DEPI 2013

Working with the legislation

All archaeology is governed by some form of heritage legislation. This is not intended to make your job more difficult, but to protect sites and their contents from unwelcome or unwarranted interference or damage. All Australian states and territories have some form of heritage legislation that needs to be followed, but usually this treats non-Indigenous, or historic, heritage quite separately. Definitions and requirements are outlined in different legislative frameworks and are administered by separate arms of government. Unfortunately, the form and intent of the legislation varies widely and is not necessarily equally effective in all states. Many states do not zealously enforce their heritage legislation and, even where they do, complying with the law is not the same thing as conducting good archaeological research that helps to solve CHM problems or contribute to new knowledge about the past.

In general, since artefact collection and excavation are the most physically damaging of archaeological activities (see Chapter 8: Surface collection and excavation), these are usually the most heavily regulated through a legal permitting system. Before an administering authority will approve an excavation permit, however, it will require you to demonstrate that you have carefully thought through your fieldwork. It will ask you to submit a research design as
part of your permit application (see Chapter 2: Designing your project on page ##) and this will usually include recommendations for the conservation and curation of any artefacts removed from the site. Under the provisions of many state and territory heritage Acts, sites and their material contents (i.e. their artefacts) are the property of the Crown. The exceptions are rock art sites and scarred trees, which remain the property of the private owner of the land containing such sites, and, some of the newer Indigenous heritage legislation which vests ownership of certain kinds of Aboriginal objects (such as human remains and secret/sacred objects) in Aboriginal people, rather than the government. Proposed changes to Aboriginal heritage legislation in NSW at the time of writing aim to vest the ownership of all Aboriginal heritage in Aboriginal people, and would be the first Act of its kind to do so. This may mean that you will have varying requirements to liaise with the appropriate government trustees (usually the state museum), the correct Indigenous custodians and/or the legal administering body to ensure that requirements for the proper care and long-term custodianship of artefacts removed from a site are being met.

There will also often be a requirement that you provide a written report at the completion of your project and, often, that you submit recording forms for any new sites to the administering body. Most states maintain some form of database or register of heritage sites. Just as it may help your fieldwork to know what other sites have already been recorded in your area, other researchers may also want to know about your sites. It is also sometimes the case that access to site databases or records may be restricted, particularly for places that are prone to interference, such as shipwreck sites or Indigenous sites. Most states also have their own set of standardised recording forms, so make sure you obtain copies of these before you go into the field and that you fill them in completely and accurately before you submit them (see also ‘Creating field data: making observations in the field’ in Chapter 2). Because the precise requirements of
legislation vary from state to state, make sure that you are aware of the relevant cultural heritage legislation and the requirements of the administering body in your state or territory before you begin fieldwork. At the end of the day, this is your professional responsibility.

**Don’t interfere with heritage sites**

It is both illegal and unethical to knowingly damage a heritage site. Indeed, in some jurisdictions, it is even illegal to damage a site *unknowingly*. Any form of unsanctioned alteration to, removal from, addition to, or interference with, the fabric of a site may be viewed as ‘damage’. Even ostensibly ‘useful’ activities have the potential to cause damage, such as removing invasive vegetation overgrowth from an abandoned building (its removal may physically harm parts of the building), ‘tidying up’ an historic site (what you perceive to be ‘old junk’ may in fact be important archaeological artefacts), re-erecting an official sign that has collapsed in a rockshelter (this may disturb the subsurface archaeological deposits), moving artefacts, or cleaning graffiti from a rock art surface (this may remove traces of the art). Even though it may seem counter-intuitive, sometimes the apparent ‘messiness’ or physical degeneration of a site is actually part of its significance. Even if it is not, you must have permission from the relevant state authority—and, where applicable, landowners and Indigenous custodians—before you interfere in any way with a heritage site.

**State legislation**

There is a lot of legislation relating to heritage matters and it changes regularly, so it is the responsibility of all practising archaeologists to ensure that they are aware of, and adhere to, the relevant frameworks for each state in which they work. As a general overview, each state and territory tries to bring their heritage legislation into line with standards in other states, although there is still
considerable variation in how each Act is administered and implemented. The similarities are probably most apparent in the various pieces of historic heritage legislation (i.e. those Acts designed to protect non-Indigenous archaeological sites, artefacts and places). Every state Heritage Act protecting historic resources throughout Australia has established an independent advisory body (usually referred to as a heritage council) and a state heritage register for listing significant sites. Heritage councils are independent of the government departments responsible for implementing the legislation, and act as advisory bodies to oversee the listing process and subsequent work at listed sites. As a result, most historic sites legislation tends to focus on listing sites, rather than managing the archaeological search for sites. Many archaeological features, by their very nature, can’t be known about until development or some other potentially damaging activity reveals them, or until someone goes to an area and actively searches for them, and so can’t be protected by a 'listings only' approach. The crucial difference here is between regimes that offer ‘blanket’ protection (i.e. protection that uniformly covers all sites and artefacts, regardless of whether or not they have been previously unrecorded, and including those that are subsurface and therefore only suspected based on desktop historical research) and those that only protect sites and artefacts that are already listed (i.e. that are already known).

Some commentators on Indigenous archaeology have highlighted the disjunction between the fabric-based (i.e. archaeological, or tangible) nature of much legislation and the social values (i.e. the intangible values) attributed to places, landscapes and objects by Aboriginal people as the core problem that has side-lined archaeological research and made it peripheral to both managers of Aboriginal heritage and the empowerment of Aboriginal groups (e.g. see Brown 2007). Along with a move to devolve decision making on heritage matters to the local level and vest it in local Aboriginal groups, these criticisms have, in part, led
to recent, quite substantial changes in much Indigenous heritage legislation around Australia. Recent changes in Queensland and Victoria are aiming for better protection of Indigenous cultural heritage by integrating it more closely with planning regimes and creating a stronger framework within which Aboriginal people can control and manage their own heritage (Shearing 2006). How these changes work in practice, though, vary from state to state, and the realities of the outcomes will only become apparent with time.

**Local government**

Local governments also make decisions about heritage, albeit under different pieces of legislation. Local city and shire councils exercise control over planning and development processes within their boundaries, although the extent to which this will incorporate heritage matters will vary from council to council. These councils are still bound by general state heritage legislation, but any protection offered to heritage sites at the local government level will usually be allied to town planning schemes and planning Acts and will be considered alongside other planning issues. Local government councils may maintain their own lists or registers of locally important heritage places, both Aboriginal and European.

**Other statutory and non-statutory heritage bodies**

Apart from the government statutory bodies who administer heritage legislation, there are various other bodies with an interest in particular types of heritage. The Sydney Harbour Foreshore Authority (in NSW) and the Port Arthur Historic Site Management Authority (in Tasmania), for example, are restricted statutory bodies that govern properties under their management, although they themselves are still governed by the wider provisions of state heritage legislation. The Historic Houses Trust of New South Wales and the History Trust
of South Australia are government bodies, but are non-statutory (i.e. they don’t administer any legislation) and have a role in preserving and interpreting particular heritage sites and museums.

Non-government, and therefore non-statutory but still state-based, bodies also play a role in protecting heritage. The National Trust has operated in Australia since the 1940s and is the most prominent of these. It is a community-based organisation with semi-autonomous branches in each state and territory. It maintains its own list of mainly historic places: the Register of the National Estate. The National Trust owns and manages a significant number of heritage properties, typically stately homes and other historically significant places, and cares for them under the auspices of the Burra Charter (see Chapter 10).

**National legislation**

In general, state Acts provide legal protection for the physical evidence of past human occupation, while Commonwealth Acts, such as the *Aboriginal and Torres Strait Islander Heritage Protection Act 1984*, deal with heritage in a wider sense.

The *Historic Shipwrecks Act 1976* protects all wrecks in Australian waters older than 75 years, regardless of whether they are known or not (except for those in state waters, bays or rivers, which are covered by state Acts). The *HS Act* provides for some wrecks to be protected by an exclusion zone, which means that you will need a permit to visit them. Other wrecks may also require permits if they are situated in a restricted area or are within a Marine Park with restricted access. The transfer, possession and custody of shipwreck relics, including coins, are also regulated through the *Historic Shipwrecks Act*, even if you came into possession of this material long before the Act itself existed.

There are two pieces of federal legislation that are specifically relevant to Indigenous heritage management: *The Aboriginal and Torres Strait Islander Heritage Protection Act 1984 (ATSIHP Act)* and the *Native Title Act 1994*. Each
focuses on different issues and articulates with state-based Indigenous heritage legislation in differing ways. The purpose of the ATSIHP Act is to preserve and protect areas and objects of significance to Aboriginal people (S4). It applies to all Australian states and territories, regardless of the forms of Indigenous heritage protection that exist at a state level, but it does not limit or exclude the operation of state or territory legislation. The relevant Minister can use this Act to make emergency declarations where an Indigenous person or group has made an application for an area to be protected due to a perceived ‘serious and immediate threat of injury or desecration’ (S9). In practice, this Act has represented a form of protection that can be used to override state-level measures where these are perceived to have been inadequate (Pearson and Sullivan 1995: 53).

The Native Title Act 1994 is a broad and complex piece of legislation whose relevance to Indigenous heritage management may not be immediately obvious. However, the passing of this Act has seen tremendous changes in heritage management in Australia, particularly in terms of legislative frameworks. The Act is premised on recognition that Aboriginal and Torres Strait Islander peoples are the original inhabitants of Australia, were dispossessed of their lands and that this has led to disadvantage in Australian society today. The Act broadly aims to recognise and protect the ‘native title rights and interests’ of Aboriginal and Torres Strait Islander peoples. This is defined as ‘the communal, group or individual rights and interests of Aboriginal peoples or Torres Strait Islanders in relation to land or waters’ who, by traditional law and custom, have a connection with areas of land and water (S223). Under this Act, Indigenous groups around Australia have been able to make applications for recognition of these rights and interests, leading to Federal Court determinations as to whether native title does or does not exist for particular areas. Indigenous groups who submit such an
application are referred to as ‘native title applicants’ under the Act, while those who successfully lodge an application are recognised as native title holders.

The implications of this legislation for Indigenous CHM have included a major restructuring of the practice of Indigenous heritage management at the state level. The various ‘relics’ Acts of the 1960s–1970s positioned archaeologists as the ‘experts’ and—often—as the key decision makers about site significance and management, with little or no room for the involvement of Indigenous people (see Byrne 1996). However, the Native Title Act has meant that, in some states, such as Queensland and Victoria, the legislation has been rewritten to acknowledge Indigenous people’s native title rights and interests. In very practical terms, this means that native title applicants or holders are recognised as being the key stakeholders who not only need to be consulted about heritage management, but who also need to authorise particular management actions—such as the excavation of sites threatened by development. Legislative reviews that were underway at the time of writing will probably result in this approach being adopted in other states and territories. Thus, although native title is a complex and at times fraught process, it nevertheless is important that archaeologists and heritage managers are aware of its key provisions and influence over state-based legislation, particularly as older Acts are replaced and amended.

The Australian government is also responsible for administering legislation that promotes more proactive protection of significant objects and places. The Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act) has the widest implications for archaeologists, because it is the only national scheme for environmental and heritage protection that applies to all forms of cultural heritage. The EPBC Act applies specifically to matters of national environmental significance, or that will have a significant impact on a matter of national environmental significance. These principally include activities that will
potentially impact places on the World or National Heritage Lists, that include important or threatened ecological communities or species, or that represent important resources or areas (e.g. marine areas, water resources) of national significance. The key mechanism for protection then is not that it provides blanket protection to a particular class of heritage site, or that it includes regulations governing development activity or research. Instead, it includes provisions for proactively nominating places for inclusion on the National Heritage List in order to bring these places under the protections afforded by other parts of the EPBC Act.

Importantly though, only those places that have outstanding heritage value to the nation, and that meet a range of criteria outlined in the EPBC Act, can be placed on the National Heritage List. Uniquely, these criteria incorporate places of both natural and cultural value, and some of the places inscribed on the National Heritage List are recognised for both sets of values. For example, the listing for Ningaloo in Western Australia recognises the reef systems, subterranean fauna and archaeological sites dating to the late Pleistocene (Department of Environment 2016). The Australian Heritage Council assesses nominations under the criteria outlined in the EPBC Act, and in doing so draw on a set of publicly available guidelines (Australian Heritage Council 2009). The EPBC Act also applies to projects undertaken by the Commonwealth or that will affect Commonwealth land. A separate list—the Commonwealth Heritage List—exists for those places that are on land owned or leased by the Commonwealth, though this functions in much the same way as the National Heritage List.

World heritage

The Australian government is a signatory to the Convention Concerning the Protection of the World Cultural and Natural Heritage 1975 (the World Heritage Convention). The World Heritage Convention is administered by the United
Nations Educational, Scientific and Cultural Organization (UNESCO), and is the mechanism by which nominations can be put forward by state signatories for inscription of places on the World Heritage List. At its broadest level, this aims to protect places or areas that are of outstanding universal significance, including for their cultural and natural values. Articles 1 and 2 of the convention list the range of features, formations, sites and places that are protected. Less than 20 places are currently listed in Australia, many of which are quite well-known to Australian archaeologists: Fraser Island, Kakadu National Park, Uluru Kata-Tjuta National Park and the Willandra Lakes. Australian World Heritage Properties are automatically included on the National or Commonwealth Heritage List, and as such are afforded protection under the EPBC Act. This helps to ensure that the Australian government fulfils its obligations as a signatory to the World Heritage Convention.

UNESCO are also active in the development of other conventions for the protection of heritage, as well as for heritage management and significance assessment more broadly. Apart from the World Heritage List, UNESCO maintains a separate List of World Heritage in Danger. This is for world heritage properties that are ‘threatened by serious and specific dangers’, for instance, by rapid deterioration, armed conflict, natural disasters or through the deleterious actions of people (Article 11[4]). All nominations for World Heritage places in Australia are required to be submitted to UNESCO through the Commonwealth government even though the Australian government does not make the decision to list a place, which rests solely with UNESCO’s World Heritage Committee.

**Archaeologists and their profession**

Archaeologists’ responsibilities to their profession revolve around the role of archaeology in the context of broader heritage conservation, maintaining
standards so that data can be compared between projects, and representing the discipline in the public arena.

Conservation is the process of saving what is important—but this does not mean saving everything (for more information on this complicated balancing act, see Chapter 10). As an archaeologist, you have a primary ethical responsibility towards the proper conservation and management of the heritage resource (sites, their settings and the objects they contain) and will become an integral part of the process of deciding what is important and what should be conserved. This may be particularly tricky in a development context, since, even though a client is paying your wages, your first duty is still to the resource, which may well mean that you need to give them advice that is counter to their wishes. It may also be tricky in the context of your own work, since archaeological excavation or surface collection is an inherently destructive process. No excavated or collected site can ever be put back: once removed, it is gone forever and only exists in your recording forms, field notes, reports, photographs, publications and archives. This means that the quality of the data absolutely depends on how well you conduct the work, and what methods and techniques were available to you at the time. It is therefore a primary ethical responsibility of all archaeologists that excavation is only undertaken by professionals (or under professional supervision), and never without proper research and planning. It is for this reason that excavation, or the collection of artefacts, is the one aspect of archaeology which is most likely to be regulated by legislation governing who may undertake such activities and how they should be conducted. As a result, rather than destroying the resource in its entirety, archaeologists tend to leave parts of a site unexcavated, so that future archaeologists can revisit it with newer methods and questions.

An archaeologist’s responsibility to standards relates to the ways in which your data are collected, recorded and archived and the potential for the results of
your project to be comparable with others. Some areas of Australia have undergone decades of archaeological work by different people at different (and sometimes the same) sites, but the extent to which each new project has contributed new knowledge to extend what we already know is debatable. Unfortunately, Australian archaeology is still often fractured by the idiosyncratic use of concepts, definitions and methods between practitioners that derive from different training regimes at universities, specific histories of practice, particular contexts of work, and according to the varied requirements of state authorities or proponents. As a simplistic example, if no one understands what you mean by a ‘convex flake tool’, or if you simply refer to an artefact as ‘unusual’, this will prevent anyone from drawing comparisons between their data and yours. It is only by achieving a greater level of consistency in how we record things, why we record things in certain ways and how we make that data available, that the enormous pool of information generated by archaeology has any possibility of contributing new insights into our understanding of the past.

Making your results available means that the reports resulting from fieldwork should be accessible to others. This is not always possible, of course—particularly if your report contains secret/sacred or otherwise confidential information—but ideally you should supply one copy to the client or funding body, one copy to the appropriate state or federal heritage authority, copies to any interest groups who participated in the project, one copy to accompany the finds (if your project involved collection or excavation), and one copy to the nearest appropriate public archive or library (Birmingham and Murray 1987: 92). It is also an ethical requirement that your field notes and other primary data are kept accessible and available as part of a permanent project archive (see ‘Data management plans’ in Chapter 2). This will require thinking through the ways in which you record data, how you store the resulting materials and how you can keep them safe across the long term.
Finally, you have a responsibility to create a positive image of the profession through your dealings with others. If it is at all possible to encourage public participation in your project, this can be an excellent way of creating positive awareness. Wherever possible it is also worthwhile to encourage volunteers or to suggest and develop displays or other interpretive material for public presentation that will result in positive publicity for your project and awareness of the discipline in general (see Appendix 8, as well as ‘Working with Indigenous communities’ and ‘Working with non-Indigenous communities’ on pages ## and ##).

Archaeological data and intellectual property

Archaeological data is intellectual property. However, even if you collect this data, it is not always your intellectual property. If you are working on a consultancy project, it is the client funding the research who technically owns this archive, and you therefore have some responsibility to turn the contents over to them. This raises two thorny problems. First, who owns the intellectual property generated by your project? And second, what are the ethical responsibilities for keeping project archives accessible? In general, it is unethical for you to retain exclusive rights to information that you have been paid to collect as part of a project, unless this has been clearly identified as a necessary part of the process (for example, when Indigenous people request that information be protected as sensitive, although even then you would not retain exclusive rights. Instead this would rest with the Indigenous people). This does not mean that any subsequent academic papers or publications written by you from your data are ‘owned’ by anyone else. In general, and unless negotiated otherwise, the information you collect while in the field is technically the property of whoever funded the project, while what you do with that material
(i.e. your interpretations, synthesis or publications) are owned by you. In addition, while it is very easy to say that you should turn the contents of your archive over to the funding body, this may not always be the best outcome. If you are working for a small client, for example, they may not wish to be burdened with a whole lot of extra data and may have no facilities for storing this appropriately. By relinquishing it, you may actually run the risk of preventing future researchers from having access to these data again (including yourself). Unfortunately, there is no central repository for this kind of primary information, and you will have to judge for yourself what is best for the long-term storage of your archive. If you are working for a government department they may include conditions in their permit setting out the intellectual property arrangements, in which case, always make sure you read the fine print—you don’t necessarily have to agree to the conditions and you may be able to negotiate them. Intellectual property is a very grey area, and before undertaking any fieldwork you should investigate the requirements and expectations of all concerned.

**Neale Draper’s* advice on intellectual property**

Whenever Indigenous cultural knowledge is involved—or oral history as another example—then the question of intellectual property is more complex than just ‘the writer of the words’. In most cases, our consulting practice uses a fairly standard intellectual property statement for our reports, with the following components:

- Ownership of the intellectual property rights of ethnographic information provided by Aboriginal people remains the property of those named persons.
- Ownership of the primary materials created in the course of the research remains the property of the named researchers and the consulting firm.
- Ownership of the report lies with either the Indigenous organisation(s) involved with the proponent (e.g. developer or government) having the right to use the
report for specific purposes, or the report is jointly owned by those parties, or
the proponent owns the report (as a ‘deliverable’).

I also add a note as follows:

• The professional advice and opinions contained in this report are those of the
consultants, XXXX, and do not represent the opinions and policies of the client,
YYYY. The professional advice and opinions contained in this report do not
constitute legal advice.

• Finally, there often is a statement regarding whether the report includes any
culturally sensitive material (to the best of our knowledge).

• In these ways, heritage consulting reports—in fact any Indigenous heritage
reports or publications to some degree—have additional copyright
considerations compared to material from some other disciplines that is written
and published from a university context.

*Neale Draper is Managing Director of Neale Draper and Associates

Work health and safety

Archaeology brings with it many potential risks, both for your own health and
safety and that of those around you. Archaeologists tend to work outside and, in
doing so, are exposed to heat, cold, wind and rain. There are things to trip over
and things that will sometimes fall over (or things that we might fall into). There
are animals and insects that will sting, bite, attack or even try to eat you, as well
as plants that can cause annoying rashes or cause allergic responses—potentially
ending in a stay in hospital. A browse through one of the few available books on
health, safety and archaeology reveals all manner of other serious health and
safety issues that can be associated with archaeology: Lyme disease, rabies,
infections linked to fungi, exposure to poisons, toxins or heavy metals in the
environment, unexploded ordinance and many others (see Poirier and Feder
Furthermore, our work practices have many risky dimensions: we spend long hours walking or digging, we lift heavy things, we dive, we walk through long grass and we regularly work in awkward, difficult or dangerous situations. Field archaeology is no place for the faint-hearted!

Professional archaeologists must have a serious regard for safety and there are a number of reasons for this. To begin with, most of us have at least some regard for our own health and safety and want to avoid doing things that cause us pain or injury and we extend this attitude to those around us as well. With experience, you build up knowledge of the things you can do in the field or the lab that can contribute to the continued good health of everyone involved in a project. You learn to wear appropriate clothes for the conditions you are working in or to ensure that your equipment (whether it be a vehicle or a tape measure) works correctly and is safe to operate.

In an ideal world, this would be a perfectly adequate way to manage your health and safety if it were not for one vital flaw: it assumes that you have the experience necessary to make informed decisions. People who are new to working in a particular setting may not be aware of some of the taken-for-granted assumptions that someone else, who is more experienced, might rely on. So it is important—for the good of both yourself and others—that you take time to think through known workplace hazards, even if they seem very unlikely ever to occur. This is doubly important where we are working with people who might have no previous experience of archaeology at all, such as community members or students. This is part of the logic behind those seemingly boring health and safety talks that should be mandatory at the beginning of all archaeological projects: to share collective wisdom about the known hazards associated with the work you are about to do, and to identify steps to manage these.

The second reason to take work health and safety seriously is that it is a legal requirement. If you bump into a consultant archaeologist who is en route to a
mining job you will likely find them wearing high visibility work wear and steel capped safety boots. This is not designer work-wear for archaeology, but a clear reflection of the ‘safety first’ culture in which archaeologists routinely work. Many large corporations set their own standards and policies: for example, Rio Tinto have elaborate policies about safety that aim to help them achieve their vision of ‘an injury and illness free workplace where everyone gets home safe and healthy each day of their working life’ (Rio Tinto 2011). It follows, then, that, when archaeological firms work for other companies as consultants or subcontractors, they will be required to adhere to whatever policies that client has in place.

It is not just companies who set the agenda for work health and safety, of course, because providing a safe workplace is a legislative requirement in Australia as outlined in the Commonwealth Work Health and Safety Act 2011 (WHS Act). If you aim to become a professional archaeologist then this legislation should be as important to you as heritage legislation, because it outlines requirements associated with work health and safety and links directly to similarly focused state-based legislative frameworks. Indeed, the WHS Act 2011 was enacted in order to ensure that the various pieces of state-based health and safety legislation were harmonised to ensure consistency. It is now the case that you can read up on the relevant provisions of the WHS Act in the knowledge that they will be broadly relevant across Australia. The central point of the WHS Act is that any ‘Person Conducting a Business or Undertaking’ has a duty of care to ensure, as much as reasonably practicable, the health and safety of workers either engaged by that person or who are carrying out activities under the influence or direction of that person. The WHS Act 2011 has strict definitions of what constitutes hazards and risks, and outlines how to manage those risks.

Each workplace has responded to the WHS Act 2011 in different ways and a common response is to have active risk management processes in operation. You
might have experienced the impact of these kinds of legislative processes as students involved in university field trips because field trip leaders (whether staff or other students) have a duty of care to ensure your health and safety. Typically, it means you are required to fill out forms. The key point, though, is that it is against the law, and also very unprofessional, not to take workplace health and safety seriously and to put people in situations where there are unmanaged or ill-considered risks. While major Australian archaeological organisations currently lack guidelines for assessing workplace health and safety hazards for archaeological projects, the United Kingdom-based Chartered Institute for Archaeologists does (see http://archaeologists.net).

**Insurance and liability**

Insurance transfers financial risk from one person (the insured) to another (the insurer) in return for a nominated sum of money. However, insurance does not remove liability for an action. Insurance is simply an agreement for the insurer to meet some or all of the financial costs of the insured where the insured is liable for such costs. It is your responsibility to make sure that you are adequately insured should you, or someone working for you, incur an injury in the course of work.

The major types of insurance that archaeologists need to consider for all fieldwork projects are:

- public liability insurance;
- professional indemnity insurance;
- worker’s compensation insurance; and
- motor vehicle insurance.
Public liability insurance is necessary to protect you in the case of accidents. The first and most obvious way an accident could happen is if you, or one of your employees, visit a client’s premises and your actions cause injury to another person. The second way would be if someone visiting you (such as a member of the general public visiting your site) has an accident. Public liability insurance protects you if such accidents occur and a claim is made against you. Public liability insurance also covers you if damage is caused to third party property while at the client’s place of business. An example would be if an employee broke a valuable item while making a delivery at a customer’s home. The claim to replace the item would be covered by public liability insurance.

Professional indemnity insurance will protect you from mistakes that you make which cause financial loss to a third party. In archaeology, such mistakes might be around the incorrect identification of artefacts or misleading interpretations of a site’s use. If others rely on this information and it subsequently causes them financial loss, you could be liable. If your work is subject to investigation by a court it will be forensically examined. All of your assumptions will be tested and you will need to prove each step of the process by which you came to your conclusions. If it is found that your conclusions are not supported by irrefutable facts, you could find yourself open to litigation. Professional indemnity insurance covers legal fees and damages in the event of such a claim.

If you employ assistants at any time, you are legally obliged to obtain Worker’s Compensation Insurance. If you become a full member of AACAI, you will need to join AACAI’s Professional Indemnity Scheme unless you already have separate, equivalent cover.

Archaeologists also routinely travel long distances, and often to places that are difficult to access. Motor Vehicle Insurance is required if motor vehicles will be used in a project. This should include comprehensive or third party property
damage motor vehicle insurance, so that you are covered in case of an accident in which you are at fault.

**Useful resources**


The Chartered Institute for Archaeologists (CIfA): http://archaeologists.net/.
CHAPTER TWO

DESIGNING YOUR PROJECT

What you will learn from this chapter

• How to design a research project
• Approaches to project management in archaeology
• Principles and procedures for managing and archiving your data
• The importance of accurate record keeping
• Systems for collecting data in the field

Professional archaeological fieldwork is not something that can be done ad hoc. It has to be tailored to particular research questions and should only be undertaken after proper planning. The types of planning required will relate to the wider contexts in which archaeology is set (see Chapter 1: The context of archaeological fieldwork), such as the legal and ethical implications of your work, and what costs are associated with it. A great deal of your planning, however, will be devoted to the specifics of your project, including what motivates it, what it can contribute to archaeological knowledge, what kinds of data you need to collect, the collection methods that you need to use and what will happen to the data when you've finished. This level of planning is necessary to ensure that you make the most of your field time and your resources. Of course, even the most well thought-out and carefully planned research must be flexible enough to cope with the changing conditions of fieldwork and, in reality, you will need to balance what you would like to do with the various external constraints placed upon you and the project (Orser and Fagan 1995: 159).
Routine constraints include insufficient time, not enough funding (there is never enough funding or time in archaeological research) and an inability to access certain sites or areas. A well-planned project will consider all of these issues well ahead of fieldwork so that you make the most of your time in the field, while also ensuring that you complete those tasks that are essential to your aims.

What are projects?

Much of what archaeologists do involves working on projects. While students might participate in a project as volunteers in the field or the lab, the first time most archaeologists find themselves running an archaeological project comes when they undertake an Honours or Masters research project. Of course, projects are not only about research, and any archaeologist working in the commercial heritage management sector will find themselves employed to help complete projects that have been commissioned by clients. More senior consultants and researchers will routinely manage multiple projects in a year, and are often working on several at any one time. In short, much of what we do in archaeology involves participating in or managing projects, so it follows that this is one of the major skillsets that new archaeologists need to learn.

So what are projects? One commonly used definition is that they are temporary endeavours with defined beginning and end points, that involve undertaking a range of activities and tasks that contribute to pre-defined outcomes (Lee 2006: 4). At a general level, a majority of archaeological projects can be considered as a form of research: that is, systematic investigations oriented towards increasing knowledge about a particular problem, though the kinds of problems being investigated will vary a great deal. In a commercial setting, research often tends to have a more applied or practical focus—for example, to identify heritage places, to assess cultural significance, or to
investigate approaches to conserving such places. Academic or ‘pure’ research, on the other hand, is often focused on investigations into theoretical and conceptual issues such as the ‘big questions’ students are introduced to during their archaeological studies: the origins of agriculture, the dispersal of modern humans, or tracing the way humans responded to climate change through time. These have less immediate practical relevance and are more about contributing new knowledge with medium- or long-term social outcomes in mind. The division between academic and applied research is not absolute, however, and there are often very strong overlaps between the two. Many good consultants will incorporate academic research questions into their commercially-oriented investigations, while academic research can have important implications for applied heritage management work. Furthermore, the processes of designing both commercial and academic research projects have many similarities.

**Research designs**

Archaeological fieldwork should always be focused on a specific research problem, question or hypothesis. These issues are outlined in a research design, and writing this document is a critical step in the research process. A research design demonstrates that you have thought through what it is you are planning to do, how you are going to do it, what you hope to find out and why a particular research topic is significant, relevant or interesting (in other words, worth doing) in the first place. A research design will not only be a tool you can use to organise yourself, but also to obtain funding and permissions, because the quality of your research design will determine whether you can obtain a grant, scholarship, consulting contract, or permit to carry out the research. So, it is important to take them seriously.
The specific format and structure of a research design can vary depending on why it is being written. For example, a research design written for a government permit application can be quite different to that required by funding agencies or by a research ethics committee. However, there are a number of key elements that should feature in all good research designs. Here we focus on the essentials.

**What’s your problem? (and we mean that in a nice way)**

Narrowing down your research to a particular problem is the most difficult, yet most important, part of writing an impressive research design. Not every study will be earth-shattering in its findings, but every project should be sufficiently well thought out that it does not simply reinvent the wheel. This means that you will have to carry out enough background research to help you to identify and develop your research problem. Inspiration for new research projects can come from many different sources, but turning this idea into a good research design will only come from an in-depth and nuanced understanding of the literature (see Figure 2.1, page ##).

In developing your research problem, you must establish that the problem addresses a question, or a set of related questions, the answers to which will make a contribution to knowledge—regardless of whether this is academic or applied. The archaeology should be able to provide insights that no other discipline can. If the research proposes to answer questions that are marginal, or outside the range of current discussion in the discipline, you will need to show even more clearly that the answer will make a contribution. Importantly, you must define a clearly stated question, not just a general topic area or a set of data. Questions oriented merely towards the collection of new data are rarely sufficient starting points for the design of research in themselves—instead you should consider to what end the data can be used, and how it might contribute to new knowledge.
Finally, a good research project should also be achievable. Trying to establish where or when a specific type of Indigenous artefact was first used in Australia, for example, is unanswerable. In a commercial context, a research design that attempts to locate every single heritage site in an 8000 hectare study area within two weeks is probably doomed to failure (if you even made it past the tender submission). Thinking about feasibility early on can help you to narrow down the scope of your project to make it realistic, giving you a better chance of achieving some clear outcomes. Whatever your problem is, be sure to think it through and discuss it with others—your thesis supervisor, your client, your colleagues or your manager—because it will condition nearly all other aspects of fieldwork. The more carefully it is conceived, the more efficient and productive your field program will be.

[[INSERT FIGURE 2.1 HERE]].

**Figure 2.1: Thinking through your research problem**

**Defining your aims**

Research aims are different to your question, though it is not uncommon to see the terms ‘question’ and ‘aims’ used interchangeably, which can be quite confusing. Aims are where you reduce your question into more specific, achievable tasks, effectively creating a ‘to do’ list for your project. They are a means of operationalising your question—that is, putting it into action by breaking it down into more achievable elements. Aims are therefore concise statements about the things that you need to do in order to answer your question. For example, the research question ‘Did nineteenth century Chinese gold prospectors change their building style for a north Queensland setting?’ might include such varied aims as:

1. Synthesise known Chinese building practices within mining contexts in south-eastern Australia.

3. Compare and contrast these two suites of practices to understand how they are similar and how they diverge.

4. Analyse archival and other historical documents to understand the backgrounds of Chinese gold miners in south-eastern Australia and north Queensland.

5. Analyse archival and other historical documents to understand Chinese building practices more broadly, including in other gold mining areas nationally and internationally.

It is important to develop specific aims, rather than general ones (e.g. ‘conduct a field survey’) because this will help to ensure that the data being collected is useful and relevant to your question.

**The literature review**

Reviewing previous work relevant to your question is a critical element of a research design, and in fact, is largely what distinguishes a good research design from a mediocre one. The literature review is a synthesis of the arguments and ideas of others. That is, they tell the story of previous research around a particular question, or a study area. Importantly, a literature review is not merely a summary of what others have said or done—this is more akin to an annotated bibliography. A literature review involves synthesis, comparison and critique—whereas an annotated bibliography consists of a basic summary of a variety of sources. An annotated bibliography is, however, a good first step towards a literature review.

There are several major types of literature review. One that is common in the sciences and social sciences is the ‘systematic review’, which uses a specific methodology to identify, appraise and synthesise relevant studies in order to
address a research question (Petticrew and Roberts 2006: 9). These reviews are often a standalone research project, are very comprehensive and are conducted over months or years. They emphasise objectivity and adopt strategies to minimise bias. In contrast, a non-systematic review tends to be more of an informal or subjective exploration of the literature surrounding a specific or general topic, and is what is meant when people use the term ‘literature review’ as we do here. They are much more common within archaeology, and provide a means of collating background material relevant to a research project, as well as enabling a synthesis of this material, often with the intention of advocating a particular argument. They typically provide the platform for a new research project by identifying debates and problems relating to your own project.

The focus of an archaeological literature review will, of course, depend on the question and aims of the project. For example, according to the Department of Environment, Climate Change and Water (DECCW) the purpose of a literature review in a heritage study is to provide a framework for interpreting the material traces within the subject area (DECCW 2010b: 6). It should include a synthesis of the known archaeology of the region, including: major sites previously found within or near the study area; past management activities; ethnographic or historic information relevant to the study; and, finally, legislative and policy context for the project. A literature review for a research project might include some of these elements, but it should also engage with the academic literature relating to the central question, including theoretical debates, methods, comparative datasets or case studies, previous results or interpretations. More importantly, as the literature review is compiled, one’s knowledge of the literature will increase, providing new insights on the question or problem under investigation. For this reason, it is generally the case that the research question and aims are developed and revised in concert with the development of the literature review. The question and aims of a research
project should be developed iteratively, as one’s knowledge of the subject at hand increases during the literature review phase.

A literature review can also help to clarify and communicate the significance of a research project. That is, why should people care about this research project? Most research projects address questions that are of local or regional importance—for example, excavations of a new rockshelter will improve knowledge about local occupation patterns and technological or economic change through time, and local archaeologists may be very interested in the results. But what is the wider significance of this work? Would an archaeologist working on the other side of the country—or even the world—be interested in your results? A good research project will also have relevance beyond the local level, and at a national or even international level; indeed, contributing to nationally or internationally significant research debates is one of the major criteria for many large research grant applications. If your project is only of local interest, why should a national or international funding scheme support it, or national or international archaeologists take notice of it? The only way that you can identify and communicate the wider significance of your research is via a literature review that places your project in a wider context beyond the local.

Methods

The methods you intend to use are a final critical element of your research design and you should go into as much detail as possible. A good place to begin is to read about the methods used in similar, previous studies. What kinds of methods have been used and what was the order in which different tasks were undertaken? What kinds of equipment or resources were required? Were any specialised techniques used—such as analysing stone artefacts or ceramics—that you will need to learn? Are there techniques that require people with particular expertise, or specialist technical facilities (e.g. for radiocarbon dating)?
You will also need to consider how your data will be managed during and after your fieldwork. For example, will you use forms designed by others or do you need to design your own? Do you need to use a database to store the data, and if so, how should you design that database? Finally, what methods will you use to conduct your analyses?

A common mistake made by students is to write up the research methods as a list of techniques they plan to use. A good methods section is much more than this and should delve into the *specifics* of how different techniques will be used. For example, simply saying that you will collect artefacts visible on the ground surface is a very different proposition to explaining the details of precisely how you will do this. What types of artefacts will you collect and what criteria will you use to decide? What size area do you intend to collect from? Will you collect everything or are you intending to collect a sample? How will you choose that sample? How will you keep track of the original spatial context in your recording system? Factors such as these will have important implications for the results of your research and so need to be clearly explained. Furthermore, because a range of methods can be used for any particular situation, it is important to justify your choices—particularly if you are adopting an unconventional approach. Why is one method preferred over others? How will it give you better data?

**Final comments**

A research design maps out the logic of your proposed research project, both for your benefit and the benefit of others, and often takes the form of a research proposal. This allows others to understand the focus of your research, its overall context, how the research was structured and the methods that you used to obtain your data. The specific format of the research design can vary depending on whom it is written for; for example, is it part of a grant or permit application, a Doctoral research application or a report on a consultancy project? Regardless
of the audience, the four elements discussed here could be considered a minimum requirement: do you have a clear, achievable question; have you thought through your specific aims; have you demonstrated your knowledge of previous research on this topic; and, finally, do you have a clear understanding of the methods you will use to collect your data? Other information is also frequently required. For example, in a research design submitted as part of a thesis proposal, potential students are typically required to outline the significance of their project, as well as their timeline and ethical considerations. In other cases, such as for a permit application to conduct an excavation, you might be asked to indicate community attitudes to the project and to demonstrate the extent of community involvement and support, as well as outline your qualifications and expertise.

‘Desktop’ research

Desktop research is an essential preliminary element of your literature review, but is also fundamental to the wider research necessary to complete your research project. It includes reading about previous research in your study area, or on similar topics and questions elsewhere in the country (or the world), as well as reviewing existing sources of historical, ethnographic and environmental information so that you embark on fieldwork with as much useful knowledge as possible. Desktop research provides the crucial background context that helps you to develop more significant questions, understand the range of previous studies, including their strengths and weaknesses, and identify what methods have and have not worked in other studies. It also prepares you for the mechanics of fieldwork by helping to identify such things as the potential locations of sites, particularly sites recorded by earlier researchers, or relevant environmental, topographic or other features. Desktop research requires the
collation of a wide range of sources, from historical documents in archives and libraries, to map collections, the files of government departments and will range across electronic and other datasets.

**Using historical documents**

One of your first priorities will be to investigate the history of an area, as this will give you the best guide as to what to expect. Historical documents come in many forms, from company reports and accounts, birth, death and marriage certificates, wills and probate inventories, maps and plans, to diaries, letters and photographs, or newspaper articles and advertisements. It is not always possible to search exhaustively for every piece of documentation that relates to a site or area, and many documents may be of little use in answering archaeological questions, although they may still help you to understand the context of artefacts and sites. In practice, you will probably have to target particular types of documents that are more likely to provide you with useful information.

One major distinction you need to be aware of is between **primary** and **secondary sources** and their respective uses. Primary sources are first-hand accounts prepared at the time of an event (such as surveyor’s plans, newspaper articles, government correspondence or diary entries), whereas secondary sources (such as regional histories) are usually compiled at a much later date. Although secondary sources may well be based on primary sources, they are usually only an interpretation of selected parts of them. They are often a good place to start, however, as they can provide overviews of places or events and may contain useful information which can then be cross-checked or followed up in more detail from primary sources. When researching an area or a site, start with the secondary sources to find out where the major sites were located, or what general interpretations of past human behaviour exist, and follow this up with more detailed primary source research for more specific information.
Of course, it is equally possible for both primary and secondary sources to be wrong, so as a researcher you must keep an open and critical mind when examining any historical document. Just as you should be aware of your own biases, you need to consider that all documents are prepared for a reason and that this reason will condition the nature and content of the document. Whatever documentary material you are using, you need to question the source of the information and try to verify it by cross-checking with other sources wherever possible (Sagazio et al. 1992: 7). Remember, also, that the availability of different documents will vary widely from place to place and time period to time period.

Major repositories for primary documents include:

- **Federal repositories**, such as the National Library, the National Archives or the Australian War Memorial, which contain a range of Commonwealth government material (National Archives), and extensive collections of Australiana, photographs, oral histories and pictures (National Library). The Australian War Memorial holds collections relating to all aspects of Australian involvement in military campaigns, including hundreds of thousands of online photographs. The Australian Institute of Aboriginal and Torres Strait Islander Studies (AIATSIS) maintains an excellent collection of archival and library resources related to Indigenous people both pre- and post-contact, linked to an online database.

- **State repositories**, such as State Libraries, which hold invaluable collections of material relating to the development of their respective state and its people, including personal correspondence and extensive pictorial and photographic collections.

- **State archives** (also known as State records), which are the nominated repositories for official state government correspondence and records. These may include maps and plans, government gazettes, census information, electoral rolls, and official correspondence (both letters in
and letters out), as well as reports from the various iterations of government departments.

- In addition, some government departments maintain their own archives and others are tasked with holding on to historical records as part of their long-term responsibilities. Birth, death and marriage certificates and land title records are two examples of records that are still held by their respective departments. As a result, these may not be openly accessible documents and you may need to get formal permission to access them.

- Private or university archives may hold special collections of information relating to specific areas, such as university or company histories.

- Local repositories, such as historical societies, local museums or regional heritage centres, often contain a wealth of rare local information. For any historical archaeological study you undertake, it is well worth visiting the local historical society to evaluate their material.

**Finding historical sources online**

With the increasing availability of primary and secondary sources online, the range of information that a researcher can access easily is now more extensive than ever. TROVE (nla.gov.au/trove/) is probably the best-known gateway to a wide range of historical research materials. Developed by the National Library of Australia, it is a ‘one stop shop’ that provides fully searchable, direct access (i.e. through the National Library’s collections) or indirect access (i.e. through other libraries’ or institutions’ collections) to millions of online primary and secondary sources, including the largest collection of digitised historical newspapers covering all states and territories, diaries, letters and archives (currently limited, although more will become available in future), photographs, theses, books and maps. Also fully searchable through TROVE is the collection of materials held by AIATSIS, linked to MURA, its searchable online catalogue. Some of these items are available electronically. The National Library also offers a library card for
free access to journals and other high-quality academic and other e-resources, so that, if you are not affiliated to a university, you can still make use of a wide range of up to date scholarly research. To sign up for a NLA library card you only need to live in Australia or be able to supply an Australian residential address, and fill out a simple online form: http://www.nla.gov.au/getalibrarycard/.

Other searchable and online collections of historical materials include Archive.org (https://archive.org/), which holds over 6 million freely available books, including many nineteenth century Australian ethnohistorical and other sources held in US university libraries (see ‘Ethnohistorical research’ below), and the Hathi Trust (www.hathitrust.org), an institutional partnership to archive and share digitised collections.

The other important factor to bear in mind when conducting primary documentary research is to ensure that you always cite primary sources adequately. This is not as easy as it sounds. How do you reference a probate inventory? A letter? Or an undated and unattributed newspaper clipping? While there are no hard-and-fast rules, the key to citing a primary document is to make sure that you provide enough detail to enable another researcher to find the same item. To ensure this, you must remember to include:

- A description of the document, including the author and the title (if there is one). If there is no formal title, you can refer to it in terms of the type of document (e.g. ‘marriage certificate’, or ‘certificate of title’). If the document is a letter, it is usual to include the name of the recipient as well.
- The date of the document or document bundle (if known). If you don’t know the precise date, a date range will suffice, usually indicated by the use of ‘c’ for ‘circa’ written before the date, indicating that it falls within a range of ten years either side. If you don’t know this or can’t work it out, you will have to note down ‘n.d.’ for ‘not dated’ as part of your reference.
In this way, you signal to the reader that it is the document which is at fault, not your scholarship.

• The location of the document, including the name of the collection, the precise reference numbers allocated by the repository (if any) and the place where the document may be consulted. This will be a relatively simple task if the document is held in a formal collection, but may be more challenging if it is held by a local historical society, or a private individual.

• As a guide to the kind of information to include, here are some hypothetical examples:
  
  • Baptismal Register of the Church of England for the Parish of Beresfield 1871–1898. Held at the church, Martindale.
  
  • Correspondence and papers relating to the Easthope settlement 1883–1926, 2/8179.3. NSW Archives Authority, Sydney.
  
  • Davis and Bolton family papers 1911–1946. Held by Mrs Jennifer Jackson, Atherton.
  
  
  • Easton and District Historical Society, n.d. Carina Provincial School, 12-page typescript in the Easton and District Historical Society Collection, Browns Plains.
  
  • Register of burials at the Fairmont cemetery. List compiled by the Marshall Historical Society and held by the secretary.

**Ethnohistorical research**

*Ethnohistorical research* uses historical accounts of Indigenous people to help address particular research questions. Ethnohistorical sources represent an important aspect of Indigenous archaeological research and can provide a
deeper sense of Indigenous peoples’ lifeways at what Keen (2004) refers to as ‘the threshold of colonisation’ or the period immediately after Europeans made contact with Indigenous groups around Australia. Anthropologists sometimes refer to Aboriginal societies at this time as ‘classical’ societies, and as being broadly representative of social and cultural forms that existed immediately prior to European colonisation. Ethnohistorical sources are of value when attempting to reconstruct what life was like prior to European colonisation, and are also increasingly used in investigations of post-contact Aboriginal lifeways via historical archaeological methods. These sources can help to improve knowledge of the food and resources use, technology, demography, settlement types, social organisation, ceremonial and religious life and much more. Sources include explorers’ journals, official reports, settlers’ diaries, letters or reminiscences, accounts of early anthropologists, and any other early record left by those who came in contact with Indigenous people. You can find this material in any major or state library, and even in local historical society collections and libraries.

Ethnohistorical sources will have the same inherent problems as all written documents (see ‘Using historical documents’ on page ##). They were written by a particular person for a particular purpose, and will tend only to include the information that the observer thought was relevant at the time. They may frequently include romantic or racist views, misunderstandings or blatantly inaccurate information. The cultural barriers between Europeans and Indigenous people also affected the accuracy of observations—many accounts contain descriptive or other incidental observations of cultures that Europeans understood poorly or for which they had little sympathy (Byrne 1996). In addition, the very nature of contact and colonialism meant that Indigenous societies may have significantly changed by the time European settlers, explorers, ethnologists and ethnographers were making their observations. The
impact of colonial violence, disease and cultural change was shocking. Butlin (1983) estimates that up to 80 per cent of Aboriginal populations died in the first few decades after contact. This impact was so great that ethnohistorical sources relating to pre-contact Indigenous lifeways need to be used with great care—particularly if the aim is to account for archaeological evidence from many thousands of years ago. Also, as Hiscock (2008: 285) points out, Aboriginal societies changed through time. However, the real value of ethnohistorical sources is to provide a starting point for asking questions about pre-contact lifeways, establish potential interpretations that are not inherently Eurocentric and highlight their significance to contemporary Indigenous communities. Archaeological techniques can help to trace ethnography and to ‘create a history that extends seamlessly from the present or near-present into the deeper past’ (David et al. 2006: 8).

While there is little question that ethnohistorical sources require critical evaluation, and that contact and colonialism contributed to great changes in Indigenous societies, most archaeologists recognise the importance of ethnohistory as one of a range of information sources that can inform our understanding of the past. At the very least it can provide a starting point for critical investigations.

**Existing archaeological datasets**

Archaeological datasets collected by others are one of the most important sources of data to consider for your project. These might include varied things such as site cards held by a government agency, unpublished reports, site plans and photographs, or collections of archaeological material held in museums or research laboratories. They might be hard copy or digital. All relevant previous datasets should at least be considered as a potential source of data for your own research project. Doing so can broaden the amount of research data you have at
hand, or reduce the amount of field-based data collection that you need to carry out yourself. Indeed, many research projects are exclusively focused on field data collected by others, and conducting these kinds of projects are important in terms of minimising impact on the archaeological record, and ensuring that the results of previous work are exhaustively studied and published.

One of the first places to look for previous site data is in the published and unpublished literature for your study area. A review of this material will quickly allow you to identify what kinds of information have been recorded, whether any collections were made of cultural materials—for instance during excavations—and the kinds of methods that were used to collect data in the first place. If a dataset looks especially promising, it can be worthwhile to contact the original researchers to find out whether they have information they are willing to share with you. Be aware, though, that not all researchers will hand over their entire dataset to someone new on the scene. In addition, it can be worthwhile to contact major museums, as these institutions are often the final repositories for more significant collections and curators are often very welcoming of researchers. Publicly accessible datasets are often restricted to built heritage places and shipwrecks, and the reason for this is that there are ethical issues around disclosing the locations of more sensitive places.

Most states maintain registers of cultural heritage sites as part of state-based heritage legislation and these are also important places to search. Occasionally these are freely available online, though this often relates only to non-Indigenous sites. The Australian e-heritage portal (http://eheritage.metadata.net/), for example, provides online access to separate non-Indigenous state heritage databases, although at this stage is only limited to Queensland, South Australian and Victorian records. Even if not directly accessible to the public, many heritage registers can be accessed through a formal application process, often requiring the permission of Traditional Owners. Another important repository that is
rapidly growing in terms of content is Research Data Australia, which publishes information about a wide range of data generated through Australian research projects. This includes links to actual datasets that can be accessed online, as well as ‘metadata’ about datasets and collections that are not accessible online. Many museums and repositories share listings of collections with Research Data Australia, which means that it is a convenient central location for searching for data relevant to a new research project.

Where such tools are available, either publicly or by request, a quick database search can reveal whether there are any existing datasets for your study area. The next step is to investigate what else is known about them—in other words, tracking down reports or published papers with details about this earlier work. Again, public, online access to such information is not commonplace and largely applies to non-Indigenous material. Some collections of historical archaeological reports (and occasionally other reports) are publically available in digital format: NSW Archaeology Online, for example, is an initiative of the University of Sydney that makes available in fully searchable mode over 1000 historical archaeological reports, largely completed before the mid-1990s.

There are important limitations to using other people’s data. As we have seen, the research design adopted for a project determines the kinds of data collected in the field. What this means in practice is that data that might be of interest to you now might not have been of interest to previous researchers. For example, a research project that set out to look at pre-contact settlement patterns by recording the location of every Indigenous site in the study area might seem very comprehensive. However, if you are specifically interested in the kinds of artefacts that people used and how they varied from site to site, then their data may actually only be of limited value to you. Another limitation is that you cannot control the quality of other people’s data, and indeed, it can be difficult even to assess or verify that a dataset is consistently high quality. People
make mistakes, particularly in difficult field situations, and subsequent changes of recording, storage or coordinate systems can introduce new errors (see ‘Site cards, older coordinates and the problems with relocating sites’ on page ##). When you use other people’s data you are taking it at face value and trusting that they have reported their results carefully and honestly. So, if you are lucky enough to be able to access data collected by others it is important that you make a critical assessment of it and decide not only whether it is appropriate to include, but also whether there are any major problems with it. Some of these limitations simply reflect changing technology or methods. For example, a common limitation with site data collected prior to satellite navigation devices becoming widely available (about 2000) is that they often have coordinates that are accurate to only a few hundred metres at best. This is no fault of the researchers and indeed, in 50 years’ time, archaeologists of the future are just as likely to bemoan the accuracy of our current systems.

**Predictive models: Reviewing the landscape context**

Archaeological material is not distributed evenly across the landscape. The distribution of this material depends on a number of related factors, such as preservation conditions over time, the degree to which sites are exposed through erosion or a lack of vegetation, and the actual decisions of the people creating the sites and depositing the materials in the first place. The purpose of reviewing the landscape context in your study area is to assist in the prediction of:

- the potential of the landscape, over time, to have accumulated and preserved objects;
- the ways people have used the landscape in the past, with reference to the presence of resources, surfaces for art, other focal points for activities and settlement; and
- the likely distribution of the material traces of Aboriginal land use based on the above. (DECCW 2010b: 8)
Predictive models are used to produce a series of testable statements to predict the nature and extent of archaeological sites in the landscape (cf. DECCW 2010b: 10). They should be used to correlate sites with landforms, soils, water and vegetation. This information is fundamental to the development of a robust surveying strategy and to the location of sites in a field survey.

The Department of Environment, Climate Change and Water in NSW have developed clear guidelines on what should be included in a predictive model:

- the distribution of known sites, summarised or modelled using the descriptions of landscape units interpreted in terms of their archaeological potential;
- the patterning of material traces from known social and behavioural characteristics as evidenced in the ethnohistorical review;
- the distribution of natural resources, and the probable land use strategies employed by people in the specific landscape context;
- the spatial and temporal relationships of sites;
- what sorts of material traces are predicted to be present, and in what densities; and
- inferences about past Aboriginal occupation of the landscape based on the evidence collected and presented. (DECCW 2010b: 10)

According to the particular situation, predictive models may be either simple observations relating to past experience and the sum of available knowledge or detailed models and considerations of large landscape areas (DECCW 2010b: 10).

**Project management**

Projects not only require a clear sense of the activities and tasks that need to be carried out, but they also need to be completed within a set of project-specific limitations or **constraints**. The types of constraints that immediately come to mind are those associated with resources: for instance, the amount of funding available for a project is perhaps one of the most important to think about
because your budget tends to influence many other parts of the project. Your constraints will directly affect how long you can spend on the project, what kinds of equipment or specialist services you can purchase or hire, and even the number of people that you can pay or cater for, but there are other types of constraints that also need to be considered, such as whether there are limitations on the kinds of research methods permitted at a site. For example, a museum is unlikely to allow you to take artefacts away from their stores, or to conduct any form of destructive analysis, so this is an important limitation to think about. Access limitations to an area can also fundamentally shape a project.

**Project management** is the process of balancing time and resource use, while also ensuring that a project’s aims are met within set constraints. Experienced archaeologists tend to pay a great deal of attention to careful project management, because failure to do so can lead to spectacular disasters. Imagine running out of funding for fieldwork costs and personnel mid-way through excavating a test pit in a promising site, or completing a first rate heritage survey for an important client only to submit the final report three months late because you forgot to schedule sufficient time for reporting. It is for these reasons that project management is something that all archaeologists should become familiar with—fortunately, it is not some arcane art that only a chosen few are able to master or learn. There are many books and websites about project management and different kinds of software that you can use to help plan and conduct projects, including one comprehensive account of how to manage a research project for those working in archaeology and heritage management (see Lee 2006).
Data in archaeology

‘Data’ is a term that is used frequently in archaeology, yet concrete definitions are elusive. At a general level, the term is often used as shorthand to describe empirical evidence, or information that can be verified by observation or experience. This can include quantitative and qualitative data, with the former representing information relating to the qualities or characteristics of a phenomenon, whereas the latter relates to information derived from measurements of quantities. Both are critical to archaeological interpretation, and all archaeologists record both kinds of data across the wide range of settings in which they work. For example, when cataloguing artefacts, one might collect a wide range of quantitative data, such as artefact dimensions, edge angles, weights and so on, along with qualitative data, such as a description of an artefact’s shape and form or a description of the context in which it was found. Archaeologists heavily draw on both types of empirical data as a basis for higher order reasoning and interpretation.

Importantly, data do not include the material culture, sites, people or landscapes we work with. These are potential sources of data, but it is not until we make systematic observations of these phenomena that we have created a dataset. Lewis Binford (1987) highlighted some of the complexities associated with this process, suggesting that archaeology was different to many other disciplines where researchers make direct, first-hand observations of phenomena to create their data. Instead, he suggested that archaeological data are derived from observations of the material remnants of events or processes that took place at some point in the past. In other words, our observations are of phenomena that only indirectly relate to the things we are interested in—typically, people in the past. We can neither observe nor ask questions of those people, unless we are working on contemporary sites and therefore conducting ethno-archaeology or oral histories with living people.
For Binford then, ‘all archaeological data are generated by us in our terms’, while ‘all responsibility for accuracy and reliability rests with us’ (Binford 1987: 393). It follows that the methods we use in the field (how we choose to make and record our observations) and the way we curate or manage our data during and after fieldwork are of the utmost importance, because both have a major potential to affect the kinds of conclusions that we draw from the datasets. Moreover, it has important implications for how others might use our datasets as well—could someone understand how you collected your dataset and the decisions you made in terms of how you organised and archived that dataset? Could that data be used as a basis for addressing a research question developed by another researcher?

Creating field data: making observations in the field

Deciding how you are going to record data while in the field is a crucial part of project planning, since field observations in all their forms constitute the basic data of any project and therefore the accurate and thorough recording of field observations is the core task of any fieldwork project. Field observations will cover a wide variety of complementary information that is essential for understanding the context in which the research was undertaken, the physical and geographical context of any sites that were found, the site and artefact specific data that was collected and the limitations of the project. Making all facets of the fieldwork process transparent via well recorded field observations is also the only way in which an archaeologist can ensure that their results will be able to be compared to those generated by other projects, and therefore will contribute to the pool of current knowledge (see ‘Archaeologists and their profession’ on page ##). For any fieldwork, you may not always be able to record the maximum amount of information, but you must ensure that, whatever the
other limitations of the project, you always record a basic minimum of information.

Every project will employ several systems of field observation to collect information from the broadest scale (i.e. at the level of the landscape and surrounding environment) to the narrowest (i.e. at the site, context, unit or artefact level). These will be complementary and overlapping, and may include journals or notebooks, recording forms (either hard copy or digital), illustrations, maps and plans, audio or video recordings, or photographs. The overlap between systems of field observation is important for two reasons: the first is that one system will extend the information captured in another (e.g. general notes might be in your journal, but specific details of water sources and vegetation on a recording form); the second is that to some extent these will also contain redundancy, in that the same information will be recorded in more than one medium. In archaeology this is a good thing—it means that, should any of your data sources be lost, or not filled out correctly or completely, you will have alternative sources for key information. If you’re recording in a remote area, for example, where access to consumable or replacement goods is limited, then it is important to plan for the worst in terms of your equipment. This ranges from ensuring you have enough batteries and extra recording equipment, such as callipers or tape measures, through to ensuring that you bring along a second laptop or tablet as a backup. Furthermore, taking printed versions of electronic recording forms makes good sense, because, if something electronic stops working, then you can always revert to tried and tested paper-based recording methods. Failing that, it is always possible to create tables for recording data manually with a ruler. Cloud storage and backup options are also increasingly important for field research, as digital datasets can be relatively easily backed up to a secure location thereby ensuring that loss of digital equipment (e.g. damage or theft of laptops) does not mean complete loss of data.
Field journals and notebooks

One of the most fundamental modes of observational recording is through keeping some kind of core field journal or notebook. This is essentially a diary in which you record the day-to-day details of your fieldwork, from the sites you record or the features you excavate, right down to the weather and light conditions (which can affect your ability to locate sites or identify artefacts, particularly stone artefacts), the full names of the people who participate each day and any problems you encounter. It is also the place where you can record any impressions or interpretations as they occur to you. This will be particularly important if you are one of many fieldworkers on a large project and your results are to be analysed or written up by someone else, but it will also help to jog your memory later when you come to write up your report. Your field journal will form an invaluable record of your fieldwork and, since you cannot predict what questions may interest future researchers, one day it may even provide new and unforeseen ‘data’. As a formal record of your fieldwork, another archaeologist should be able to reconstruct your field program and understand the reasoning behind your decisions just by reading your notes. Remember, the more information you record in your field journal, the easier it will be for you or someone else to write up your results in the end. Don’t trust your memory—write everything down. A good field journal will contain enough information for you to make some basic interpretations of what you are seeing, which can be expanded upon later when you come to write up your report.

Taking good notes in the field takes practice and discipline, and it can also be difficult to know what to write down during the day. There is a general method that can be used to help, which uses a combination of brief jottings taken during the day, coupled with expanded summaries that write up these jottings in full. Jottings are intended not as a full or detailed account of what you were doing, hearing or thinking during the day, but instead are a prompt to help you
remember important details later. For example, if you were talking to a community member about a heritage site, you might note down key words, important quotes and the general gist of the conversation because it would be difficult to maintain the conversation while taking very detailed notes. Importantly, it could potentially be quite difficult to make sense of those jottings if too much time is allowed to pass after taking them, and furthermore, your jottings are likely to be very difficult for other researchers to make sense of—particularly if they are unable to talk to you. For these reasons, jottings should always be ‘written up’ into more detailed summaries as soon as possible, so that you can properly expand on all of the important details that you’ve documented in your jottings. This can be done during breaks throughout the day (e.g. in the shade at lunch) or each evening. Summaries should be included in your notebook, though sometimes it can be easier to use a word processor (particularly if your writing is messy). Experienced field archaeologists will frequently spend their evenings on this important task, and it is an essential part of taking good notes. Importantly, many people have their own individual approach to taking field notes, so if you are working with more experienced archaeologists, ask about their personal approach to see if you can learn any new tips and tricks to develop your own.

**Important things to note in your field journal**

- The date, weather, light conditions and full names of personnel.
- An account of what you did during the day, as you did it (jottings).
- A daily summary of activities for the day, including details of the methods you used and that identifies and expands on key findings, issues and ideas that you jotted down during the day.
- Progress made on the project during the course of the day.
- Any problems you encountered and the solutions you adopted.
• Any new research questions generated during the course of fieldwork, or interesting ideas to follow up.

• Any interpretations of sites or features which occur to you during the course of fieldwork.

• The reasoning behind any changes made to your methods or any decisions which affected the course of fieldwork and its possible outcomes.

• An index to other plans, datasets, sketches or forms completed to help you recall the other places you recorded critical information.

[[INSERT FIGURE 2.2 HERE]]

Figure 2.2: A page from archaeologist Robert Stone’s field journal

Paper-based recording systems

Paper-based recording forms are the simplest way to standardise data collection. While they may need to be redesigned (or tweaked) for each particular project depending on what questions you’re asking and what particular variables you need to collect, a form can be an efficient ‘low-tech’ way of gathering information consistently. One great advantage of hard copy forms is that they do not require batteries, and a good form can act as a checklist, eliminate errors, standardise terms and parameters and greatly speed up the recording process. More importantly, thinking about what fields should be included on your recording forms and why will help you to focus your methods and prepare you for the specifics of fieldwork.

While there are various arguments for and against hard copy versus digital recording methods, data are increasingly recorded and made available in electronic forms. Just as government departments have their own hard copy recording forms, some have digital versions of these as well: the AHIMS
Aboriginal site recording mobile app for NSW (http://www.environment.nsw.gov.au/licences/DECCAHIMSSiteRecordingForm.htm#app), for example, is a free download that lets you record sites digitally for uploading into the Office of Environment and Heritage’s database.

**Mobile apps**

Archaeologists have frequently been early adopters of a range of new ‘paperless’ approaches for recording field data. This trend began in the 1990s with laptops, which enabled archaeologists to create, use and edit digital datasets in the field. With the release of personal digital assistant (PDA) devices in the 1990s, however, archaeologists began to experiment with customised approaches to recording field data. Some adopted Microsoft DOS-based packages for creating structured datasets, such as *Entrer Trois*, written by archaeologists Shannon McPherron and Simon Holdaway (McPherron and Holdaway 1997). A more common approach involved using commercial software on mobile devices to allow for data capture in field scenarios, such as spreadsheet software, databases and Geographic Information Systems (GIS). Through the 2000s, these technologies advanced rapidly, and in recent times, this trend has been enhanced as a result of the widespread adoption of very powerful mobile devices in the form of smartphones and tablets. Since 2010, there has been a complete transformation of field recording approaches, and it continues to be a rapidly changing space. Paperless recording includes a wide array of approaches ranging from the very simple to the very complex, including standalone applications that run on a single digital handset, databases that will run on a single mobile device, as well as server- or ‘cloud’-based databases that can be deployed across dozens of devices (or more).

Standalone options involve downloading an application to a mobile device and then customising this via a software interface on your computer. This
normally includes designing a schema, or overall structure for your data, to ensure that you can record field data in a consistent manner. Standalone systems have a data structure that is similar to that of a traditional paper-based form entered into a digital table or spreadsheet, with unique tables for different types of sites, features or artefacts. When these are recorded, they appear as a unique record in the table (or another row in the spreadsheet). At this stage you might be wondering why bother with a specialised application when you can simply open a spreadsheet on your handset? The reason is that standalone data recording software takes the digital spreadsheet concept further, formatting it in ways that are visually more appealing, and that are easier to use and navigate on a recording device. They incorporate drop down value lists, check boxes and other ways of automating data entry. Standalone options are usually capable of exporting spreadsheets or text delimited files that can be ingested by other computer-based software. Their advantages are that they are quick and easy to use, particularly where you are recording simple datasets and just want an efficient and workable system on a low budget (usually less than $10). Importantly, these approaches are limited in that they can only be used on a single handset, which is not so useful if you have multiple teams who are collecting data in the field. Furthermore, they offer what are known in database parlance as ‘flat’ data schemas—that is, a series of standalone tables that do not link to each other—all of the data can be captured in a single, flat file similar to a spreadsheet. This too can constraint data capture, particularly where there are complex relationships between different entities that you want to record.

Great improvements on standalone systems came with the development of databases that could be deployed to mobile devices. A database is simply an organised collection of (digital) information that includes many cross-references (or relationships) between tables, which in practice creates a much more efficient recording system, creating links between diverse types of data. Again,
the range of available products is very broad, but generally speaking, database systems allow archaeologists to create or customise a database on a computer, which can then be transferred to a mobile device in order to both enter and access datasets while in the field. A database requires a greater commitment to learn and use, particularly where modelling relationships is concerned, but they are ideal where you are using more complex recording methods in the field (e.g. for recording landform and associated artefact types, or for undertaking an excavation). One suite of software that is very useful for archaeologists is Filemaker™ Pro, which creates powerful but easy to use mobile databases (see ‘Using Filemaker™ Pro and Filemaker™ Go’ on page ##), though there are many different products that can achieve a similar result. These types of databases can be deployed to a handset for use in the field, and transferred back to your computer once your fieldwork is over. It is also possible to create relational databases with a visual mapping interface that enables users to record spatial data in the field and to associate attribute data with the features being mapped. The main advantage with using databases is that they can create complex datasets, though the time required to learn how to create and use one does tend to discourage many people.

Increasingly though, server-based, or ‘cloud’, options are used by archaeologists because of their greater flexibility. These simply take a relational database and host it on the internet, so that multiple users can connect to it via many different mobile devices while in the field. This breaks away from a dependency on one mobile device, and provides distinct benefits on large field projects where there may be multiple teams of people recording in the field at the same time. Some cloud solutions require constant internet access, which is a major constraint when working away from mobile phone networks, but increasingly, many allow for disconnected editing, and this enables users to create a local copy of a database on a mobile device, edit it as needed, then
synchronise the recorded data back to the cloud once internet coverage is regained. This is ideal in a large country such as Australia, where mobile internet is still unreliable in many areas and archaeologists working in the field are frequently completely offline for days or even weeks. Like standalone relational databases, cloud options require a decent amount of technical know-how if you want to set them up yourself, though there is a rapidly increasing range of options that are making it much easier for users to subscribe to a web service, design a data schema and then sync to their mobile device. Furthermore, many allow you to visualise data on a map interface, and so replicate some of the functionality of a GIS (see ‘Geographic Information Systems’ on page ##). Many commercial operators exist in this space, such as ArcGIS Collector, Fulcrum, CartoDB and GIS cloud and can be easily found via a web search. Another, more recent advance is that some server options require no internet at all, and users simply create a local server on their own computer, or take a mobile server ‘in a box’ with them into the field (e.g. the Federated Archaeological Information Management System (FAIMS) system, https://www.fedarch.org/wordpress/).

**Backing up field data**

One of the key factors to think about when planning a field trip is to think about how you will back up your data while still in the field. Physical plans and notebooks can be lost or damaged (e.g. water damage), while mobile handsets can be dropped, stolen, or sometimes simply stop working for no apparent reason at all. These types of misfortunes will almost certainly occur at some stage, so you should have a plan to ensure that if or when they do, you do not lose too much valuable data. Another, all too common way of losing data is through bad digital file management practices that might see important files misnamed or misplaced on your computer, or worse, accidentally deleted or overwritten by newer datasets. The following tips will hopefully help you to avoid such situations.
1. Digitise as much of your hard copy data as soon as possible. Site recording forms, notebooks, plans and so on can be quickly and easily photographed at the end of each day. Once photographed, you can easily back up your data with other digital data collected during the project. If this is not possible, then photocopying important data and storing it in a separate location can also be good practice.

2. Give all digital files a unique name, preferably with a date in the file name. It can be useful to label files with the year, month and day, so that it is easy to find a file from a particular day, or to ensure you do not accidentally overwrite earlier files (for example, ‘2016-02-26 site recording database’).

3. Regardless of the mobile recording platform in use, be sure to export data from a mobile handset at least once per day. If you are recording large amounts of data, particularly where that data cannot be easily accessed again, then you might want to do this more often. Many mobile applications will allow you to email data to yourself, upload it to an internet server, or ideally, duplicate the entire database onto another computer or even to a cloud server. What you do will depend on the structure of the data itself, but whatever the case, do not simply let data accumulate on your device throughout a field trip, without any backups at all, because loss of that device means your data will also be lost.

4. Adopt careful file management practices. Ensure all digital data (such as images, notes, databases or survey instrument data) are stored on your computer in a systematic way. One simple approach is to create a folder on your computer for your project, and within that, create a folder for each day of the trip. All data from a day of work can then be stored only in that folder. This way, you create a dataset that mirrors the way your field trip was organised. A version of this can be archived intact and then a duplicate version can be reorganised later, as needed. Although simple, this can be beneficial because it does not require too much thinking when you’re tired at the end of each day—and you could safely ask assistants or colleagues to follow the same conventions.
5. Back up your laptop or computer regularly while in the field. There is little point taking the above measures if your laptop then becomes the sole device on which digital data are stored, since laptops are just as prone to damage or loss in the field. So, take at least one external hard drive and back up your machine to that drive at least once per day. Store the hard drive somewhere safe. If you’re travelling, consider giving a colleague the backup disk so that if your luggage is lost, your computer and backup are not lost together. Even better, look into cloud-based backup options that will allow you to securely back up digital data to the internet. This almost entirely eliminates the potential for losing digital data when in the field.

These steps may seem extreme and a little pedantic, but at the end of the day the time, effort and expense of a field trip is represented solely in the data that you take home; the loss of that data means that all that time, expense and effort will be wasted!

One of the key considerations when choosing a paperless recording system is that your data are easily accessible, both in the short term, for use in other software or by other people, as well as in the medium to long term in an archival context. Central to both issues is that your data can be exported and accessed via other software without losing detail or significantly altering the data structure. With flat tables, this is relatively simple, as individual tables can be exported to a delimited text file, which is a highly transferable and open format—enabling you or others to open the file with a very wide range of software. But, what if your standalone application has allowed you to associate images or attachments with recorded data? If you export your dataset, are these links preserved or do you end up with two unrelated datasets—a folder of images, and a table containing other data? Or does it output a PDF with embedded images and data that cannot be easily edited or read by other software? Such factors can be important if you want to work with your data in other software. Relational databases can present
similar challenges. For example, a complex Filemaker™ Pro database, being a proprietary product, would need to be completely rebuilt in another piece of software if you wanted to store that data in an open format suitable for long-term archiving. This is because proprietary software changes through time, and can even become obsolete, which can mean that accessing a complex data structure created on an older software version can be very difficult. Try accessing data created in a Windows 3.1 DOS application on a modern computer: the task is rarely straightforward, and would probably require specialist IT support. This can, to a large extent, be addressed by good data planning and management, and by using open data formats from the outset wherever possible (see ‘Data curation’, on page ##).

**Using Filemaker™ Pro and Filemaker™ Go**

Filemaker™ Pro is a very powerful relational database that runs on Mac and Windows computers, and has been around for many years. The interface is quite simple to use, even for first-time users who want to design a basic database. A free iOS application called Filemaker™ Go accompanies Filemaker, and enables you to view/enter/query data from mobile devices. As with any database, it is important to develop a data schema that maps out how the data will be structured. For example:

- What tables will you use? These are the primary vehicle for data storage, so, for example, on a site database you may need tables for different site or artefact types that you plan to record.

- How will you uniquely identify features (sites, artefacts, etc.)? Filemaker™, like many databases, will allow you to create serial numbers so that a unique identifier will be created for each new feature that is recorded.

- What approaches will you use for standardising data? Drop-down value lists, auto-entry fields (e.g. a date, recorder’s name or site identification number will be entered
automatically for new records), and check boxes can all be very useful for standardising data entry to maintain consistency.

- Are there relationships between different tables that you want to create? For example, it might be useful to be able to look up all artefacts that have been recorded on a particular site, or to create a link between a particular site and all of the photographs taken of that site.

It is important to test your database thoroughly before using it for data entry. The reason for this is that, like a piece of writing, an early version of your database will almost certainly contain errors. These errors may not only cause headaches in the field, but more importantly, can result in data being lost completely, or not recorded in its correct context. You can also customise the layout and look of your database and include logos or other images, colours and so on to create a more visually appealing interface for your various recording forms. In addition, you can customise your database to display correctly for the mobile device that you plan to use in the field (via Filemaker™ Go). For example, you can have the database formatted for different iPad or iPhone versions, although, in our experience, older iPhones are typically harder to work with due to their small screen size, while a larger screen makes data entry and viewing much simpler. If you only want one mobile device to have a copy of the dataset, then all you need in the field is a PC/Mac running iTunes™ that your mobile device can connect to, and it is a simple matter of dragging the database into the correct location.

You can also host Filemaker™ datasets on your very own server (over a local wifi network), or via the internet. This allows multiple users to connect to the same database using Filemaker™ Go. At the time of writing, however, it does not enable disconnected editing, so you need to ensure that all handsets will have local network coverage, mobile internet or be in close proximity to the laptop, otherwise the database will not work. Other options, such as the FAIMS mobile application, overcome this problem by allowing
Disconnected editing, so if this is important to you then Filemaker™ is probably not the best choice to make.

**Data curation**

Archaeologists routinely collect many different kinds of data at different scales: from the collection of background historical information to landscape and site location data through to specific data about individual artefacts and samples and everything in between. Qualitative and quantitative data are collected and stored in both physical and digital formats, and a very wide range of options exist in terms of how one curates—or organises and looks after—these different data. Despite the challenges, all archaeologists have responsibilities to archive the information they collect appropriately, regardless of whether they are students, volunteers, consultants, government archaeologists, or undertaking research in universities. For some state jurisdictions (e.g. Indigenous heritage in NSW) there is a requirement that records be kept in a legible form for at least five years after the completion of a project. All university-based researchers (and that includes research students) are required to comply with the Australian Code for the Responsible Conduct of Research, which has very clear provisions for data storage, retention, disposal and access (NHMRC and ARC 2007). Arguably, this policy also applies to non-university-based researchers (and the institutions they work for), such as those working with the cultural heritage management sector.

Since the 1990s, the range of types of data generated by archaeological projects has expanded into the digital realm, and ‘data management’ is often taken to mean digital data management. This raises a major problem when faced with both physical and digital data collections (Niven and Pierce-McManamon 2011):

> Much of the information produced by archaeological research over the past century exists in lengthy, technical, limited-distribution reports,
tables, and charts scattered in offices across the nation. The data contained in these resources are often encoded in computer cards, magnetic tapes and floppy disks that are degrading in archives, museums, bookshelves, filing cabinets, or desk drawers; all the while, technology to retrieve these data—and the human knowledge required to make them meaningful—rapidly disappears.

A range of initiatives has been established to address this issue. For example, the Archaeology Data Service (UK) and Digital Antiquity (USA) have collaborated to create the *Guide to Good Practice* (Archaeology Data Service and Digital Antiquity 2015), which provides comprehensive guidelines on digital data management in archaeology. This guide notes a strong trend away from the use of physical archiving measures to fully digital archival workflows, and is based on the premise that ‘any digital data produced from archaeological investigation should be managed and archived in a digital format’ so as to ensure ‘maximum accessibility and reusability of the data’ (Niven and Pierce-McManamon 2011). A range of resources have been established to assist with this goal, including repositories such as the Digital Archaeological Record (tDAR) (http://tdar.org/), the Archaeology Data Service (http://archaeologydataservice.ac.uk/) and the Australian-based FAIMS repository (http://fedarch.org/). Researchers working within the field of Aboriginal Studies in Australia also have the option of lodging original datasets with AIATSIS. However, a researcher is still faced with making a range of important decisions about how these data should be organised and managed.

**Data management plans**

Management of an archaeological dataset is based on sound planning at the beginning of a project, well ahead of any fieldwork taking place. This needs to
take into account management of both physical data and digital data. Physical data might include:

- original historical documents;
- original field drawings; and
- field notes, journals or paper recording forms.

The durability of hard copy records relies on the materials remaining stable over the long term and being kept in appropriate storage conditions. Many of these materials could be converted to an appropriate digital format and managed as part of a digital collection—and indeed, this is what we recommend here. Digitising as much as possible helps to ensure that a near-to-complete digital dataset can be appropriately documented, managed, backed up and if appropriate, archived in such a way that it is accessible to others. Even so, a single collection of original and irreplaceable physical material should be curated in an appropriate institution, together with an inventory of what the collection contains and appropriate documentation—including a data management plan and potentially a copy of the digital dataset together with shared labelling conventions to enable cross-referencing.

Responsibility for curating digital archaeological data extends to the information encoded as discrete bits of data and not just the media on which they reside. The three central problems with digital data curation (Archaeology Data Service and Digital Antiquity 2013) are that:

- Archaeological data can be lost because the physical digital media degrades.
- If the physical digital media is treated as an artefact in itself that has to be preserved, then this can render the data contained on it inaccessible to the vast majority of potential users. CDs and other digital media will degrade over time, or cease to be accessible to users, and will eventually become obsolete as computer hardware and software changes.
• The format of digital information will become unusable over time due to software and hardware advances.

Concerns with the long-term viability and storage of digital data centre around the costs involved in continually transferring (‘migrating’) data and upgrading programs to keep the data current and to prevent degradation or corruption, and the risk of losing data, either partially or wholly, over the short and long term. Digital metadata also needs to be collected so that users can search for, and access, digital archaeological records (Archaeology Data Service and Digital Antiquity 2013) (see ‘Metadata’ below). Proprietary software is expensive, and sometimes quickly becomes obsolete, so some repositories will not accept digital materials unless they are produced using open-source software.

The range of digital data emerging from a research project is diverse and could reasonably include:

• documents that help to describe the project, such as your research design, project-specific guidelines and procedures, and project outputs such as unpublished reports, publications or posters;
• statutory documentation, such as information about ethics clearances, permit approvals, letters of support and permissions;
• digitised field data, such as plans, maps, journals, forms and drawings;
• databases or tabular data (e.g. spreadsheets);
• digital photos, audio files, video files; and
• GIS files, geophysical datasets or 3D models.

Niven and Pierce-McManamon (2011) suggest that a variety of factors need to be taken into account when developing a management plan for these types of data. These include:
• Where will the dataset be archived? Will a new repository be required or will the data be submitted to an existing repository—such as tDAR, FAIMS, or a more generic repository (e.g. Open Context, http://opencontext.org/, or Dataverse, http://dataverse.org/)? Does your institution have its own repository?

• What types of digital data will be archived and in what formats will different data types be stored?

• What kinds of documentation and metadata are required, and at what level should documentation be provided? For example, should documentation be developed for individual files, collections of files, or entire projects?

It is not possible to apply the same data management plan for all datasets, because the management plan is dependent on the types of data, who will use the data, budgets, privacy issues and so on. Dataverse.org, a prominent data repository developed by Harvard University, provides a data management template as a basis for developing a unique management plan for each digital dataset (Harvard University Institute for Quantitative Social Science 2016). This provides an excellent starting point for archaeologists developing a data management plan, especially when taken together with the detailed guidelines on digital data archiving outlined in the Caring for Digital Data in Archaeology: Guide to Good Practice (Archaeology Data Service and Digital Antiquity 2013). We recommend that all researchers investigate these and other resources to create their own, tailored data management plans.

**Write it down and put your name on it—Aedeen Cremin’s tips for creating field records and archives**

It is amazing how many records get lost or become useless over time because they are not properly labelled. It is said that when Professor R.J.C. Atkinson died, a box full of...
notebooks was discovered among his things. The notebooks contained meticulous measurements of stones from megalithic monuments, probably including Stonehenge, which he had excavated in the 1950s. None of the notebooks were labelled and therefore all of that work went to waste. Don’t let that happen to you. Here is a checklist to think about:

- Label every piece of paper you handle, explaining what it is and put your name and the date on it.
- Acquire a notebook for each job—and label it, with title, your name and the date of use. The small stitched books are best, as you are not tempted to tear pages out. Yes, you’ll end up with a box of half-empty notebooks, but at least you’ll be able to find them when you need to. An obsolete disk or inadequate pro-forma will not give you the information you need in six months’, let alone six years’, time.
- Never ‘lend’ your notebooks to anyone. They may never be returned, published or acknowledged. If somebody wants them that badly, they can pay to photocopy or scan them.
- Put a copyright sign on any original documents you produce. It takes 30 seconds and protects you. Of course, put your name and contact details on the document—people can’t acknowledge your work if they don’t know who you are.
- Fully label any sketches you make, e.g. not ‘W’ but ‘timber-framed double-hung sash window’ or ‘rock-cut well’, etc. Put a north arrow, scale, the date and your name on the sketch. If the drawing is not to scale, say so. Label descriptions and measurements on the sketch if you can; if not, list them as a caption.
- Keep a full photographic record, with as many details as you can fit in, e.g. not ‘stamper battery from S’ but ‘1915 stamper battery viewed from the 1930s mine shaft. Distance from shaft 15m. Engine base is on right, stamper base on left; remains of amalgamation trays at centre. From SSE’. Carry a compass and always check, don’t guesstimate.
• Anything that involves other people needs to have their names listed in full. An image labelled ‘Jo, Alex and Rob on site’ is not going to be very useful to anybody else.

• On a long-term project, survey or excavation, keep an ongoing field diary (yes, in the same notebook). There will be things you notice that may not be catered for in the pro-formas and it is good to have these on record, however casually. The sequence of work is also useful to know about later on.

• Remember that nothing is published on time, which is why you need to keep proper records. In the 1960s, I worked on an excavation where the first director had died unexpectedly, leaving the work unfinished. His successor finished the excavation but never published the research, as he had other work in train. He, too, died unexpectedly. Forty years later, a third person was finally commissioned to publish the full excavation report. Whether he did or not I don’t know—I just hope our record keeping was OK. I certainly have no record of any sort, not even a souvenir snapshot. This sort of thing happens.

• The notebooks are your physical archive. If you have a career in archaeology, they will be of interest to other people later, so don’t throw them away even when you think they’re past their use-by date.

• The same applies to the raw materials of databases. The Greater Angkor Project has analysed about 10,000 sherds of eleventh to thirteenth century ceramics over the past 15 years. The inventory sheets for the first 4000 entered into the database have now disappeared because the Project did not then have adequate storage facilities. The loss is probably not great, since we can go back to the original sherds if necessary, but this all takes time. The original database program itself has also become obsolete, which means updating and so on—another time-consuming activity.
Tips for making your physical archive last

It is not enough simply to create an archive by putting all your materials together. You must also ensure that you have used the correct media so that the recordings last and that everything is properly labelled and cross-referenced, so that if anything becomes separated from the rest of the archive, it can be replaced correctly.

- Use acid-free notebooks. Although slightly more expensive than regular ones, these will last much longer and are more resistant to fading or deterioration. Several versions of durable paper notebooks are also available and can be used in all weather conditions.
- Never take field notes or fill in recording forms with an ink pen, because this will run if dampened. Highlighter pens, all water-based markers and soft-lead pencils are also unacceptable. Instead, use a ballpoint pen or a hard-lead pencil.
- Avoid recycled paper, as this is less chemically stable. Also avoid colour-stock paper, sticky tape and post-it notes, as these will all deteriorate over time.
- Avoid metal staples or paperclips, or spiral bound notebooks, as these will rust.
- Never split up or mix your records, or cull what seems to be irrelevant material.
- Digitise as much of your material as possible, as soon after your fieldwork as possible, and include these materials within your project archive.

Useful resources

The Archaeological Data Service: http://ads.ahds.ac.uk: This site promotes good practice in the creation and use of digital data in archaeology and provides technical advice to the research community. The page on standards, http://ads.ahds.ac.uk/project/userinfo/standards.html, is particularly useful.

Digital Antiquity, which also maintains tDAR (The Digital Archaeological Record), which functions as a repository, a research tool and a public access portal for digital archaeological records: http://www.digitalantiquity.org/.

Open Context is a secure repository for archiving datasets so that the data itself can be openly accessed by other researchers.Datasets are allocated a Digital Object Identifier (DOI), and can be cited in the context of other research: http://opencontext.org/.
The Federated Archaeological Information Management System (FAIMS): https://www.fedarch.org/. FAIMS is an Australian-based information management system for archaeology. It has developed apps for Android devices for digital data capture, developed tools to process, analyse and visualise this data and also contains an online repository for digital archaeological data.

Australian Museums and Galleries online: www.amol.org.au/. This site is useful for background research, and contains links to Australian museums and galleries, as well as a national database of museum and gallery records. Also see Heritage Victoria’s online Archaeological Collections: http://artefacts.heritage.vic.gov.au/imu.php?request=search.

The MoRPHE guidelines (Management of Research Projects in the Historic Environment), published by Historic England (Lee 2006), provides useful, practical information on how to manage projects, and are highly relevant to archaeological and cultural heritage projects. Even though it is focused on the United Kingdom, in many respects the framework can be applied equally well in other settings. There are also many supplementary technical guidelines (see: https://historicengland.org.uk/advice/technical-advice/project-management-for-heritage/).

NSW Archaeology Online provides direct, searchable access to hundreds of ‘grey’ literature reports and theses on the historical archaeology of Sydney and surrounding areas in NSW: http://nswaol.library.usyd.edu.au/index.jsp?page=home.

Research Data Australia. This online repository lists metadata for datasets across a wide range of Australian research and cultural institutions, as well as within government agencies. It is an ideal way to find out what data exists and where it is held: https://researchdata.ands.org.au/.

SHARD (Sonoma Historic Artifact Research Database) http://www.sha.org/index.php/view/page/artifact_cataloging_system. This is a cooperative effort to provide a freely downloadable historical archaeological MS Access database for use with nineteenth and twentieth century sites.
CHAPTER THREE

MAPS AND NAVIGATION

What you will learn from this chapter

• Common map types
• The relationship between datums and coordinate systems
• How to understand scale
• How to calculate a grid reference from a map
• The pros and cons of hand-held GPS
• The principles of more advanced GPS devices
• How to navigate using compasses, maps and global positioning systems (GPS)

The basics

Maps are indispensable in field archaeology. They help archaeologists to navigate, organise field surveys, record certain types of data (e.g. site locations) and communicate results to others. The two essential skills that all archaeologists should understand are how to ‘read’ a map and extrapolate from that to the physical features you can see around you, and the relationship between this and other methods of navigation, such as the range of options offered by Satellite Navigation Systems (Satnav), such as those using the Global Positioning System (GPS). This will involve understanding general concepts of datums, projections and scale, as well as the differing principles on which coordinate systems are based.
Coordinates and datums

Coordinates

The term ‘coordinate’ is commonly used to refer to a specific geographic point in the real world. Coordinates are represented as sets of numbers, for instance, a 2D coordinate can be represented as a latitude and longitude or as an easting and northing. A third dimension—height—can also be added in order to increase the precision of a coordinate in 3D space. One of the main purposes of a map is to provide coordinates—specific geographic locational references—for features of interest. In commercial archaeology, for example, a developer might provide a consultant archaeologist with a map showing the coordinates of the boundaries of a development area. In turn, the consultant might record a series of coordinates to show the boundaries of the area traversed during a field survey, as well as coordinates for those sites identified. But what do these coordinates refer to?

A coordinate is a reference to a model of the shape of the Earth’s surface. In order to have a precise system for obtaining coordinates, an imaginary grid-like mesh of lines is created that covers the planet. The Earth is often depicted as a sphere, but in reality it is shaped more like an ellipse, that is, it is slightly flatter at the North and South Poles, and wider at the Equator. Furthermore, the Earth’s surface is irregular, with areas of higher or lower elevation depending on where you are. Because of these topographic irregularities, it is necessary to base reference systems on simplified models depicting the shape of the Earth.

Ellipsoidal reference systems are models based on the idea that the Earth is best represented as an ellipsoid, even though the Earth’s surface deviates from a perfectly ellipsoidal shape. Coordinates taken from the ellipsoidal model are commonly known as the geodetic coordinate system and coordinates in latitude and longitude are known as geodetic coordinates. Geodetic coordinates
are a system with global coverage, but geodetic coordinates will sometimes also be referred to as geographic coordinates. This can be a point of confusion, since there are many different kinds of geographic coordinate systems, and geodetic is just one. Here we use the term ‘geodetic coordinates’ to refer to a coordinate system based only on ellipsoidal models of the Earth (see also Spencer et al. 2003: 38).

**Geodetic datums**

The problem with geodetic coordinates is that they are based on a uniform mathematical model of the Earth’s surface that do not precisely take into account variations in topography. In order to obtain accurate ground coordinates, therefore, it is necessary to have a means of translating coordinates from the model reference ellipsoid into the actual shape of the Earth at a particular place. Geodetic datums provide this link, allowing you to translate coordinates from the reference ellipsoid to the real world (Spencer et al. 2003: 38). There are two general types of geodetic datums: local geodetic datums, which use a local point of origin and thus best approximate the size and shape of a specific part of the Earth’s surface only, and global geocentric datums, which use the Earth’s centre of mass as their point of origin and thus best approximate the size and shape of the Earth as a whole.

One of the most common global geocentric datums is the World Geocentric System 1984 (WGS84), which was developed by the United States government for military purposes. Most countries, however, have developed local datums. For instance, Australian maps created before the 1980s used the Australian Geodetic Datum 1966 (AGD66), which was replaced by the Australian Geodetic Datum 1984 (AGD84). The difference between these two datums was minimal, so coordinates determined according to one or the other will only vary in position by between 2–5m. In 2000, however, the Australian government began
using the Geocentric Datum of Australia 1995 (GDA94). Because this is a
geocentric (or global) datum, its origin point is not the same as for AGD66 or
AGD84 and so there will be approximately 200m difference between coordinates
using the GDA94 system and either of the earlier systems. This will be an issue if
you are working with older maps or site recordings that have been made before
2000.

**Latitude and longitude**

Most maps depict a mesh of latitude and longitude lines, with latitude running
horizontally around the globe and longitude running vertically, roughly from the North to
South Pole. The Equator is the origin point (0°) for all lines of latitude since they run
parallel to it. Latitudes above the Equator are given in positive degrees which increase in
magnitude as they move north (to +90° N); latitudes below the Equator are given in
negative degrees and increase as they move south (-90° S). For lines of longitude the
Royal Observatory at Greenwich (in the United Kingdom) is the origin point or prime
meridian (0°). Longitude to the east of Greenwich is given in positive degrees to a
maximum of +180° E; longitude to the west of Greenwich is given in negative degrees to
a maximum of -180° W. As such, a geodetic coordinate is always given as degrees
longitude (e.g. 141° East) and latitude (e.g. 35° South). Geodetic coordinates should
always indicate whether a longitude is east or west of the prime meridian, and whether a
latitude is north or south of the Equator by using positive or negative degrees (e.g. -35°
43’ 30” South, 141° 10’ 05” East).

Geodetic coordinates can be represented in several different ways, including:

- as degrees, minutes, seconds (DMS), where latitude is expressed as -35° 43’ 30”
  South, and longitude as -141° 10’ 05” East;
- as decimal minutes: latitude -35° 43.5’, longitude -141° 10.08’; or
- as decimal degrees: -35.725°, -141.168.
To convert between DMS and decimal minutes or decimal degrees:

- decimal minutes = Degrees, minutes + (seconds/60);
- decimal degrees = Degrees + (minutes/60) + (seconds/3600).

There are also numerous conversion applications available for mobile devices, computers and over the internet. Many common web-based mapping applications with global coverage use geodetic coordinates expressed in decimal degrees. Similarly, it is simpler to work with decimal degrees in GIS packages.

**Projected coordinate systems**

A **projection** is a means of transforming geodetic coordinates from 3D onto a 2D plane, or in other words, flattening a part of the ellipsoid to a flat surface (Spencer et al. 2003: 42). These are also known as **planar coordinate systems**, though the term ‘projected coordinates’ or ‘projection’ is frequently used to mean the same thing. Planar coordinates simplify the process of making measurements in the field because they are based on a metric system, with recorded increments measurable in metres and centimetres. They also make map-based navigation simpler, because distances are in metres and metres can be measured simply with a scale ruler (see ‘Map scale’ on page ##). Furthermore, satellite navigation devices can display information about these projected grids, which can be particularly helpful when designing field sampling strategies (see also ‘Satellite navigation’ on page ##).

There are many different types of projection systems and these are all designed to minimise the amount of distortion for particular areas. The most commonly used projected coordinate system is the **Universal Transverse Mercator (UTM)**, which divides the world into 60 zones, each of which is 6° of longitude wide and runs from north to south. These **projected grid zones** are split at the Equator into the northern and southern hemispheres, meaning there
are some 120 zones in total. Each zone has a unique grid coordinate set that consists of **eastings** and **northings**. Eastings run vertically (the same direction as lines of longitude) and are numbered incrementally, increasing as one moves to the east within any zone. Northings run horizontally (like lines of latitude) and numbered increments increase as one moves to the north within any zone. This can be a little confusing at first, as northings describe lines that run east to west, while eastings describe lines that run north to south, but if you look at the projected grid lines on a topographic map you will see the numbers for different northings increase as you move your position to the north, while eastings increase as you move to the east, hence the naming convention.

**Grid coordinates** are a combination of an easting and a northing (e.g. 650,000 E, 8,750,000 N), and are sometimes also referred to as X (easting) and Y (northing) coordinates, reflecting the fact that they are ultimately Cartesian coordinates. Unlike geodetic coordinates, grid coordinates do not directly relate to the central meridian in Greenwich. Instead, each grid zone has its own central meridian running north–south. The origin point for eastings within any grid zone is the intersection of this central meridian with the Equator, which is allocated the arbitrary easting of 500,000m. The origin point for northings is also the Equator, which in the southern hemisphere is allocated the arbitrary northing of 10,000,000m, decreasing southwards.

Australia is covered by twelve zones of the UTM grid system, from 47 in the west through to 58 in the east. Like many countries, Australia has its own projected coordinate system, the **Map Grid of Australia (MGA)**. This is based on the UTM system and so uses the same system of zones and arbitrary eastings and northings. Its origin point, however, is based on the origin point for the Geocentric Datum of Australia. Most maps and digital datasets published by Australian State and Commonwealth agencies use the Map Grid of Australia projection system, and in doing so provide a more locally applicable set of
eastings and northings. Earlier projections that you may encounter include the Australian Map Grid 1984 (AMG84) and the Australian Map Grid 1966 (AMG66) which corresponded to the older datums (see ‘Geodetic datums’ on page ##).

While there are many benefits to using eastings and northings in the field, they do pose some problems. One common issue is that if the zone of a particular grid coordinate is not noted alongside the coordinate itself, it can be difficult to understand what zone is being referred to. This is important when coordinate data are being shared, or when you are entering coordinates manually into a satellite navigation device, since you might find that the point you have recorded appears to be in the wrong location if the correct zone is not also provided. Furthermore, because topographic and other common maps are projected, north often means grid north—that is, north for the grid zone in which you are working. This will be different to magnetic and true north, and so corrections are required (see ‘North’ on page ##).

Maps

Regardless of the digital options available, the paper map is indispensable and all field archaeologists should ensure they have appropriate hard copy maps with them at all times. Paper maps communicate a range of information intended for very different uses, and so the first step in using a physical map is to find one that is relevant to your field research.

There are several different types of map that you will become familiar with in the course of archaeological work. The most common of these are topographic, geological and cadastral maps. A **topographic map** depicts relief (horizontal and vertical variations in terrain), together with the location of landmarks, roads and generalised information on vegetation. It will also indicate easting and northing values and latitude and longitude values. A **geological map** will depict rock
formations, geological zones and soil types and will help you to understand the landscape context of your project area and any sites or materials within it. A **cadastral map** will depict land parcels (owned portions of land) and property boundaries developed from survey plans, along with key features such as access roads, railways and waterways, and sometimes other land title information, such as parcel numbers, ownership and size. Historical cadastral maps can be a good source of background information on land use and settlement patterns during the desktop research phase because they will reveal details of changing land use and settlement patterns over time, as well as, in some cases, land ownership. They can cover towns, parishes or counties (they will often be referred to as township, parish or county maps in archival catalogues) and will often record, among other things, the location and size of privately owned parcels of land, major transportation routes and the transfer of land from the Crown to private ownership. It is important, however, to remember that they will only list the name of the *first* land grantee (i.e. the person to whom the government first transferred that parcel of land), and not subsequent transfers. To find out about all subsequent owners and transfers you will need to do a title search through a Land Titles Office (see ‘Carlotta Kellaway’s tips for researching the history of a building’ on page ##).

Other specialised maps of relevance to archaeologists present information about ecosystem types, bathymetry (underwater relief), land systems, or surface geology. Libraries, state and federal government agencies and private retailers provide access to maps of various kinds, and many are also available as digital files, enabling you to print out the parts that are relevant to your project. While all types of maps are potentially useful, coverage will vary across Australia, with the best coverage usually restricted to major towns and their immediate environs. Increasingly, many archaeologists use digital datasets to create their own customised maps. For example, computer-based **Geographic Information**
**Systems (GIS)** enable different kinds of information—topographic, cadastral, geological, vegetation and more—to be overlaid, allowing you to compare spatial relationships and identify changes over time (see ‘Geographic Information Systems’ on page ##).

**Map scale**

In order to present information on a physical map, trade-offs are made in terms of the level of accuracy or detail used to represent real world features. This process involves systematically reducing or *scaling down* the size of real world features at a set ratio in order to be able to depict them on a map. This ratio is referred to as a **scale**. Topographic maps are often produced at a scale of 1:50,000; at this scale, 1 measurement unit on the map equals 50,000 of those same units in the real world; so, for example, 1 cm will be 50,000 cm, or 500 m. To make things even easier, this ratio is also converted into a linear bar scale at the bottom of the map to show you this relationship graphically. At scales of 1:250 or larger, something which is 50 cm long is far too small to be depicted on a map.

When describing the area represented by a map, the terms ‘small scale’ and ‘large scale’ are easily confused. The easiest way to remember this is that small scale means ‘small in detail’, while large scale means ‘large in detail’. This is illustrated in Figure 3.1. That is, on a small scale map a large area will be depicted with relatively little detail, while a large scale map will present the same area in greater detail. In Australia, published maps come in a standard range from very small scales that cover enormous areas (such as 1:250,000 or 1:1,000,000) to large scale, covering much smaller areas in greater detail (such as 1:25,000 scale maps covering only 750 square kilometres). Such terms are entirely relative, though, since in the context of creating a site plan (see Chapter
6), a scale of 1:25,000 would be a very small scale compared to a site plan produced at a scale of 1:250!

[[INSERT FIGURE 3.1 HERE]]

**Figure 3.1: The relationship between the area of a map’s coverage and its scale**

**North**

One of the first challenges to using any map is that it will represent more than one kind of north and failing to grasp this may lead to problems in the field, such as getting lost, failing to relocate sites or creating errors in the data recording process. Anyone using a map, compass, surveying equipment or a GPS in the field should be aware of the three types of north: magnetic north, true north and grid north (Figure 3.2).

[[INSERT FIGURE 3.2 HERE]]

**Figure 3.2: Using a topographic map to calculate the difference between true and magnetic north**

**Magnetic north** is the direction to the magnetic meridian near the North Pole. The location of magnetic north is constantly in flux because of the changes in the Earth’s magnetic field. The motion of molten iron alloys within the Earth’s core creates a magnetic field around the planet and this is almost vertical at the North and South Poles. In effect, this magnetic field points downwards almost along the Earth’s rotational axis. The direction to magnetic north can be readily measured with a magnetic compass which indicates the direction of magnetic north. As such, by using a compass, bearings can be obtained from one place to another; for instance, you might obtain a bearing of 130° from your current position (A) to your destination (B) (see ‘Compasses’ below’). This measurement is actually the horizontal angle between magnetic north and an imaginary straight line drawn along the centre of your compass dial and pointed at your
target or destination. Magnetic north is important in archaeology because it is often the quickest and simplest means of calculating the position of other kinds of north (see ‘Converting between different norths’ on page ##), and is indispensable for navigation, creating survey plans, and so on. For this reason, you should always include a compass in your field kit.

**True north** is the direction of the Earth’s geographic North Pole. This is also known as the geodetic meridian, which is a north-south line drawn between the mean centre at the geographic North and South Poles (Ghilani and Wolf 2012: 172).

**Grid north** is different to both magnetic and true north. When you look at any official map, you will see solid black lines running vertically and horizontally across it. These are the grid lines that indicate eastings and northings. The direction of the vertical lines (the eastings) on the map indicate grid north, following the convention that a map is usually oriented with north at the top. On topographic maps, these grids refer to a specific map projection, and details about which projection is being used can be found at the bottom of the map.

**Reading contour lines**

Topographic maps provide a very useful means of understanding patterns of relief in the landscape via contour lines, which mark the rise and fall of the land. Understanding what contour lines represent is essential for navigation in the field, as well as for planning fieldwork. For example, it can be very useful to know whether you are going to be walking up the side of a mountain or surveying around a gorge, as opposed to walking on relatively flat ground. Each of these terrains has specific features and challenges, as well as different potential for containing sites, and being aware of the rise and fall of the land is important to planning the amount of time it will take to conduct a survey.
Contour lines are imaginary lines joining places of equal height in a landscape (Figure 3.3). These are the thick and thin wavy lines you can see all over the map, some of which have small numbers attached to them at various intervals. On the map, each contour line represents a particular height above sea level, and the numbers will tell you how many metres above sea level each contour line is. The most important things to remember about contour lines are that:

- when they are close together on the map they indicate steep slopes;
- when they are far apart on the map they indicate gentle slopes;
- when they are uniformly spaced on the map they indicate uniform slopes;
- when they decrease in spacing (when read from high to low), the slope is convex (outward sloping, like a hill); and
- when they increase in spacing (when read from high to low), the slope is concave (inward sloping, like a valley).

[FIGURE 3.3: Contour lines and slope]

Obtaining coordinates

Many textbooks and map reading guides refer to four- or six-figure grid references derived from the grid of eastings and northings that comprise a projected or planar coordinate system, as shown on a topographic map. A four-figure grid reference is a reference to the numeric label provided for major eastings and northings lines drawn on the map. The first two of the four-figure grid reference refer to the easting, while the second two refer to the north, for example 0469 would indicate an area reference to a grid square (see also Geoscience Australia’s [2006] *Map Reading Guide: How to Use Topographic Maps*). This can be useful for designing a sampling strategy (see ‘Finding sites’ on page ##), for example, to indicate for which grid squares you completed surveys. They can also be useful to quickly point out or describe (e.g. in your notes) where
an important landscape feature is. A six-figure grid reference divides a grid square into a further 100 smaller squares with the addition of 10 additional eastings and northings. To find a six-figure grid reference on a map, you therefore simply need to divide the grid square into a further ten lines running west–east and from north–south. The nearest lines that cross to the west and south of your point should be given as the third value in your easting and northing, respectively. If you are using grid references, then this is generally preferable to a four-figure grid reference, as it increases the precision of your grid reference. These generalised grid references can be very useful when navigating in the field, and many people still use them. They are also commonly used in some national parks and other conservation areas. When giving grid references it is essential to note down the map sheet name and number, otherwise no one will know what map your grid reference is referring to!

While knowledge of these types of generalised grid references is helpful, it is now much more common practice to provide full grid coordinates. This is because four- or six-figure grid references are insufficient for use on a satellite navigation device, or in a digital mapping application, as they lack precision. Furthermore, grid references rely on having a specific map on hand in order to use them, which means they are not very useful when attempting to share data with others. A full grid coordinate refers to the actual easting and northing for any position, and includes adding in some additional information that is available on a map sheet (see ‘Obtaining a grid coordinate from a topographic map’ on page #.#) and this makes the coordinate universally useful. They also work well with digital tools. For example, satellite navigation devices can easily calculate a full coordinate to within 5–10 m, while some professional grade survey devices can calculate a position to within a few centimetres. In both cases, these coordinates can be displayed on a digital map such as web mapping applications or fully fledged GIS packages—and indeed, can even be displayed on a mobile
device in the field (complete with the relevant topographic maps!). Importantly, all topographic maps published by the Commonwealth of Australia include all the information you require to find a full grid coordinate for a position on the map, and it is very easy to convert a full coordinate to a grid reference, if required.

A useful point to remember with grid coordinates is that eastings and northings are in metres. For example, if you travel 550 m due east of the easting 717000, you would be at an easting of 717550. It is the same for northings, though the northing increases as you travel north (e.g. 8535020 is 20 m north of 8535000). While a GPS handset will usually give you a coordinate to the nearest metre, it is not usually possible to obtain a coordinate to this degree of accuracy from a published topographic map in Australia, but if you take a six-figure grid reference and add zeros these can be entered into a satellite navigation device. To do this, you need to look at obtaining the full grid coordinate from the map sheet the grid reference was based on (see ‘Obtaining a grid coordinate from a topographic map’ on page ##).

Always read a grid coordinate from the bottom left-hand (south-western) corner of the relevant grid square. Grid coordinates should always be given in this order—easting first, northing second (in other words, you always read gridlines from left to right and then bottom to top). Under no circumstances should they be reversed! It is also important to include the datum or projection information, which is generally prominently labelled on the map sheet (e.g. WGS84 or GDA94) with detailed information about this provided in the map notes (usually, at the bottom centre of the map). The map zone (e.g. 54L) is viewable on topographic maps published by the Commonwealth of Australia. This information need not be included with each and every coordinate, but it is important to write down in your field notes when starting a new field project (or
if, for some reason, you change datums during your fieldwork), and it is essential that you include this information when sharing or archiving your data.

[[INSERT TABLE 3.1 HERE]]

Obtaining a grid coordinate from a topographic map

To obtain a grid coordinate to the nearest 100 m for a location on a topographic map, follow these steps referring to Figure 3.4 as you go:

1. Identify the first two digits in your coordinate by referring to the south-western corner of your map. Generally, this is as shown in Figure 3.4, with one or two small superscript numbers ahead of two larger numbers and three zeros (i.e. $326^{000}$ m $8072^{000}$ m N). These refer to the full coordinates at the south-western corner of your map, and are usually only provided once on a topographic map. Write down ‘3’ as the first number in your easting and ‘80’ as the beginning of your northing.

2. The border around your map shows large black figures that label the eastings and northings at 1000 m intervals. Locate the nearest vertical easting to the west of the site, and the nearest horizontal northing to the south of your site. Write these two digits down for both the easting and northing. Using the example in Figure 3.4, you will now have 326 and 8072.

3. Further divide the grid square into ten equal vertical eastings, and identify the number of the nearest easting to the west of the site. Do the same horizontally, by subdividing the northings into tenths. In doing this, you are identifying minor eastings and northings within the grid square. Write these two numbers down. In the example in Figure 3.4, we have 3268 E and 80723 N. A ruler, protractor or map reading square can help
with estimating tenths. If you have none of these things, then use a piece of paper and the linear scale provided on the map to mark the tenths.

4. Because you are only obtaining a coordinate to the nearest 100 m, add ‘00’ at the end of your easting and northing (e.g. in our example, we now have 717900E and 8534500N). This is your easting and northing, providing your grid coordinate.

5. Find the datum and zone on your map. In Australia, it will commonly be WGS84 or GDA94. It can sometimes be useful for other people if you also write down the map sheet name and number (e.g. 7971-4 Jack’s Hill), but be aware that, while humans find this information useful, a global navigation satellite system (GNSS) handset or mapping application will not require it and it is not strictly required because the point of a full coordinate is that it is meaningful even without a specific map in hand. Add this information to your easting and northing and you have a full coordinate as follows: 326800E 8072300N (MGA94, Zone 54L).

[[INSERT FIGURE 3.4. HERE]]

Figure 3.4: Calculating a grid reference

Compasses

A compass uses a double-ended magnetised needle to indicate north, with the magnetic end often coloured red or black. In the most common types the magnetic needle floats within clear liquid inside a plastic or metal housing that allows the needle to rotate so that it will always point towards magnetic north. On some compasses the outside of this housing features a movable dial that indicates bearings in degrees. These increase incrementally in a clockwise direction from 0° (north) at the top to 90° (east), 180° (south), 270° (west) and
back to north. These bearings are often referred to as ‘due’ north, east, south or west. The housing of the compass may also contain direction of travel lines or some other means to sight the compass on a feature (Figure 3.5).

[[INSERT FIGURE 3.5 HERE]]

**Figure 3.5: Different types of compasses**

Before using a compass for the first time it is important to know what local attraction is. Local attraction refers to any localised magnetic fields that can influence the direction of a compass needle and cause it to point away from magnetic north. For instance, large metal features such as posts, concrete reinforced with metal, buried metal structures (e.g. pipes) and metal fences all have weak magnetic fields that are strong enough to influence a compass reading. Electricity can also cause local attraction, so you need to be aware of the location of power lines or other such features. The area that local attraction will influence depends on the feature in question. For example, a large metal structure, such as a transmission tower, will have a much stronger local magnetic field than, say, a single metal fence post. Indeed, even some metal jewellery worn on the upper body of the compass user can cause local attraction. It is usually best to avoid using a compass near any feature with local attraction, since there will be no way to prevent it from influencing your reading.

There are three common types of compass used by archaeologists (see Figure 3.5). The first, and most common, are baseplate compasses which are typically made of hard plastic and are flat and designed to be held in the palm of your hand. They are characterised by a flat, transparent baseplate with sighting lines indicated together with a rotating compass dial that houses the magnetic needle. They are the least accurate, and are difficult to obtain bearings beyond 2–5 degrees in accuracy, however, they are easily used for beginners and are excellent for general navigation and site surveying purposes where an error of 2–5° is not likely to cause significant problems. For greater accuracy, to within 1–
2°, archaeologists should ideally use either a prismatic compass or a sighting compass. Both should be held up to eye level and aligned with the target or destination point. The **prismatic compass** uses one or two small mirrors that allow a specific position to be sighted while taking a bearing from a floating needle. While they can be somewhat confusing to use for the first time, because of the arrangement of adjustable mirrors, vanes and other small moving parts, they are a core item in many archaeological field kits. **Optical sighting compasses** provide a slightly greater degree of accuracy. They feature a magnetised disk that points to north (instead of a floating needle), which is contained in a small metal housing. Magnifying optics within the housing allow you to see the bearings indicated on the magnetic disk. They are used by being held close to the eye, with a sighting taken through the device to the target. Like prismatic compasses, they can take some getting used to, but they can obtain a higher degree of accuracy than other types of compass. With care, a bearing of 0.5–1° can be obtained by an experienced user.

**Compass tips**

Compasses are essential for field navigation and all archaeologists should be familiar with their use, particularly if you’re navigating (even with the aid of a GNSS handset), drawing plans or conducting site surveys. Below are some of the essential skills you need to know.

[[INSERT FIGURE 3.6 HERE]]

**Figure 3.6: Taking a compass bearing**

*Find the direction of magnetic north.* The compass always points to magnetic north, and this is indicated by the coloured tip of the magnetic needle (which is often red), so simply looking at this provides you with a general indication of where north is. If you want to be more precise, you can also rotate the compass dial so that 0° (or ‘N’) on the dial aligns with the direction of travel lines on the compass baseplate (see Figure 3.6).
Once you’ve done that, rotate the compass (and yourself) so that both the 0° and direction of travel lines both align with the magnetic needle.

**Obtaining a bearing in the field.** A **bearing** (also called a **forward bearing**) is the angle between two imaginary lines extending from the centre of your compass dial. The first is a line to magnetic north along the magnetic needle and the second is a line to your target, or the feature that you want to record a bearing to (e.g. a survey point or a navigation waypoint). To obtain a bearing from an orienteering compass:

- Point the direction of travel lines toward your target or destination.
- Keep the compass fixed on your target, but move the dial so that north (0°) matches the direction of the compass needle.
- The difference between the direction of travel lines and the direction of the compass needle will give you the angle or bearing from where you are standing to the feature: simply read where the direction of travel lines intersect with the degrees indicated on your compass dial. That is your bearing.

This can be achieved much more quickly with a sighting or prismatic compass. Simply take a sight through the compass to your target and note down the bearing.

**Obtaining a back bearing.** A **back bearing** is precisely 180° inverse to a forward bearing. Knowing a back bearing can be useful in situations where you need to record a bearing from your destination back to your point of origin (e.g. when you want to avoid getting lost or want to check the accuracy of your bearing). Obtaining a back bearing might also be necessary if it is not possible to obtain an accurate forward bearing at your origin point, for example, because of local attraction (or prickly vegetation!). To find a back bearing, simply subtract 180° from the forward bearing if it is over 180°, and add 180° to the forward bearing where the forward bearing is less than 180°.

**Checking bearings.** It is not uncommon for errors to be made with a compass due to local attraction or because the user has misread the bearing. There are two ways these errors can be minimised or avoided. First, for important bearings, such as when setting
up a survey instrument or taking a bearing for a baseline, get a second opinion. If two people cannot agree on the bearing, then you at least know someone is incorrect. Keep taking bearings until you agree. This is particularly important if a user is new to using a particular type of compass (especially with prismatic or sighting compasses). Second, if possible, take a reverse bearing from the target point back to your destination point. The difference between the two readings should be 180°. If this is not the case, either user error or local attraction is influencing one of your bearings. But which?

**Using waypoints.** A waypoint is simply a specific coordinate in physical space. While the term is commonly used with GNSS navigation, they are also important when using compasses for navigation purposes. If navigating with a compass, always take a bearing to a specific waypoint before commencing your journey. This might be a prominent tree, a landmark, a building or some other obvious physical feature, and by walking towards it, you always have something to aim for. In very flat country with tall vegetation (e.g. typical Australian savannah woodland), however, this can be difficult because you have only limited visibility, so more care should be taken and more waypoints used to help navigate.

**Digital compasses.** Phones and GNSS handsets frequently include a digital compass. Care should be taken if using these, as they sometimes lack the precision of a good quality compass and may result in errors. Be sure to understand what ‘north’ the device is pointing to (see ‘North’ on page ##) and make sure that you have completed any necessary calibration required to use the instrument (read the owner’s manual). There are also specialised digital compasses that provide a very precise means of obtaining a bearing, and these can be purchased from specialised scientific equipment suppliers.

**Converting between different norths**

Using a compass in the field is very convenient, but it is always necessary to apply one of several correction factors in order to represent compass bearings
accurately on a paper or digital map, or when compass navigation relies upon bearings that are derived from a map (see ‘North’ on page ##).

**Magnetic declination** is the difference between true and magnetic north, and is expressed as an angle. Declination varies depending on where you are because of the variation in the strength of the Earth’s magnetic field. Most of Australia east of about Kalgoorlie is in an eastern or positive declination, while only a small part of the south-west of Western Australia falls within a western declination. Most topographic maps provide the magnetic declination value at the time of publication, which will be indicated in a small figure alongside a small north arrow at the bottom of the map sheet. You should always take careful note of the small print, which explains how to apply a correction factor to adjust the magnetic declination value for each year since the map was published. You can also easily obtain the precise magnetic declination for a time and place using any number of web-based applications. For example, the United States’ National Oceanic and Atmospheric Administration (NOAA) provides a useful declination calculator at [http://www.ngdc.noaa.gov/geomag/declination.shtml](http://www.ngdc.noaa.gov/geomag/declination.shtml), while there are numerous smart phone applications that will do the same thing.

A magnetic declination value can be used to convert a bearing from magnetic north to true north, or vice versa. To convert from magnetic to true north, subtract the declination value from the compass bearing if you are in an eastern (positive) declination, and add it to the bearing if you are in a western (negative) declination (Figure 3.7). It is simply a matter of doing the opposite when you need to convert from true north to magnetic north.

![Figure 3.7: MD conversions](http://www.ngdc.noaa.gov/geomag/declination.shtml)
situations where this might be useful. For example, if you were using a
topographic map and compass to navigate to a site you would need to convert
grid bearings derived from the map to magnetic north so that you could navigate
using the compass. Similarly, to plot compass bearings on a map so that you can
show your route, you would need to convert magnetic bearings obtained from
your compass to the grid bearings that are present on the map. Another common
scenario is when there is a need to create a survey plan showing a UTM grid,
such as when using a total station to obtain data for entry into a GIS.

There are two correction factors to take into account when doing this: Grid
convergence and the Grid-Magnetic Angle. Like magnetic declination, these are
both represented as angles and the precise correction factors need to be
calculated each time you head into the field. Grid convergence is simply the
difference between true north and grid north in whichever projection system
you are using. This is usually less than ±2° and is a basis for converting from grid
north to true north, or vice versa. By combining the grid convergence value with
magnetic declination, you can quite easily calculate the Grid-Magnetic Angle (G-
MA). This angular value is essential, because it allows grid bearings to be
converted to magnetic and vice versa.

**Satellite navigation**

Satellite-based positioning systems with worldwide coverage have made the
location and mapping of sites more efficient and detailed than ever. The best-
known of these is the **Global Positioning System (GPS)**, a term that has entered
common usage to refer to receivers or handsets that connect to this satellite
system. The GPS is not the only satellite navigation system of interest to
archaeologists: the Russian **GLONASS**, which is a separate network of satellites
providing similar positional precision, is increasingly being used alongside GPS
in survey grade satellite navigation equipment. While the term ‘GPS’ is frequently used as a catch-all for satellite navigation systems, here we use the term ‘global navigation satellite system’ (GNSS) or ‘satnav devices’ to describe both of these global geospatial positioning systems. Other countries, such as India, are also currently developing new systems, so increasingly it will be the case that satnav devices draw on multiple GNSS networks.

**Obtaining GNSS coordinates**

A GNSS receiver is a device—often a small handset—that will provide the user with 3D coordinates at a specific location. This position is estimated based on signals received from a navigation satellite system depending on how well your handset is able to ‘connect’ to individual satellites. Most consumer handsets use GPS, but dual systems that will connect to GLONASS are increasingly common and usually offer higher precision. Handsets will attempt to connect to multiple satellites to allow your position to be calculated. The number of satellites required for a coordinate to be calculated varies: a low precision coordinate could be obtained from three or four satellites, but newer handsets will connect to as many satellites as possible. Some of the more accurate GNSS handsets increase precision by using both the GPS and GLONASS networks—and claim 3–5 m accuracy. Generally, horizontal coordinates are more accurate than vertical ones.

Locational information can be viewed on the receiver both via a graphical map display and in numerical format. Coordinates can be stored as waypoints and then later exported to a computer, while most GNSS receivers can also create ‘track logs’ that record your coordinate at set intervals. Tracklogs are a fantastic means of recording movements during a survey and also are useful for navigational purposes. Handsets using the global positioning system calculate your location as a latitude and longitude using the WGS84 datum (see ‘Geodetic
datums’ on page ##). You can customise how your handset presents this information, for instance, you can set it automatically to convert WGS84 to different types of geodetic datums or even into specific map projection systems depending on where you’re working. In Australia, many handsets allow you to project coordinates into a specific zone of the Map Grid of Australia (1994) projection system, which is very useful when used alongside a topographic map, as the grid coordinates displayed on your handset directly relate to the grid printed on your map.

**Positional errors with GNSS handsets**

All GNSS-derived coordinates include a positional error, though the error margin is quite variable. Positional precision or accuracy is usually indicated on the device as an estimate of ±X metres, which in practice means that your coordinate is accurate to within plus or minus X metres of your current position. An error of ± 5–7 m is very good for a consumer grade handset, while an error of 20–30 m is quite poor. If your handset does not show the error margin, then you should reconsider whether you should be using it in the field. It is also important to think about what degree of error is acceptable given the aims of your project. For instance, creating a large scale survey (e.g. 1:500) plan of a site using a GPS with an error of ±15–20 m is not going to yield a very accurate plan, but the same GPS might be ideal for creating a small scale plan illustrating the relative positions of sites recorded in the field, or your survey extent (e.g. at a scale of 1:10,000). As with any surveying equipment, there is always a threshold at which an error margin becomes unacceptable.

The first issue to consider when thinking about positional error is the device you plan to use. This is because the accuracy and reliability of GNSS handsets can vary widely. Handsets that are old, low cost or built into some smartphones or other electronic devices can often have greater degrees of imprecision as a result.
of the hardware built into them. Newer handsets are more likely to have hardware enabling faster or more precise position estimates, with an increasing number claiming accuracy in the order of ±2.5–5 m. Common hand-held GNSS receivers provide readings accurate only to between 5–10 m, while more advanced, surveying grade GNSS equipment provides sub-centimetre accuracy, and are very useful for generating detailed survey plans (see ‘Differential and Real Time Kinematic GPS’ on page ##). If you are purchasing a GNSS handset, make sure to do your research in order to find one that will provide suitable accuracy for your needs.

A number of sources of error will influence GNSS handset precision. Atmospheric interference influences the positional accuracy of all standard GNSS receivers, distorting satellite signals as they pass through the ionosphere. While advanced users can post-process recorded data to reduce this error, it is generally an error margin that needs to be accepted because there is little that can be done in the field to decrease it. Survey grade GNSS instruments can correct for this error, significantly increasing accuracy (see ‘Differential and Real Time Kinematic GPS’ on page ##). Similarly, the relative position and availability of satellites is a major influence on accuracy but there is little that can be done to control this. The environment in which a handset is being used is also influential. A handset will be unable to connect to a satellite if the signal has to pass through buildings or other physical obstacles (e.g. large hills or a dense tree canopy). This can reduce the number of visible satellites, and thereby reduce precision. A related source of error is ‘multi-pathing’, which occurs when your handset receives an indirect signal from a satellite because the signal has ‘bounced’ off a physical obstruction, for instance, a large building that deflects the signal. Multi-pathing can occur wherever there are large, physical obstacles, including heavy woodland, buildings or even prominent landforms. Generally speaking, the best reception will be possible where you have a clear view of the sky in all
directions; if a landform or feature obscures this, there is a risk of multi-path error. You can try and improve accuracy by averaging coordinates by manually taking numerous readings for the same point over a number of hours or days. Some handsets will automatically average a position, which is a useful function, and simply requires leaving the unit to take measurements for a few hours.

**Site cards, older coordinates and the problems with relocating sites**

At some point you may be faced with the challenge of having to relocate sites found by other people, some of which may have been recorded many years ago using older systems. When you acquire site data from a government register search, for example, you may be given information from site cards that were recorded using an older projection or an earlier geodetic datum, or where the device itself had very low precision. It is essential to think about possible positional errors whenever using data collected by others, especially where that data was collected prior to about 2005.

In NSW, for example, the first site cards were held (as actual hard copy cards) by the Australian Museum, then transferred to the National Parks and Wildlife Service (NPWS) in the mid-1970s when that agency assumed jurisdiction over Indigenous sites. The earliest site coordinates were recorded on imperial maps, which only recorded sites to the nearest 100 yards (approximately 91 m). The conversion to metric maps occurred later and didn’t take place all at once, so many sites were still being recorded in imperial coordinates well into the 1980s. When the NPWS imported these site coordinates into their first computerised database (called MINARK) in the mid-1980s they converted the imperial positions to metric using the map datum and grid system that was current at the time (AGD84). AGD84 was later replaced by a newer datum, however, that shifted the location of all points in space by about 200 m. At each of these stages further potential errors were introduced, irrespective of whether or not the site coordinates were accurate to begin with. Even when sites have been recorded directly in the metric
system, some site cards may only provide the coordinates without specifying the datum, so you won’t know whether these were recorded using AGD or GDA until you try and find them in the field. In addition, site cards contain varying levels of information and you may be left trying to interpret a brief written description of a site to see if it matches what you can see in front of you; this will not be helped if the site conditions have changed since it was first recorded (which, of course, is highly likely).

All of this means that trying to relocate such sites is complicated, if not impossible in some cases, and will probably take you a lot longer than you expect. Your success will rely on your knowledge of mapping systems and conversion processes, your understanding of the conditions under which sites were recorded originally (and by whom), and your ability to question the data and interpret what you see—and in some cases you still may not be certain that you’ve found the sites at all.

**Differential and Real Time Kinematic GPS**

Both Differential GPS (DGPS) and Real Time Kinematic (RTK) GPS are alternatives to hand-held GPS that correct for the various sources of error affecting GNSS network signals (see ‘Obtaining GNSS coordinates’ on page ##). Many DGPS and RTK GPS devices can receive information from all available GNSS networks (GPS, GLONASS, etc.) and use a second, stationary base unit at a known location to calculate the degree of error between the base and a mobile GPS unit. The closer the stationary unit is to the mobile unit the more accurate the error correction will be, since both will be accessing the same satellites and the signal will be travelling a similar path through the atmosphere and encountering the same sources of potential error. A DGPS uses software to apply the correction factor during post processing of the data (i.e. after the survey is finished). An RTK GPS, on the other hand, receives the correction factor in real time (i.e. as you are using it) via a radio signal so you can check the quality of the measurements immediately. Both DGPS and RTK provide rapid, highly accurate means to collect
spatial data across large areas, since they allow users to carry a portable unit for recording data. The costs of purchasing this equipment, however, can be significant and prohibitive.

DGPS and RTK units can be used to record site locations or to produce detailed plans of sites. DGPS can achieve a horizontal accuracy of less than one metre and RTK improves this to around one centimetre. As with all GPS use, however, selecting times with the best satellite geometry for a survey will provide more accurate results, although this may not always be within your control. Single network DGPS is most accurate when the distance between the base and mobile unit is less than 20 km, unless multiple GNSS networks are used, in which case it will be accurate over larger distances. An RTK can operate up to 30–40 km from the base station, but only when using a more expensive dual-frequency system. Single-frequency systems will be cheaper, but will only operate up to a maximum of 10 km from the base station. RTK systems that rely on mobile phone coverage for correction signals lose accuracy as you move further away from the base station, and are also redundant in areas where you have no phone coverage. Ideally, you should know the location of your base station to the same accuracy as you expect your positions to be calculated. The base station needs to have a clear view of the sky and a continuous line-of-sight to the mobile unit.

**Mud maps**

Strictly speaking, these are not maps, but rough sketches of an area which are not usually drawn to scale (i.e. they are not measured accurately). Mud maps are created in two main situations:

- to record the route you travelled to a site, so that you or someone else can find the site again (a travelling mud map); and
to give a general idea of the shape and context of a site if you don’t have enough time to record it properly but need to know its basic layout (a site mud map).

Travelling mud maps are an important and relatively easy way of making sure you can relocate a site. They are made fairly quickly and only need to contain the information that is essential to finding your way back to a site. They are not really necessary in urban or suburban contexts, but will be essential in rural or remote contexts where locations can only be described in relation to physical features of the landscape. Travelling mud maps are something that may be used by other researchers at some stage in the future (i.e. to relocate your sites), so it is best if you are as explicit in your directions as possible. Some fundamental rules for making travelling mud maps are:

- Make sure that the core information relates to the decisions you make at turning points on the route. Every decision to turn should be recorded.
- While mud maps are not made to scale, some indication of distance travelled between waypoints is essential. You can do this by simply noting the speedometer reading in the car, or by counting the number of paces you walked.
- Major, permanent features on the landscape should be recorded to indicate waypoints on the route.

Figure 3.8: A travelling mud map

Mud maps of sites are made to give a general overview of what the site looks like. They turn abstract phrases such as ‘a large scatter of stone artefacts’ into a concrete image of the site itself. Again, these maps are made quickly and only contain the most significant information and will not be useful for in-depth research or for making critical management decisions (such as how close to the
site a road can be built). They should never be used as a substitute for a proper, scaled map or plan.

If you’re working by yourself, you can construct a mud map using a compass to plot direction and your pace length (the length of your stride) to measure distance. Before you can employ this technique you need to know how to use a compass (see ‘Compass tips’ on page ##) and how to calculate your pace length (see ‘Pacing it out’ in Chapter 6).

Some fundamental rules for making mud maps of sites are:

- Include at least one permanent feature on the map, and all of the major features.
- Show the approximate location of all archaeological materials, the extent of their area and any areas of damage.
- Include basic information, such as a north arrow, your name and the date on which you made the mud map.
- Dimensions can be included in approximate terms (e.g. approximately 20 m), but it is best if you pace this out, rather than guess it.
- Don’t forget to augment the mud map with a universal grid reference, photos and notes and never rely on a mud map as the only recording of a site’s location or its contents.
- Consider taking a coordinate for a prominent feature, to help others relocate the site in future.

[[INSERT FIGURE 3.9 HERE]]

Figure 3.9: A mud map of the site

Useful resources

Online maps and geographic information for Australian states and territories: http://australia.gov.au/content/online-mapping-services. All states and territories provide some means to access their spatial data online, such as SIX: The Spatial Information

MapConnect: An interactive service provided by the Australian government that allows you to download Australian maps and data for free: http://www.ga.gov.au/scientific-topics/geographic-information/topographic-maps-data/mapconnect.

Constructed to facilitate the minerals industry, http://www.geoscience.gov.au/about.html allows you to view scanned geological maps for any area of Australia.

Fundamentals of mapping provided by the Intergovernmental Committee on Surveying and Mapping at http://www.icsm.gov.au/mapping/index.html. This site provides a comprehensive overview of the principles and practices of mapping and cartography, including datums, projections, types of maps, GPS and navigation.
CHAPTER FOUR

RECORDING LANDSCAPES

What you will learn from this chapter

• The difference between site and non-site approaches to archaeology
• Strategies for sampling in archaeology
• Techniques for remote sensing and the different kinds of data they provide
• The basics of recording slope, geology, soils, transects, ground-surface visibility and vegetation
• The importance of assessing effective survey coverage

Landscapes in archaeology

The term ‘landscape’ is frequently used in discussions of field survey, and can mean very different things. At a basic level, landscape means the physical features of an area. In archaeology, this is often used to refer to a combination of characteristics, including surface geology, geomorphology, contemporary vegetation and topography. The term ‘landscape’, however, is also frequently used to describe the combined natural and cultural features of an area, recognising that humans frequently modify natural landscapes, sometimes subtly and sometimes dramatically. For this reason, it is not possible to talk about a ‘natural’ physical landscape that is free of evidence of human activity, and when describing physical landscapes we need to take into account evidence of cultural practices that have helped to shape them. Here we use the term ‘physical landscape’ to describe the physical qualities of an area of land.
We take the term ‘landscape approach’ to mean a regional approach to investigating past human activities within a physical landscape, and the cultural practices that have shaped these landscapes. This approach seeks information and connections on a larger scale, beyond specific bounded sites, and explores the relationships between sites, material culture and the physical landscape itself. Analysis of spatial relationships is integral to this and archaeologists interested in these relationships might investigate issues relating to the distribution of particular artefacts or site types and possible relationships to natural or cultural features in a particular study. In thinking about human activity at this scale, it is also important to recognise three key points. First, landscapes change through time, often in ways that are difficult to discern without specialist training—so the landscape that you encounter during your surveys is almost certainly quite different to that which existed 100, 1000 or 10,000 years ago. For this reason, some archaeologists who adopt a landscape approach often collaborate with specialists who can help reconstruct past landscapes (or palaeo-environments) via studies of past vegetation (palaeoecology) and the evolution of physical landscapes (geomorphology). Second, past human activity within a landscape varied through time and across space, being structured by cultural practices, social organisation, economic systems and so on. A key element of landscape archaeology involves trying to identify and understand archaeological patterning linked to how people used different parts of a landscape, and how this may have changed through time.

Central to addressing questions about human activity at a regional scale, however, is recognition of a third key point that unifies landscape approaches in archaeology: that site formation processes (or taphonomy) can have differential impacts on the preservation of archaeological residues within a physical landscape. Geomorphological processes, or natural processes that shape the Earth’s surface, for instance, can remove, bury, expose or conserve cultural
materials. For example, a shell midden created atop a small ridge will be more likely to be preserved than one deposited on a beach ridge near the shoreline where storm surges would potentially destroy it. Key to a landscape approach, then, involves trying to answer questions about the differential impacts of taphonomy across a landscape. Certain landforms are more or less likely to preserve evidence of past activity by people and will have been of different importance to people in the past. The portion of a site that you can see might simply be visible because of active erosion, land clearance or other factors (see ‘Determining effective survey coverage: what reveals, what conceals’ on page ##). It might be a small part of what is really a more or less continuous background scatter in the landscape, not all of which is visible to you. In this case there is really no point in focusing on sites per se, since you can’t be certain that what you are seeing was not created over a very long time span, perhaps by many different people and separate activities.

**Non-site or distributional approaches** look at the ways that archaeological artefacts or features are distributed across a landscape and take this as the basic unit of analysis, rather than focusing on discrete concentrations of material, or ‘sites’ (Richards 2008) (see also ‘What is a site?’ on page ##). Non-site archaeology aims to map the distribution of archaeological material first, then place interpretive boundaries (which may or may not be called sites) over this distribution later on the basis of survey results and the research questions. Such an approach is particularly suited to exploratory surveys, since it gives you the ability to study both artefact-rich and artefact-poor areas equally before deciding where to focus subsequent work. Using such an approach, however, will require you to make critical decisions about how to define a site (see ‘Defining a site boundary’ on page ##) and therefore how you’re going to deal with the lower density material located around, or between, concentrations.
Landscape approaches also sometimes entail investigation of not only physical environments, but also the social or cultural landscapes in which people lived. These terms often have meanings linked to very specific theoretical frameworks, but generally relate to the ontological and experiential dimensions of a physical landscape (or features within it) for people who lived in or passed through it. Researchers exploring these issues might consider how people in the past perceived a landscape in terms of power, cosmology, social organisation, gender, or economic status, for example. If the objective of a landscape approach is to understand human activity beyond the ‘site’, then exploring what a landscape meant to people is as important as understanding the effects of taphonomy on-site preservation. Here we focus principally on fundamental methods for recording data at a landscape scale, rather than conceptual or theoretical issues of what constitutes a social or cultural landscape, and refer the reader to various volumes dealing with these issues in more depth (see Ashmore and Knapp 1999; Bender 1993; David and Thomas 2008; Layton and Ucko 1999).

Finding sites

Regardless of whether you are undertaking a research or consultancy project, the initial part of most archaeological fieldwork will be directed towards finding sites. Field survey is the process of systematically searching for archaeological materials or other features of interest (e.g. certain landforms), in order to address archaeological research questions. Field surveys can be intensively focused on a small area (such as a paddock) to document the distribution of artefacts on the ground surface, or they can be focused on very large areas (such as a national park or even an entire state) to understand the distribution of archaeological materials across a broader landscape. Regardless of the intensity, surveying is an essential skill for the archaeologist, particularly in Australia.
where much of the country remains unsurveyed by archaeologists at all, and so consequently a majority of employment opportunities involve organising, conducting, and reporting on field surveys.

Unfortunately, there is no fool-proof way to conduct a survey, and the likelihood of you finding archaeological materials depends on a number of factors, including the ground-surface visibility conditions you encounter in the field (see ‘Determining effective survey coverage: what reveals, what conceals’ on page #), how much time or labour is available, how large an area you have to survey and the nature of the sites themselves. Indeed, even the most well-organised and well-funded field survey is highly unlikely to find all of the sites or artefacts that exist in a study area, but you can maximise your chances by having a strong research design (see ‘Research designs’ on page ##) and by planning your methods in advance so that they are appropriate to the goals of your study. Another consideration in field survey is a sound understanding of the landscape context you’re working in.

**Survey design**

The purpose of an archaeological survey is to inspect the survey area for archaeological evidence relevant to the project’s research design. More specifically, this usually involves looking for archaeological deposits on the ground surface (such as artefacts or discarded food remains), for evidence of landscape modification (mounds, depressions, clearings), built structures (buildings, stone arrangements), rock art, or areas where there may be buried archaeological deposits (e.g. rockshelters) (see Chapter 5: Recording sites). A **survey design** is an overview of the methods that will be used to do this and will discuss issues such as survey intensity, sampling, site identification, site recording and logistics. Surveys are designed to address key aims in the research design, and so it follows that they will be unique and tailored to each research
project. In some cases, an archaeologist will design and conduct a survey to identify the full range of archaeological features within a defined area, while in others, particular types of features might be the focus. A field survey designed solely to find rock art sites, for instance, would adopt very different methods to one focused on finding historical artefacts within the same landscape. A commercial archaeological project designed to identify all archaeological features would use an entirely different method again. As such, you should never attempt to design a field survey without a good research question to guide you.

It can be difficult to make firm decisions about survey methods if you are entirely unfamiliar with the area being investigated. While desktop research into the known archaeological record and the characteristics of the landscape is essential (see “Desktop” research’ on page ##), it is also often very helpful to conduct an initial reconnaissance visit. Such a survey allows you to see whether there are any obvious site types, to assess the vegetation and landforms and to identify logistical issues, such as the location of fences, tracks, impassable waterways, areas of disturbance and so on. Reconnaissance visits are usually quite informal in that there is no specific survey strategy, but instead, involve driving or walking through parts of the survey area that are of interest in order to learn more about the area and, in turn, to help you devise the best survey strategy to use. The survey phases following on from a reconnaissance visit require more formal methods that are clear before commencing work. This is the phase during which you will record all visible sites, so when devising your survey methods for this phase you will need to consider two key issues: survey intensity and coverage.

**Survey intensity**

The conventional approach to field survey involves survey team members walking parallel to each other along a survey transect (Figure 4.1), which is
usually predetermined and designed to obtain an adequate sample (see ‘Sampling’ below). **Survey intensity** refers to the interval between individual team members, and is a good indicator of the level of detail of a survey (Richards 2008: 554). High-intensity survey means that people are walking closer together, while low-intensity survey means people are spaced further apart. It is difficult to make generalisations about the degree of intensity that should be used in a field survey, as it depends entirely on the questions and aims driving the research, as well as the landscape you're working in. To make decisions about survey intensity it is necessary to consider the expected ground visibility in the area being surveyed and the characteristics of the archaeological record being investigated. Excellent ground-surface visibility during a survey where the focus was on physically prominent archaeological sites would be conducive to low survey intensity, because the sites would be relatively easy to find. For example, a survey to locate the remains of historic buildings in an arid or semi-arid landscape could conceivably have people spaced out at 30–50 m intervals and achieve appropriate results. Yet, if the intention was to find more subtle surface deposits of stone or historical artefacts in this same landscape, then this strategy would be unlikely to be very successful, as isolated artefacts or even concentrations of artefacts could be easily missed. If this was a problem, then a higher intensity survey would be necessary—with people spaced at perhaps 5, 10 or 15 m intervals.

Generally speaking, survey intensity should be consistent throughout a project to ensure comparable results. Some research designs, however, may call for several phases of field survey and differing levels of survey intensity in each phase. For instance, an initial low-intensity survey may allow a survey team to cover large areas relatively quickly. This could then be followed by more strategic, high-intensity surveys around areas of interest, such as places where
artefacts are more numerous, where ground-surface visibility is very good, or where ground disturbance by modern activities is low.

[[INSERT FIGURE 4.1 HERE]]

**Figure 4.1: High- and low-intensity surveys**

**Sampling**

Archaeologists are often only able to examine a proportion of an overall collection or study area. This might mean choosing a selection of artefacts from within a surface deposit of many thousands, or surveying only a small percentage of an overall area. **Sampling** is the process by which a researcher chooses which parts of that data they will record, collect or analyse, given the various constraints on their project and what they wish to know. Sampling is a fundamental archaeological method and will condition all subsequent aspects of your project, including how reliable your data are at representing a larger dataset, how much variability you are really capturing in your data, and how believable your interpretations of that data are. Sampling choices need to be carefully thought through and made explicit in your research methods, so that the bases for data collection and subsequent interpretation are transparent.

A dataset, site, or landscape can be sampled using one of a range of methods—often divided into probability and non-probability methods. **Probability sampling** means that all sample units have an equal probability of being sampled via one of a range of approaches. These include **simple random sampling**, which involves using a table of random numbers (or random numbers generated by computer software) to choose sampling units. **Stratified random sampling** creates sub-classifications within the sample area or population and ensures that the same number of sample units are randomly selected from each category. **Systematic sampling** focuses on obtaining an even distribution of
sample units from the sampling universe. The **stratified systematic** approach classifies the sampling universe (as per a stratified sampling approach), but then systematically chooses a smaller sample unit from within each category. **Non-probability or judgement sampling**, on the other hand, involves using personal judgement to select the sample units. This usually relates to established criteria. For example, you might want to collect all diagnostic artefacts, to record only certain types of artefacts or to survey all areas near watercourses.

**Selecting a suitable sampling strategy**

Sampling is critical in field surveys because it is rarely the case that you have the resources to survey all of your study area comprehensively. Instead, you have to make decisions about which areas you want to survey in order to address your research questions. Even where complete coverage is the objective, it is unlikely that this will be achieved because surface vegetation, the experience of your survey team, field conditions (e.g. wet or very hot weather) or taphonomic processes will potentially impact whether archaeological materials are identified. Furthermore, as Richards (2008: 556) notes, the areal extent over which an individual is able to identify archaeological surface materials competently is limited to less than several metres around them, so a high-intensity survey at 5 m intervals still leaves gaps between individual transects. So, in this sense, complete coverage of an area at high intensity can still be considered a systematic sub-sample of around 20 per cent, as each team member is probably only effectively surveying a 2 m swathe within a 10 m wide transect.

[[INSERT FIGURE 4.2 HERE]]

**Figure 4.2: Walking transects**

That aside, it is still very important to consider your sampling strategy carefully, because this, in turn, will influence where you place your **sampling units**. Sampling units can take several forms. In illustrations of sampling...
methods, they are often depicted as a grid of squares at a consistent size. In field survey it is commonly the case that these would be tens or even hundreds of metres in size and distributed according to a relevant sampling strategy. Surveying these sampling units involves systematically traversing each area at an appropriate level of intensity (see Figure 4.1 on page ##). That said, these methods are not commonly used in Australia because it is often necessary to move between individual sample units by foot. **Linear sampling units, or transects,** are frequently used instead, largely because they are more efficient to walk. The sample area can be broken up into a series of long rectangular sample units that are of uniform width and length, and then sampled using one of a range of sampling strategies.

[[INSERT FIGURE 4.3 HERE]]

**Figure 4.3: The advantages and disadvantages of different sampling strategies**

**Judgement or non-probabilistic survey strategies**

This is a sample in which the researcher exercises their own judgement as to which areas will be most productive to survey. This judgement is usually based on past experience of where sites are likely to be located and the desktop research that has been conducted into how the area might have been used in the past (see “Desktop” research’ on page ##). In a typical judgement survey the area would be divided into its various geographic zones (hill, creek, plain, gully, ridge) and the zones that are most likely to contain sites targeted for survey. In theory, while all zones might have an equal chance of containing sites, in practice we know that people use landscapes in patterned ways, and that the characteristics of certain places encouraged or discouraged use. You only need to think of a map of Australia, with major cities dotted around the edges and the low number of settlements in arid areas, to understand this idea. This patterning
is influenced by water availability, availability of suitable land for farming, aesthetic and other factors.

The advantage of a judgement sample is that areas which have a high likelihood of containing sites (such as those close to reliable water sources) can be given preference, and areas where it is highly unlikely that sites will be found (such as on extremely steep slopes or open, extensive sandplains) can be avoided. This allows time and resources to be focused on the most productive areas, and also takes the local geography into consideration. Of course, this has its disadvantages, too. Such a survey cannot help but be biased by the researcher's preconceived notions of what the archaeology should be and runs the risk of creating a self-fulfilling study (Redman 1975: 149). If a judgement sample is used, it is important that the criteria for determining the placement of survey units is made explicit so that other people can evaluate your methods and results.

**Random samples**

Some studies attempt to remedy this bias by using a random sampling strategy, in which survey areas are selected by chance rather than by design. Using this strategy, no single area is given preference over any other and all areas have an equal chance of being selected. A random sample can be **simple** (where random spots on the landscape are selected for survey, usually through imposing an imaginary grid over the study area and then selecting areas to survey within that grid based on random numbers generated from a table or computer program) or **stratified** (where the study area is divided into its geographic zones and then sampled randomly within each zone, as you would for a simple random sample survey). Like a judgement sample, a stratified random sample takes into account the geography of the study area and recognises that there might be certain factors which affected the location of sites in the past. In reality, sites are unlikely to be randomly scattered about the landscape: people tend to follow behavioural
patterns which relate to specific needs within the environment, such as water or shelter, and a stratified random sample recognises that they therefore tend to use the landscape in particular ways.

**Systematic samples**

One of the problems with a truly random sample is that some areas or sites are likely to be over-represented or missed entirely. The goal of systematic samples is to remedy this by ensuring that a portion of every area is sampled. You can do this either by **systematic random sampling**, where the first sample unit or area is selected at random and all other areas are chosen in relation to this (e.g. if you decide to place a survey square every 10 km from the first, randomly chosen, survey square), or **systematic unaligned sampling**, where the total area is divided into large blocks and then one smaller block within each larger block is chosen at random (Hester et al. 1997: 30). This still maintains a random element in the selection process, but also gives relatively even coverage across the survey area.

**Site identification and numbering systems**

Before getting into the nitty gritty of site recording, and before you leave for the field, it is important to consider how you are going to label any sites you find. ‘Site 1’ may seem a logical description at the time, but does little to tie the site into your particular research program or its geographic area, or separate your sites from someone else’s. Many archaeologists label sites with a meaningful alphabetical prefix (such as the first letter of the name of the property on which it is found or the consultancy project which generated the survey) and then a sequential number for each site found. Indigenous sites located during a power line survey for Transgrid Pty Ltd in Armidale, NSW, for example, were labelled ‘TG1’, ‘TG2’, ‘TG3’, etc. Other systems superimpose an imaginary grid over the research area and label each site according to its location within any square of
this grid. Sites recorded in the Selwyn Ranges in north-west Queensland as part of an ongoing research program, for example, were given titles such as ‘LzBe1’ which, although unpronounceable, ensured that each site name was unique to that research program. Another approach in large regional databases is simply to consecutively number sites with a prefix for the site type (e.g. ‘SM’ for shell midden or ‘CMT’ for culturally modified trees).

In some cases—particularly excavations—government agencies, such as Heritage Victoria, will control the issuing of unique prefix identifiers for you to use in order to help structure their collections. If the choice is up to you, however, then try to make your site designations meaningful and always think in the long term, particularly if your data are going to end up in a database which centralises information from many different site reports (such as any government site register). How many site ‘S1s’ are there likely to be? If your field journal or site report ever became separated from your site photographs, how likely would it be that someone else could identify those sites as belonging to your research alone? Knowing what previous research has been conducted in your area and how previous researchers identified their sites will also be crucial, since it will be important to sync your site numbering with that of other researchers.

**Determining effective survey coverage: what reveals, what conceals**

Regardless of which sampling strategy you have adopted, the reality is that in some situations your survey area may be decided for you. A landowner may refuse access to their property, Indigenous people may not want you walking in particular areas because of cultural protocols, or some places might simply be inaccessible. In any case, even if you are able to survey every centimetre of ground, it is likely that you will still only be able to see a portion of the total archaeology of the area (Drewett 1999: 44). Sites might be covered by
vegetation, soil or leaf litter, the area might not be actively eroding so that no sites are visible, or poor light from heavily overcast conditions might cause you to miss small artefacts. The important thing is to recognise and record these and any other limitations in your field journal, so that others can recognise this bias and not assume a more thorough coverage of the landscape than you have been able to achieve.

Effective survey coverage is not just how much of the survey area you have physically covered (i.e. your sample), but how favourable the conditions were for locating artefacts and sites. Some sites are highly visible (such as buildings, scarred trees or rockshelters), while others (such as stone artefacts) can be more difficult to locate and may even go unrecorded if vegetation or soil obscures them. As a result, there are two closely related factors which can skew the results of any archaeological survey:

- ground-surface visibility (i.e. how much of the surface is visible to you and what other factors—like vegetation, introduced gravel or leaf litter—might limit the detection of artefacts across this surface?); and
- ground-surface exposure (i.e. what are the prevailing sedimentation conditions? Is the ground-surface aggrading, eroding or stable and what kind of exposures are apparent as a result?).

If you’re surveying in an actively eroding area, such as a creek gully, there is a greater likelihood that artefacts will be exposed, but if you’re walking through a relatively stable and heavily grassed paddock there may well be artefacts present that you simply cannot see. This is why you need to make careful note of the changing vegetation conditions and degree of ground cover across the survey area, as well as the type and size of any exposed areas that you encounter. Information about what has caused or contributed to the disturbance will also
allow you to estimate how well preserved the site is or how seriously it has been affected.

Figure 4.4: The relationship between visibility, surface conditions and the likelihood of finding archaeological sites

To do this properly, you really need to make some estimate of how much of the ground surface is visible to you during a survey, and how much of this visible area has been eroded or disturbed, and is therefore more likely to reveal buried archaeological material. In NSW, DECCW (2010b: 16–17, 39) note that visibility on its own is not a reliable indicator of the detectability of buried archaeological material, and therefore require visibility and exposure to be recorded independently within each survey unit, and for both to be recorded to the nearest 10 per cent.

To do this, you need to take note of the approximate percentage of the survey area which is visible as bare ground, and the approximate percentage which is exposed through erosion or other processes (see Table 4.1). This does not mean that you should only focus your survey on exposed areas and ignore anything with less visibility. It is perfectly possible to find surface concentrations of artefacts in areas which technically have no visibility, provided the artefacts are conspicuous (usually this means large) enough. In general, it is accepted that the outcomes of any archaeological surface survey can only be representative of the visible, rather than the existing, archaeological record.
Potential archaeological deposits (PADs)

One goal of a surface survey is often to identify potential archaeological deposits (PADs) that can be followed up during a later excavation phase (Attenbrow 2003, 2006; Sullivan 1983). These are just as their name implies: deposits with a high (but justifiable) likelihood of containing buried artefacts or other evidence relating to past human occupation at that location, even when little or nothing is visible on the ground surface. There are two important things to emphasise about PADs: the first is that they are not sites per se. Excavation is the only way to reveal a PAD’s potential and, once excavated, it will either be defined as a site or not (depending on what you found and how you defined a site to begin with). The second thing is that labelling something as a PAD is not a definition of archaeological significance. A PAD is only an argument for potential, which must then be tested by subsurface investigation to see if your argument was correct. Only if it is excavated and then proves to be a site can you construct an argument for it having archaeological significance (or not) based on what you've found. The NSW Heritage Branch (2009: 10) makes the important follow up point that, while in most cases excavated artefacts will maintain their significance after excavation as a research collection, poor excavation and analysis methods can lessen that significance or remove it altogether, so the methods you choose are crucial components of the overall process.

Identifying a potential archaeological deposit (PAD)

Identifying a PAD requires all the same skills used to predict the location of any site—e.g. your previous ethnohistorical and other research into how the landscape was used, where other sites have been found and why, and the location of water and other resources. Geomorphology will also provide a useful perspective here, so you may need to gain an understanding of how the various soils of the area have accumulated over time.
Although initially the concept of a PAD was only applied to rockshelters (Attenbrow 2006), it is now applied to any deposit, regardless of where it occurs. You will need to develop a logical model for recognising PADs in your survey area, otherwise you will be unable to distinguish between them and any other non-archaeological soil deposits, or buried artefact deposits with lower, rather than higher, potential. We would suggest, at a minimum:

- For PADs outside of rockshelters in open contexts, they must be in areas that were suitable for camping (e.g. on alluvial river banks or terraces, ridge tops, or dunes) (Attenbrow 2006: 49).
- They must be in areas that have not been heavily disturbed by subsequent activities, or at least not disturbed to a great depth by such activities. You may find that erosion, industrial activity or other factors have exposed soil profiles in adjacent areas, allowing you to assess the nature of the undisturbed deposit.
- In rockshelters the presence of art is often used as an indicator, since this suggests some form of habitation or activity occurring at that place which could have left traces that have now become buried. For any PAD, regardless of context, evidence of habitation close to, or around, the area of potential would be important.
- Any accumulation of soil in a rockshelter could be a PAD and there does not need to be surface archaeological material, such as shell or stone artefacts, in order for there to be archaeological material below the surface. The size of the rockshelter cavity in the present is no guide either, since the accumulation of deposit over millennia will often have reduced the available space.
- PADs are usually defined during surveys, so you need to be able to distinguish them from the surrounding archaeological landscape in which they occur—if there are low-density concentrations of artefacts across the whole landscape, or many other deep deposits of soil, why is one particular location more likely to be a potential ‘site’ than any other? (DECCW 2010b: 25).
This means that PADs need to do more than just represent the ‘background scatter’ in the landscape, so you might use other ways to test for them, such as test pits or auger holes (see ‘Subsurface sampling’ on page ##).

**Describing landscapes**

As noted earlier, it is important to observe and attempt to describe the landscapes in which you are working. The amount of time you spend on describing the physical landscape will depend heavily on the project and research questions: for instance, in some settings with a complex history of landscape evolution and land use, half the challenge of the research may relate to understanding how the landscape has formed and changed through time and the impact this has had on the archaeological record. Coastal settings or riverine floodplain environments are two good examples of landscapes in which you need to be constantly thinking about the landforms and how their evolution may have shaped the archaeological record. In other situations, the landform you’re surveying might be relatively homogeneous and these factors would require little thought at all. There are a number of complementary strands of contextual information at the landscape level that you may need to record in the field: geology, geomorphology, vegetation, slope and sources of water.

**Geology**

Geology is the study of the physical structure of the Earth, including the formation of rocks and of unconsolidated sediments ultimately derived from rock (e.g. gravel, sand). Much of the focus of geological fieldwork involves investigating questions about very long-term processes of landscape evolution, either at the regional or global scale. This involves going well beyond what is visible on the surface and considering horizontal and vertical relationships
between geological structures beneath the ground surface. Archaeologists do benefit from having a knowledge of geology; not only are some of the key concepts in archaeological stratigraphy derived from geology (see ‘The principles of excavation’ on page ##) but a knowledge of surface geology can be very useful in describing landscapes or resolving quite specific archaeological problems—such as provenancing stone artefact raw materials or understanding the evolution of a nineteenth century underground mining operation.

Just as contemporary societies are attracted to particular geological formations (e.g. for mining or for recreational uses), so too were past human societies. It follows, then, that certain types of human activity in the past, and the archaeological deposits that result, are often associated with specific geological features that still exist today. Exploring these relationships can be useful not only when designing a survey, but also when analysing the distribution of sites or artefacts once your fieldwork is complete. For example, locations where particular types of raw material resources are concentrated, such as a rock outcrop, may have appealed to Indigenous people seeking to obtain raw materials to make stone artefacts. Similarly, historic mining activities tended to focus on areas with specific geological characteristics. In both cases, you might expect there to be relationships between the patterning of certain types of geological features and the distribution of archaeological sites such as stone artefact quarries, primary reduction sites, historic mine shafts, or landscape modification linked to alluvial mining activity. In addition to this, observations of surface geology can be integral to addressing questions about taphonomic processes influencing archaeological deposits. Relatively young landscapes formed during the Holocene epoch (the last 11,700 or so years [Walker et al. 2009]), for instance, will not contain evidence of older sites. Rockshelters composed of very weak sandstone may not provide a very sound preservation environment for rock art, which is likely to rapidly disappear due to erosion of
the shelter walls, but these same processes of erosion may help rapidly bury archaeological materials on the rockshelter floor—thus conserving other forms of material evidence.

In both these cases it can be useful to record some information about surface geology when conducting a field survey. Key to this is being aware of **geological formations**, which is a term used to describe a stratum of rock and/or unconsolidated sediments that has strong similarities in terms of composition and characteristics. Geological formations are the coarsest level at which geology is described, and major formations often extend over hundreds of kilometres, interspersed by numerous, more discrete formations. For example, formations characterised by harder, more resistant rocks often represent areas of higher elevation, while river valleys, as areas of lower elevation, often lack any consolidated rock formations at all and instead comprise much younger unconsolidated sediments, such as gravels, sands, alluvium and so on. While learning how to recognise and describe geological formations in the field is a very specialised undertaking, it is possible for archaeologists to access accurate information on surface geological formations quite easily for any part of Australia by purchasing or downloading 1:250,000 scale geological maps. These illustrate the geological formations visible at the surface across the entire country, and provide an indication of their age, characteristics and key technical terms to search that can help you in your desktop research. The associated descriptive information can be very useful in the field or when writing up your results. For example, on the central Murray River near Renmark, one widespread Holocene formation, the Coonambidgal formation, is described as:

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Pale grey clay, silt and sand of the Murray River channels and floodplain
(Lower terrace deposits). Disconformably overlies Monoman formation
in boreholes.
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The extent of this formation is indicated on each map sheet in which it occurs, as are all geological formations visible at the surface. With some searching through various academic databases it is possible to locate papers that describe more fully this geological formation—providing a valuable source of information to supplement your research. This information can, in turn, be drawn upon when designing a field survey; for example, major formations may serve as useful ‘zones’ or strata when developing a strategy that involves the use of probabilistic stratified methods.

**Geomorphology**

*Geomorphology* is the study of processes that occur at the Earth’s surface, in the past, present or sometimes even in the future. It differs from geology because the focus is on understanding the interaction of physical, biological and chemical processes in creating and shaping particular landforms and how landscapes develop and change through time. Many geomorphologists specialise in understanding landscape history, and attempt to reconstruct processes connected to the formation of particular landforms. This involves considering processes that are currently active, as well as those that created or modified particular landforms in the past but that are no longer active. Like archaeology, geomorphology addresses problems at varying temporal scales: the evolution of a river floodplain over tens of thousands of years; the formation of a sequence of coastal beach ridges over several thousands of years; or the erosion and deflation of a dune system since the arrival of Europeans. Field observation and mapping are essential skills in geomorphology, although satellite and airborne data (aerial images, laser scanners, spectral imagery, see ‘Geomatics in landscape archaeology’ on page #) have also become core elements of the geomorphologist's field methods.
Geomorphology is of obvious value for archaeologists given the extent to which processes of landscape evolution at varying scales shape the archaeological record. It is particularly useful when working on archaeological questions where knowledge of changes in the form and character of the physical landscape have implications for how you conduct your field research or interpret your results. For example, geomorphology has been quite central to research into the lifeways of Aboriginal people living within the Willandra Lakes region during the Pleistocene, because this is a landscape where distinct landforms created during the Pleistocene contain much of the archaeological evidence (Bowler et al. 2003). Being able to access spatial data or maps on the distribution and characteristics of particular landforms is very useful in this regard and can provide more detailed information than provided on geological maps. This can provide a greater degree of finesse in an archaeological field research project: for example, you could tailor your surveys to focus on specific landforms or examine the spatial relationships between the distribution and frequency of archaeological sites and specific landform types.

In practice, though, accessing high-quality data on landforms is difficult. Relatively detailed geomorphological data are available for much of the Australian coastline and parts of major river systems (e.g. the Murray River), while geomorphological data are sometimes included in other datasets, such as regional landuse, vegetation or conservation. State-based land mapping datasets sometimes contain data of relevance, often at a larger scale than available on geological maps. The Queensland Regional Ecosystem framework, for example, contains data on landform at a minimum of 1:50,000 scale, while the Victorian Geomorphology Framework offers mapping data up to a scale of 1:100,000. While ideal for regionally-based analyses, the scale of these types of datasets or the quality of data recorded is insufficient for localised research. As such, many geomorphologists (and some archaeologists) routinely map landforms within an
area of interest, and then use aerial or satellite imagery to extrapolate these observations to broader areas. This can be a useful exercise for archaeologists to carry out because you can create your own maps displaying information at a scale suited to your own specific research questions (see Garrison [2003] for an archaeological perspective on geomorphological mapping).

While this can be a complex exercise, and only relevant to some projects, the more fundamental field skill of identifying the landform types that exist within a particular landscape is essential. For example, being able to observe whether the site you’re recording occurs on a dune or a chenier, a river terrace or a levee, an alcove or a blow-out, can be useful not only for describing the context in which it occurs, but also for considering the kinds of processes that have shaped it. Just as with any specialist field of knowledge, however, it can be difficult to know what term to use to describe a landform and as a result there is considerable inconsistency in the Australian archaeological literature about landform types. We recommend the use of standardised terminology and methods for describing landforms as outlined in the *Australian Soil and Land Survey Field Handbook* (National Committee on Soil and Terrain 2009: 15–72). This indispensable manual provides terminology and descriptive detail to assist with field classifications of landform at two scales of high relevance to archaeologists: landform elements and landform patterns.

The **landform element** classificatory scheme is intended to be used to describe the attributes of a particular landform within a 20 m radius of an observation point. Some 80 unique landform element types have been classified based on slope, morphology, dimensions, mode of geomorphological activity and geomorphological agent (National Committee on Soil and Terrain 2009: 17). This level of classification is ideal for describing or classifying discrete landforms in the field, for instance, at a recorded site. Sometimes, however, it is necessary to describe landforms over a larger area—for instance, it may be desirable to
describe the landforms that occur within a broader survey area or on very large sites. A second, coarser level of classification—that of **landform pattern**—can be used to aid this. Landform pattern is generally based on a 300 m radius from an observation point and is used to describe the broader geomorphological setting for more detailed site-based observations (National Committee on Soil and Terrain 2009: 44–5). It encompasses attributes including relief, the most common class of slope (modal slope), stream channel occurrence, geomorphological modes, agents and status and the types of landform elements present. Some 40 landform pattern classifications exist, and these are closely linked to landform elements—since many landform elements can only occur within the broader context of distinct landform patterns.

While the terminology is somewhat specialised, these classifications provide a valuable means of standardising the description of landforms at several scales. Importantly, they take into account geomorphological processes and so encourage field archaeologists to consider observed landscape dynamics when recording sites. If these dynamics are important to your research question, then it is worth evaluating the landform recording scheme further in your own research.

**Vegetation**

Archaeologists commonly assess **vegetation** in terms of two factors: as a guide to the range of plant resources which would have been available to Indigenous peoples in the past and for what it implies about current and past land use, which has the potential both to indicate the possible existence of archaeological sites, and to affect survey conditions, such as ground-surface visibility, access and disturbance.

Vegetation is generally described according to its structure and floristics and the National Committee on Soil and Terrain (2009: 75) provides useful
guidelines for recording field observations about vegetation. **Vegetation structure** refers to the distribution of vegetation both horizontally and vertically within an observation area, together with the growth form, height and degree of cover. **Floristics** means the main family, genus or species and how they are distributed in relation to the vegetation structure.

The coarsest unit of classification is **vegetation formation**: that is, whether the dominant plants are woody or non-woody. A second, more refined level of recording is the **structural formation**: classifications based on height, cover, and growth form—or the form or shape of individual plants. *The Australian Soil and Land Survey Field Handbook* defines 38 structural formations that can be widely applied in an Australian setting to describe the vegetation at particular observation locations. Examples include:

- **Heath** (w3.1): Shrub usually less than 2 m tall, commonly with ericoid leaves. Often a member of the following families: Epacridaceae, Myrtaceae, Fabaceae, and Proteaceae. Commonly occur on nutrient poor substrates.

- **Shrub** (w3.0): Woody plant, multi stemmed at the base (or within about 200 mm from ground level), or, if single stemmed, less than about 5 m tall; not always readily distinguishable from small trees.

- **Tussock grass** (g3.0): grasses forming discrete but open tufts usually with distinctive individual shoots. These include the common agricultural grasses.

By using a standardised classification system such as this it becomes possible to describe vegetation more succinctly and accurately, in a manner that is clearer to others.

Structural formation can be recorded at three levels based on the strata—or distinct layers of foliage and/or branches—that are observed:
- The dominant or upper stratum. This is usually the tallest stratum within a formation.
- Mid-stratum. While not always present, this occurs between the dominant and ground strata.
- Ground stratum. The vegetation formation at the ground surface. If no other strata are present, this becomes the dominant stratum.

When recording vegetation, it is recommended that archaeologists record the vegetation formation for each of these three strata. If key species can be recognised within particular stratum, these should also be noted and described, although it is not always possible to identify species easily in the field (and is prone to error). Where this is not possible, note down locally used names for different species, since many species names can be tracked down if the common name is known. In addition, take photographs of a stereotypical example of the different vegetation strata or key species to supplement your notes.

Additional, more detailed recording of vegetation is possible, but is also more time consuming and often a specialist skill. For example, vegetation formations can be further classified by floristic formation by adding genus or species names (National Committee on Soil and Terrain 2009: 75), but this requires extensive knowledge of species that occur within a particular location and is probably unwarranted for most archaeological studies. Of course, your research questions and objectives will determine the amount of vegetation you need to record; however, all field recording should include at least basic information about structural formation of the upper or most dominant stratum.

**Slope**

Assessing slope can be useful in many settings, since it is a major factor influencing the distribution of archaeological materials. It is also key to the
landform classification schemes discussed above. Slope is recorded in degrees, preferably using a clinometer or estimated according to eye. Using a clinometer is similar to taking a bearing with a compass. You sight through the clinometer along the angle of the slope and, depending on whether you are sighting uphill or downhill, you can read the degrees of elevation or depression. Ideally, when using a clinometer, take your measurements over an area of slope around 20 m long. Sighting along flat ground (a horizontal plane), for example, will give you a reading in the 0–2° range. Tilting your head (and thus the clinometer) above the horizontal plane will give you a reading in degrees of elevation. The higher the number, the greater the slope. A mid-slope is in the 5–10° range and steep areas will have a value of greater than 10°. Conversely, if you are standing at the top of the slope looking down, then tilting your head and the clinometer below the horizontal plane will give you a reading in degrees of depression.

[[INSERT FIGURE 4.5 HERE]]

Figure 4.5: A guide to estimating slope by eye. When examining slope, bear in mind that the eye tends to exaggerate slope

[[INSERT TABLE 4.2 HERE]]

Water sources

One of the major environmental factors influencing human behaviour is access to fresh drinking water, because it is obviously an essential requirement for survival. Furthermore, the availability of many common food resources is influenced by proximity to fresh water. Macropods (the family of kangaroo-like marsupials), for example, need regular access to water and so it follows that well-watered landscapes will likely have more of these present, with obvious implications for how people may have used that landscape in the past. Indeed,
water provides some of the richest ecosystems available to humans. For instance, aquatic resources, such as fish, shellfish, tubers and even sea mammals, are also available in both fresh and salt water, and the environments around fresh or salt water sources often contain a high density of culturally valuable plants and other species.

The main types of water sources are:

- permanent water, such as rivers and soaks;
- semi-permanent water sources, such as large streams, some swamps and billabongs;
- ephemeral water sources, such as small streams or creeks; and
- underground water sources, including artesian water and subsurface streams or water bodies (e.g. beneath coastal dune swales).

Proximity to water influences not only the number of sites likely to be found but also the density of artefacts found at those sites. Though sites can be located quite a distance from water, most are located in reasonably close proximity to it. In fact, the vast majority of Indigenous archaeological sites are likely to occur within 500 m of a water source (Byrne 1993: 18) and, in general, sites located a long way from water will tend to be smaller and contain fewer artefacts. Sites located near a water source are often situated on ground which is reasonably elevated above that source rather than on the flats immediately adjoining it, since these are likely to have been subject to periodic flooding. Water sources also provide potential access to specific site types which will not exist anywhere else, such as axe-grinding grooves or wells.

It can be useful to record the location of all water sources in the proximity of a site, for instance:

- the distance to the nearest available water source (which may be an ephemeral creek);
• the distance to the nearest *reliable* water source; and
• the type of source in both cases.

Importantly, if you are unfamiliar with a landscape then it is important to be aware that seasonal changes can dramatically alter how you might perceive it. In many parts of Australia rainfall is very seasonal and months can pass without any rain at all, with streams and billabongs drying out completely. Furthermore, there may be perfectly good sources of water that you are not familiar with. For example, in many tropical and sub-tropical coastal locations surface water may be absent, but considerable amounts of drinkable water can be obtained by digging shallow wells in low-lying sandy depressions or dry river beds. So try not to let your incomplete knowledge of a landscape influence how you design a field survey.

**Recording taphonomic processes**

There are many different factors which can contribute to the formation of an archaeological site over time, from accidental or deliberate human activity (ploughing, construction, demolition, removal, scavenging) to the activities of animals (grazing, trampling, burrowing, digging), insects (nesting, burrowing, eating) and plants (tree roots, vegetation overgrowth). Even the elements can disturb a site’s integrity through erosion, deposition, scouring or natural collapse. In reality, no site is likely to remain totally unaffected by some type of disturbance process. The collective name that archaeologists give to these activities is *site formation* or *taphonomic processes*; any source of such a process is called a *taphonomic agent*. An assessment of the range of taphonomic processes which might have affected a site through time is principally your assessment of the integrity of a site, not only in terms of how disturbed you think it may be, but also in terms of what might have caused, or be causing, this
disturbance. This is essential, for as Stein (2001: 37) notes, archaeologists analyse patterns in the distribution of artefacts they find to make inferences about past human behaviour—so any factor shaping the distribution of archaeological materials has the potential to influence how we understand both the site and past human behaviour.

Three kinds of general taphonomic processes are of importance to archaeologists: cultural processes that create archaeological deposits in the first place; cultural processes that alter or obscure those deposits after they have been created; and natural processes that alter, obscure, destroy or preserve the archaeological record (Stein 2001: 39). This wide definition encompasses the full range of processes that will have influenced how a site has formed and changed through time—including modern or very recent processes of disturbance.

**Cultural processes** creating the archaeological record include the culturally patterned activities of people at a site or in a landscape that created the deposits in the first instance. The way that Aboriginal people collected estuarine shellfish, then processed and deposited resulting shells in the landscape, is a good example. Where people collected shellfish is influenced by resource availability and socio-demography, while aesthetic, environmental, social and cultural factors may have shaped where people processed, ate and deposited shells.

Cultural processes influencing a site after it has formed include processes in the distant past—even by the same people who created an archaeological site in the first instance—as well as those that are much more recent. For example, Aboriginal cultural practices to do with placing fish bones in fireplaces has the potential to influence the composition of archaeological sites (see Robins and Stock 1990), or the use of a rockshelter by people over thousands of years will potentially affect the preservation of evidence associated with earlier phases of occupation, as increased traffic may lead to enhanced erosion rates, or more recent site occupants may dig pits in the shelter floor. Similarly, early phases of
alluvial mining and the distinct archaeological traces associated with that record may be reshaped or entirely destroyed when new technologies or different economic conditions trigger subsequent phases of mining. A shift to underground mining is often linked to extensive vegetation clearance, along with landscape modification associated with processing and discarding mined sediments. Modern processes are also important to think about: construction activities, road building, urban expansion, agriculture and changes in grazing intensity all potentially influence sites, both directly and indirectly.

**Natural processes** include a complex array of taphonomic agents often acting in unison. They can be subdivided into three general categories: physical, biological and chemical, all of which can work both on sites and within sites to obscure, preserve, reveal, modify or even destroy sites or their various components. **Physical processes** include agents such as wind, water and gravity and the way these move sediments or archaeological materials around in the landscape. Landforms with active and ongoing geomorphological processes, for instance, are likely to have much more influence on archaeological deposits than those relict landforms where there are less active geomorphological processes. Compare, for example, the physical processes occurring on a newly formed sand dune near the sea shore with a dune further inland that formed during an earlier phase of dune development. The former landform has more frequent storm surges, is affected by tides, and is probably being created by the deposition of wind-borne sand. The more inland dune might be considered a relict landform, created during an earlier phase of dune formation and thus is likely to be more stable, perhaps only being subtly shaped by wind erosion.

**Biological processes** include the activities of different organisms on sites and can be macroscopic or microscopic in scale. Any animal that digs burrows is a good example, because this can move archaeological materials from their primary (in situ) context. Rabbits, for instance, have heavily altered many open
sites in south-eastern Australia, and cause significant problems for stratified sites such as middens, because the subtle layers within the site become mixed, destroying important evidence about how people in the past used that site. There are many other macroscopic biological processes, of course, such as any animal that disturbs soil (such as feral pigs), burrowing goannas or other lizards, birds collecting artefacts (e.g. Dwyer et al. 1985) or dogs consuming discarded food.

Finally, chemical processes often relate to the interaction between the chemical properties of an artefact and the context in which it occurs. Rusting of metal artefacts is a common example of this process, and most ferrous metals rust very rapidly when buried in acid soils or left exposed to the elements. Sites more than 40 or 50 years old are likely to have seen the destruction of many artefacts made from thin sheet iron (e.g. galvanised corrugated iron and containers), for example. The deposition of bone or shell within somewhat acidic soil conditions can also quickly cause partial or complete decomposition.

When recording sites or artefacts it is of paramount importance that as much information about the context is recorded so that considerations can be made about the influence of taphonomic processes on a site. Archaeologists place themselves in a very strong position for developing robust interpretations of the archaeological record when they begin asking questions about these processes the moment they begin to record a site or artefact. First, what natural or cultural processes have preserved, exposed, altered, obscured or even destroyed the archaeological site or materials you are investigating? Are some artefacts missing (e.g. through chemical/biological decay or human collecting)? Is the assemblage in situ or is it in a secondary context (e.g. a deflated scatter of artefacts)? Have parts of the site been differentially impacted (e.g. by erosion, or modern construction)? Second, what cultural practices associated with the creation of the site can be discerned and what methods are required to accurately collect data about these practices?
**Geomatics in landscape archaeology**

The last several decades has seen rapid advances in the development of digital technologies of relevance to archaeology, particularly in the area of *geomatics*—the acquisition, storage and manipulation of geographic data. Chief among these has been the increased accessibility of user-friendly GIS software which provides new ways of managing and analysing spatial data collected in the field. Other common technologies of relevance can be broadly categorised as *remote sensing*—or methods that gather measurements or observations about landscapes, sites or objects from a distance, without direct contact. There is a wide range of such technologies that will enable archaeologists to see features that either are not visible, or not readily comprehensible, at ground level. They range from satellite imagery or aerial photography to LiDAR, laser scanning, ground penetrating radar and other geophysical techniques. Some techniques are more useful for locating sites in a landscape or understanding their wider context (e.g. satellite imagery and aerial photography), while others are most useful for generating 3D survey information (LiDAR and laser scanning) alongside more standard 2D terrestrial mapping techniques. Geophysics is most frequently used by archaeologists as a means of subsurface investigation to identify potential excavation locations, determine the boundaries of a site or identify the presence or absence of buried features. Choice of remote sensing techniques largely depends on the purpose of the project, the scale of what is being mapped and how complex the resulting data need to be.

**Geographic Information Systems (GIS)**

It is a common misconception that GIS is exclusively the domain of specialists with years of training and experience. While this is true for those wanting to apply advanced GIS methods to archaeological datasets, it is not the case for those archaeologists seeking to use GIS for basic tasks. Indeed, with the help of
open source software it is possible for a complete GIS novice to be able to take archaeological data with a spatial component and produce dynamic maps within several hours. Many sources of digital data, ranging from digital scans of paper maps (e.g. historical or topographic maps) through to aerial imagery and remote sensing data, are used extensively in GIS platforms and a wide range of data sources are available at no or little cost.

A GIS is simply a term for computer software that is used to collect, create, manage, analyse and communicate spatial data. GIS draws on spatial datasets—usually records within a table or database—that contain coordinate information (see ‘Obtaining coordinates’ and ‘Obtaining GNSS coordinates’ on pages ## and ##), as well as qualitative or quantitative data about the feature that occurs at those coordinates. Archaeologists have long held an interest in collecting and analysing spatial data about archaeological entities. Gordon Childe’s work on European prehistory, for instance, involved analysing the distribution of different kinds of material culture across Europe, and changes in the distribution of these materials through time (Green 1981). Archaeological interest in analysing landscape-scale spatial patterns rapidly accelerated with the development of quantitative methods in archaeology after the 1950s, whereby newly emerging statistical methods were being trialled by archaeologists seeking to identify and describe patterning within archaeological assemblages (see early reviews by Aldenderfer 1987; Ammerman 1992). This included a focus on intra-site spatial analysis from the early 1970s, including analyses of patterns of spatial aggregation, statistical tests for spatial association, nearest neighbour analysis and so on (Ammerman 1992: 246). The development of personal computers after the 1970s led to rapid advances in GIS technologies.

It is not surprising, then, that archaeologists were among the earliest users of GIS packages. GIS allows for the visualisation of archaeological datasets in order to produce maps, using datasets such as topography, stream flow, landforms, and
even satellite and aerial images, as a backdrop against which archaeological data could be visualised. Moreover, GIS enables archaeologists to undertake new types of analysis, including the identification of trends and patterns within single assemblages, as well as between multiple, different datasets. For instance, it becomes possible to analyse the relationships between the distribution of archaeological sites, or certain types of sites or artefacts, and other variables, such as the location of water, proximity to the coastline, sources of raw material, distance to nearest townships and so on. While there are many archaeological examples of this globally (e.g. Wheatley and Gillings 2002) and to a lesser extent in Australia (see Holdaway et al. 1998, 2004; Godwin et al. 1999; Morrison and Shepard 2013; Ridges 2006; Rowland and Connolly 2002), GIS software has become a standard part of the field archaeologist’s kit—and a key skillset that all new archaeologists should consider developing.

**Types of GIS data**

There are two kinds of data that a GIS can use: vector and raster data. **Vector data** represent information as points, lines or polygons and are designed to store data with discrete boundaries or precise positions in the real world. Vector datasets represent the geometry of a feature graphically, that is, as a shape on screen, with each feature (point, line or polygon) representing a record—or a group of attributes for that feature. Information about these records is stored in tables and databases that are usually hidden from view by default, although it is a simple matter to open a table of data and interact with it in much the same way as in a spreadsheet application. A few dozen sites might be represented as a series of points or polygons in a GIS, with the equivalent number of **records** (or rows) in the underlying database containing the information about each of the sites displayed on screen. These underlying tables are capable of holding a range of information, but most frequently store information as text and numbers, as well as a great deal of information—potentially thousands or tens of thousands
of individual records. This information needs to be structured, that is, broken down and displayed according to different variables, as shown in Figure 4.6. Attributes represent the different characteristics or qualities of each record you are interested in, such as type, length, weight and so on. Variables are a single piece of information uniquely related to the attribute for a particular record, e.g. the actual measurements for length and width of a single artefact.

[[INSERT FIGURE 4.6 HERE]]

**Figure 4.6: Data structure example**

A GIS platform is capable of displaying many different layers of information at once, and each record in the underlying tables relates to a feature shown on the map. Importantly though, each of these layers must adhere to the same spatial geometry type. That is, a layer cannot include a mixture of point, line or polygon data types. Instead, these must be split into different tables. Examples of vector data of interest to archaeologists might include property boundaries, site locations, localities or place names, streams, roads, vegetation or landform types, contour lines or elevation, and many more.

**Raster data** is a spatial data model that divides an area into equally sized cells (or pixels). Each of these cells contains coordinate information, as well as one or more attribute values. If you enlarge a scanned topographic map or aerial image, you will see these cells. When imported to GIS platforms, these cells are allocated a value and a coordinate, usually a series of colours (e.g. on the red-green-blue [RGB] colour model). Raster data extends on this concept to allow for different kinds of attributes to be associated with individual cells, such as elevation values, a classification of vegetation or landform type, vegetation height or density, or salinity values. These allow for the representation of information that is continuous across an entire landscape, and also for different kinds of analysis to be undertaken on that data. Satellite imagery is usually represented in a raster data model, providing access to data from different
portions of the electromagnetic spectrum, allowing for more sophisticated analyses of patterns that are not visible with the naked eye (see ‘Remote sensing’, below). For example, multispectral data are frequently used in the analysis of changes in vegetation coverage through time. Analysis of raster datasets is quite a specialised field, generally falling under the label of remote sensing. While it is important to be aware of these applications of raster data, most archaeologists who are new to GIS will find that they will generally only use raster data to display images as background layers, rather than for analysis of the data that the raster contains.

Access to archaeological data in GIS format is relatively simple in Australia, with the Commonwealth government and most states and territories maintaining central data repositories where datasets are available for download (see ‘Useful resources’). Data on archaeological site locations or heritage boundaries are frequently maintained by government heritage bodies in GIS formats, though access to these datasets is often restricted. Good raster datasets are more difficult to obtain at low cost, since many companies involved in the acquisition of this data only make it available at a premium cost.

**Creating your own GIS data**

A GIS is only as good as the data it contains. As such, the first requirement of using an archaeological dataset in a GIS platform is to ensure that the dataset is correctly formatted and contains the necessary information so that it can be displayed correctly. This starts with your research design and, in particular, with your research methods, which should take into account the following issues.

- **What is the spatial geometry of the feature you are recording?** In other words, do you want to record points, lines or polygons (areas) for archaeological features? In most cases, people simply record centre points of sites or artefacts, yet most GIS packages are very capable of managing data with different kinds of spatial geometry, such as linear features.
(useful for depicting fencelines, roads, walls or boundaries) and polygons
(useful for site boundaries, sample areas, survey coverage, floor areas).

- **What is the scale at which you want to present or analyse your data?** GIS can dynamically adjust the scale of the ‘map’ you have created, but, as with drawing plans by hand, you need to make decisions early about the scale at which you would like to present your data and then tailor your recording methods appropriately. It is no use recording polygons for site boundaries to store in a GIS if you have no intention of ever creating plans at a scale where those boundaries are visible. Similarly, recording centre points for large sites and then displaying these points on a large scale map means that potentially important details about the spatial characteristics of the archaeology will be lost. Design your recording methods to collect data at the correct scale for your purposes, and choose a scale of recording that is aligned to the largest scale at which you are likely to analyse or present results (see Appendix 1).

- **What surveying techniques will you use?** We all like having a GNSS handset on hand to help with recording sites, but the inherent error in consumer grade equipment means that they are a poor choice for surveying in order to create large-scale plans. This also applies to GIS. In cases where your final plans will be at a small scale, then this may be an appropriate recording method because the error will not be visible in your final results. If you are creating large-scale plans, then adopt a more precise means of collecting spatial data in the field.

- **Which coordinate system will you use?** A GIS is most useful when all of the data you use is referenced using the same geodetic datum or grid projection. As noted, for field use, a grid projection has many advantages over the use of latitude and longitude (see ‘Coordinates and datums’ on page ##). Regardless of what you choose, be sure that you record full grid
coordinates in the field, rather than four or six-figure grid references (see 'Projected coordinate systems' on page ##), and ensure that all spatial data collection uses this across your project. When creating site plans—even when drawn manually using a tape, compass or dumpy level—be sure to include at least one coordinate so that your plan can be georeferenced later (see ‘Georectifying imagery’ below), while also taking care to note what north orientation has been used (see ‘North’ on page ##). With some forethought, all site plans can be drawn on a projected grid reference system in the field, though it is often easier to do this in the comfort of your office, provided you have collected the necessary data during the survey. Finally, if you are downloading GIS data, try to obtain this in the same coordinate system. Generally speaking, the Map Grid of Australia 1994 grid projection should be used (MGA94). If you are working overseas, choose the most recent local projection available.

- **How will you standardise your data?** GIS datasets work best when tabular data are used, that is, your dataset must be organised within a flat, table-like structure (see Figure 4.6 on page ##). When recording field data, use lists of values or categories to help ensure your data are comparable. For example, many variables can be classified into categories (e.g. glass colour, species type, site type) while numeric values should all be using the same unit (i.e. don’t use millimetres in one record and centimetres in another). This gives you greater flexibility when displaying a dataset in a GIS. For instance, you could use different coloured markers to represent different site or artefact types. If your data are not collected in a standardised way, however, it can be difficult to standardise later, as key information often will not have been collected in the field.
Choosing a GIS platform

There are many different GIS platforms that archaeologists can use. Some web mapping applications, such as Google Maps™ or Google Earth™, are ‘GIS-like’ in that they enable simple manipulation of spatial datasets against a visual map background. While these serve their purpose—usually the display of simple datasets, for viewing particular locations, or obtaining data that can be exported to a GIS—they are not a true GIS, as they lack the ability to undertake more complicated processing of data, including location-based analysis of relationships between datasets and many also struggle with displaying common vector or raster data file formats. They also have only a rudimentary capacity to create, display and manage records held within a database.

For a new GIS user, it is best to start with a platform that has good documentation, access to support and is low or no cost. Some open access GIS platforms fit the bill well in this regard, and generally provide the user with access to a very wide range of functions—certainly more than most new users will need initially. We recommend Quantum GIS (QGIS) (http://qgis.org), which is a relatively stable GIS that is available for a range of different operating systems. Users can seek assistance via free online tutorials, forums and email lists. Via a system of plug-ins, users can access a wide range of additional functions that greatly enhance the value of this software.

A range of other open source software is also available which can be accessed via a web search, such as GRASS GIS, uDig, gvSIG and Mapwindow GIS. Moreover, some very well-established commercial packages are available, including Mapinfo, ArcGIS and Autodesk. The costs of commercial packages can be extremely high, although many provide student trial licenses or are free to educational users (students or university staff). If using a trial, be sure to consider how you might access your data after the trial has expired. This is a key advantage of open source tools and formats—they are ‘built’ open from the outset so your data should always be accessible.

We recommend that anyone who is new to GIS invests some time in learning to use the software well before conducting fieldwork. This will ensure you have a clearer
understanding of what is required from your data before you collect it. Moreover, it provides a wonderful planning tool, particularly once you begin to access some of the wide range of data sources that are available.

**Georectifying imagery**

One of the most useful things that archaeologists can learn to do with a GIS is to **georectify** an image (also known as **georeferencing**). This means attributing coordinates to different parts of an image so that it can be displayed in relation to its real world position in a GIS. In effect, you are creating your very own raster dataset. Web-based mapping applications that display satellite data are a good illustration of the concept: basically, tens of thousands of individual images are ‘stitched’ together and each pixel within those images is allocated a coordinate. This allows users to look up coordinates for features identified on images or to overlay their own data onto the referenced imagery to explore relationships visually. While this example is at the more complex end of the spectrum of methods, it is not difficult to take a single image and georectify it within a GIS platform. Many kinds of imagery can be georectified for varying purposes:

- **Published maps.** While some maps published by the Commonwealth government are available as georectified digital downloads (for a price), generally, maps at a scale of 1:50,000 or larger are not available in this format. As such, one of the most useful things that an archaeologist can do when working on a new project is to scan part or all of a map and then georectify it so that you can plan your fieldwork digitally, and display your data as an overlay against a professionally drawn map (please note, however, copyright law may apply if you are doing this—particularly if you want to publish the plan!). Published topographic or geological maps are one of the easiest things to georectify, as they already have a projected coordinate system indicated, making the georectification process very simple indeed.
• *Hand-drawn site plans.* Georectification provides a means of creating a convenient digital version of your field-drawn plans. You can display a plan within its real world setting, overlay other kinds of data or begin to digitise your plan into a vector dataset.

• *Aerial images.* Aerial imagery is a very useful source of landscape data (see ‘Aerial and historic imagery’ below). Its value is enhanced when included in a GIS, since relationships with other data can be explored and new data can be derived from the image itself (e.g. landscape classification). Aerial images can be more complicated to georectify, though, since you need to be able to find the coordinates of positions on the image and make corrections for distortion in the original image. If you collect your own aerial imagery (e.g. with a drone) you can lay out your own ground control points to assist with the process (see ‘Do it yourself aerial imagery’ on page ##).

• *Historical plans.* These are among the more complex kinds of data to georectify, because many—such as those drawn by early explorers or even government surveyors—include only very generalised information and are quite inaccurate by today’s standards. This makes it difficult (if not impossible) to allocate coordinates accurately to cells within the image. If the historical plan is very similar to modern plans, then these problems are significantly reduced. It can help to ‘tile’ older plans (i.e. divide them up into a series of smaller files) as this can reduce the degree of error that would be visible across the whole plan.

It is beyond the scope of this text to provide details on how to georectify, simply because each software platform uses a different approach. The key is to ensure that the image you’re attempting to georectify is accurate enough to provide coordinates for positions (or even better, the image should show
coordinates). The smaller the size of the pixels (or cells) the better, which means that, when scanning, you should always obtain higher resolution images (300 DPI or greater).

**Aerial imagery**

Aerial photographs, as their name suggests, are literally photographs of a section of the Earth's surface taken from the air. While they were originally taken in order to map environmental features, they also provide a useful basis for desktop research and landscape interpretation. An aerial perspective to your field observations can be helpful in understanding past environments, as features such as recessional beach-lines and dunes are much easier to identify from a distance than close up. This data can be integral to understanding relationships between environments and people in the past, especially if you’re researching Indigenous settlement patterns. For the historic period, aerial photographs can provide valuable snapshots of changing demographic, land use and settlement patterns. In the same way that a larger-scale map is better for identifying particular sites or features (see 'Maps' on page ##), the lower the level of the aerial photograph (i.e. the lower the altitude at which the photograph was taken), the greater the level of detail it will provide. The first aerial photographs were taken in the late 1920s and, if you can obtain a sequence of photographs for the same area taken at different times, you may well be able to see the major changes in your area. Unfortunately, aerial photographs are limited in their ability to show the spatial layout of many sites because only large archaeological features will be visible, but they are very useful for identifying general areas which may contain sites and which therefore might be useful to survey (or avoid). In Australia, aerial photographs can be obtained through the state departments that deal with topographic maps.
Aerial photography can be viewed in hard copy or digitally as an image file, and is very useful for a range of reasons, including:

- to develop a survey strategy for a region;
- to compare regional settlement patterns through time;
- to detect locations of potential sites, such as the faint outlines of old settlements, buildings or roads;
- to gain an understanding of general environmental conditions and how these have changed over time;
- to assess a region's potential for sites, even if you can't see direct traces of them on the aerial photographs;
- to assess the changing landscape context of sites; and
- to conduct desktop-based landform mapping.

The amount and kinds of information you can deduce from an aerial photograph will depend on your knowledge, training and experience. As a start, however, it is well worth purchasing aerial imagery for any major project alongside printed or digital topographic and geological maps.

**Do it yourself aerial imagery**

There are many different approaches to obtaining your own aerial photographs. Balloons, kites, and unmanned aerial vehicles (UAVs, also known as drones) are all common vehicles for relatively low cost, low altitude aerial imagery. Balloons will be most useful when wind speeds are low, kites when wind speeds are higher. UAVs—model airplanes and hovering drones, particularly ones with multi-rotors—are more easily directed and can be programmed, but may have short flying times and may also be compromised in high winds. Technology in this area is rapidly improving because of the high interest from recreational and professional users. While UAVs have many benefits, they also have their limits. For instance, they are of little value in areas of heavy woodland, where the
features that you want to photograph are beneath dense vegetation. One overlooked tool in such scenarios involves the use of long poles (e.g. painters’ poles) that can be readily adapted to obtain images from much closer to the ground. These are ideal where you want high-resolution images of small areas, particularly of excavation trenches or for photogrammetry (see ‘Photogrammetry’ on page ##).

For DIY aerial imagery, you may need to use a lighter weight camera (which will bring certain trade-offs for sensor size, see ‘How a digital camera works’ on page ##), and preferably a robust housing (just in case). You will also need to use a faster shutter speed to freeze the motion of the camera when aloft, a higher ISO setting and/or lower f-stop values to capture the full depth of field in your image. Higher ISO settings, however, can make for grainier images. A camera setting that allows you to regulate the interval between photographs automatically is also essential. Drones, in particular, are rapidly improving and many provide a live video stream of data to a handset, while also allowing the user to direct a camera to take images or high-definition video. It is possible to program some of these devices to take photos at set intervals across a survey area. Some archaeologists are also experimenting with adding various sensors to obtain different kinds of multispectral data, and this is likely to become common practice within a few years. Higher end units already allow automated capture of imagery of various types (e.g. thermal imagery) and can automatically export images in a range of formats suitable for integration into GIS platforms or photogrammetry software.

You will also need a good system of ground control points, each of which has a geographically known and precisely recorded spatial position in order to georeference your DIY aerial images later (see ‘Georectifying imagery’ on page ##). Any marker will do, provided it is stable, visible at the altitude of the UAV, and clearly distinguishable from other markers recorded on the same image.
Photogrammetry

Photogrammetry has been defined as the ‘science, art and technology of obtaining reliable information from photographs’ (Ghilani and Wolf 2012: 799). In practice, photogrammetry involves using imagery as a basis for obtaining metrical data (i.e. measurements), as well as aiding in the interpretation or visualisation of sites, landscapes or artefacts. Historically, photogrammetry involved the use of aerial imagery taken from planes (terrestrial photogrammetry), but other forms of DIY aerial imagery are now increasingly common (see ‘Do it yourself aerial imagery’ above). The increased pixel size of digital cameras and the enhanced CPU power of personal computers have both simplified the process of photogrammetry and made it much more accessible for documenting sites, features or artefacts at ground level. For instance, many rock art researchers routinely use photogrammetry to record panels of rock art (e.g. Domingo et al. 2013), to record the surfaces of excavation units (particularly if these contain fragile features that are likely to be damaged by the process of excavation) or the process of excavation itself, as well as to model individual artefacts.

Interpretive photogrammetry involves using images as an interpretive aid, as well as to retrieve new information, for example, by identifying shapes, patterns, shadows and so on that can reveal archaeological features via aerial archaeology (e.g. Hanson and Oltean 2012). Remote sensing is another form of interpretive photogrammetry, discussed below. Metrical photogrammetry involves taking accurate spatial information from images, including measurements of distances, areas, volumes and elevations. This is quite a specialised area, since, while measurements (such as distance or area) can be
obtained from any image with an appropriate scale, there are several constraints that limit the accuracy of such measurements: namely, perspective error and spherical aberration (see ‘Taking good shots’ on page ##).

One relatively recent and very important development for archaeology has been the introduction of photogrammetry software packages aimed at both professional and recreational users. Typically, such software enables users to create 3D models and 2D orthophotos from collections of images. The software uses sophisticated modelling procedures to calculate coordinates for points within each image, using data from the camera itself (e.g. focal length). This involves the use of multiple images depicting the same features, enabling the software to build a geometric model of the features in the images. So, for example, the shape and form of a landscape, or even a site or artefact, can be accurately modelled in what is known as a 3D point cloud—tens of thousands to millions of points that together represent the geometry of the surface being modelled. While point clouds are useful, they lack the colours and tones represented in the original images, so photogrammetry software also allows users to build up what is known as a texture, which is a rendering of the colours in the base image. The outcome is an interactive 3D model that looks much the same as the source photographs, and that can be analysed in its own right to obtain measurements or be used to generate orthophotos from multiple perspectives. Data can also be exported to various formats, including GIS packages, 3D packages, as movies or simply as colour images. The value of these types of software is quite considerable, though successful use requires that perspective errors are reduced as much as possible by taking images that are as close to perpendicular to the subject as possible. Spherical aberration should also be corrected in images (see ‘Taking good shots’ on page ##). Furthermore, the processing of photogrammetry datasets requires considerable computer processing power. A collection of several dozen images may take several hours
on a standard low-end computer, and several minutes on a high-performance machine. This extends to days or even weeks for very large datasets comprising thousands of high-resolution images. A wide range of software platforms exist, ranging from those that are free or open source through to commercial software packages worth thousands of dollars.

**Satellite imagery**

Satellite imagery provides large area and high-resolution coverage of the Earth’s surface that can be used to identify visible features on the ground and, via the electromagnetic spectrum, to reveal buried features, in effect providing an aerial means of geophysical survey. The advantage of satellite over aerial imagery is that satellites can collect data from different bands of the electromagnetic spectrum, including those that are not visible to the human eye (the near, middle, far, infrared and thermal portions of the spectrum) and therefore reveal more than a photograph can. Multispectral imagery can reveal changes in moisture or heat content, for example, that might indicate buried features such as walls, or affect overlying vegetation and soils (Parcak 2009: 3). These are two different aspects of satellite data, however: the first is simply viewing a satellite image and using it in the same way as you would an aerial photograph; the second requires the processing and analysis of satellite-generated digital data, the manipulation of which, via a range of processing techniques and specific remote sensing programs, is no simple matter. To get the full benefit you really need to be, or consult, a trained specialist, but for details on the pros and cons of different forms of satellite imagery, their inherent problems and the various techniques required to process and understand satellite data, see Parcak’s work (2009).
Light and Radar (LiDAR)

LiDAR is a relatively specialised form of remote sensing—requiring both sophisticated equipment and software to collect and analyse data—but its increasing use in archaeological scenarios warrants its inclusion here. The term originally derives from the terms light and radar (hence the acronym), but has entered common use to describe a system whereby a laser transmits light to a target, which is then reflected back to the instrument for processing (Tratt 2014). This beam is delivered, collected and analysed via a LiDAR scanner, an instrument that sends tens of thousands of laser pulses a second to a survey area in order to build a high-resolution 3D model of the features being surveyed (Crutchley 2009). These scanners are commonly mounted on a plane for large-scale regional surveys, though are also commonly used in terrestrial applications in the form of 3D laser scanners. Aerial LiDAR is used to model landscapes and landforms and to identify subtle variations in topography that may be otherwise invisible via other forms of remote sensing. It can also be applied to monitoring heritage sites, since the high-resolution models can be compared to examine changes through time caused by erosion, vehicle traffic, looting or vegetation change. Furthermore, and unlike photogrammetry, the LiDAR beam can be set to scan through small gaps in vegetation coverage in order to reveal features that lie within heavily forested areas (e.g. Chase et al. 2011; Devereux et al. 2005). This enables entire landscapes to be revealed and analysed in ways that were not possible a decade ago.

Both aerial and terrestrial laser scanning have important application to landscape archaeology because of their ability to create high-resolution models of specific sites, parts of sites or entire landscapes (see ‘Digital elevation models’ below). Resolution on aerial scans is commonly below 1 m, meaning that every 1 m² area on the ground will receive at least one ‘hit’ from the scanner, but can be sub-decimetre in accuracy. Very high-resolution accuracy is common for
terrestrial laser scanners and these are particularly useful when used in conjunction with photogrammetry to create 3D models of sites.

**Digital elevation models (DEM)**

Digital elevation models (DEM) are representations of a ground surface that can be either purchased online or created by archaeologists using a variety of methods, including various forms of laser scanning or aerial photogrammetry. DEMs can take two different forms: a **digital surface model (DSM)**, which represents, literally, the surface that is being reflected by the laser (so this might be the ground surface, but might also be the roof of a building or the top of the canopy of vegetation), and a **digital terrain model (DTM)**, which post-processes the data to remove various surface features and distinguish between what was on the ground surface and what was situated above it (e.g. a roof or a tree's canopy). A DSM represents the primary data that was collected by the scanner (the original, unaltered data), while a DTM is an interpretation and recalculation of that data (and is therefore often manipulated data). This is an important distinction to bear in mind when considering your digital archive (see ‘The digital archive’ in Chapter 1), since there is a risk of losing original data or creating misleading data ‘artefacts’ through this process (English Heritage 2010: 11). A DTM is what is created when LiDAR is used to map areas with vegetation or other coverage that otherwise obscures the ground surface.

**Geophysics**

In archaeology, geophysics is mostly used to detect buried materials in preparation for excavation. Unlike LiDAR or satellite imagery, geophysics won’t help you to target large areas, but can be useful when you are trying to identify site locations more precisely, establish site boundaries or assess the subsurface archaeological potential of particular sites or features. Geophysical methods of
seeing beneath the ground surface, such as magnetometry or the use of ground-penetrating radar, have the advantage of being non-invasive, but also require access to the necessary equipment and the data need to be processed by a specialist operator with the appropriate training (see Ian Moffatt’s tips below). Since so many aspects of it require specialist training we have only dealt here with how the process of geophysical survey links to sampling issues in the field. For more detailed information on the technology, the equipment, its limitations and issues, see Lowe (2012) or Conyers (2012).

Like other forms of survey, geophysical surveys require you to make careful sampling decisions. First, you will need to decide where to place your transects, taking into account issues such as ground cover and its density, the degree of soil compaction, the presence of modern infrastructure, such as power lines or fences, or other factors that may prevent you from conducting an effective survey. Once you have chosen your areas then you will need to take into account factors such as geophysical contrast (how sharply the targeted features might contrast with the surrounding soil because of their materials, compaction, or other properties), the dimensions of features and their possible depth, and the surrounding ‘clutter’ that might confuse the readings (i.e. other objects that are likely to be detected but that are not the primary target, such as tree roots, buried or surface metal, old stream channels, shallow bedrock or ferruginous (iron oxide-rich) stones. These are analogous to background noise). Geophysical readings can also be confused by random components to the data, often attributable to the specific instrument, the operator’s field technique, or general variability in the soil and its contents.

An understanding of these issues will help you to decide how many data points you will need per square metre and how these points should be distributed across the survey area. Small, low-contrast features, such as hearths, typically require data to be systematically collected along a closely spaced
transect, which means that you might space your data points every 50 cm. Larger features can be detected with a wider spacing, so you might opt for a grid spacing of a metre or more. In cases where many anomalies are being detected without any clear indication of which are cultural and which are not, you may opt to conduct further subsurface sampling (such as with soil cores, auger holes or test pits—see ‘Subsurface sampling’ in Chapter 8) to distinguish between them.

**Ian Moffat’s tips for getting the most fizz out of ‘geofizz’**

Geophysics has emerged as a useful tool for archaeological investigations, although unfortunately many archaeologists don’t have significant geophysical experience (or vice versa), which can lead to disappointment all round. To overcome this and to ensure you get the best possible outcome from these very useful techniques, consider the following:

- **Collaborate, collaborate, collaborate!** Geophysicists may be a strange, sometimes antisocial group, but, unlike mushrooms, they don’t like being left in the dark. Communicate with them as much as possible before, during and after the geophysical survey, providing as much data (photos, site plans, geological information, etc.) as you can. This will ensure that they are cognisant of the key issues and have the best possible chance of accurately interpreting the geophysical data.

- **Relevant experience leads to good outcomes.** There are many more sets of geophysical equipment available than there are skilled practitioners with experience to use them in archaeological projects. While a mining or utility detection geophysicist with access to equipment is a great resource, you are more likely to get a better outcome if you use someone with experience doing geophysics on similar archaeological sites. If you decide to give an opportunity to a less experienced person you should be particularly mindful of the other points in this list.

- **Seeing is believing.** There is always a physical basis for your anomaly, but it may not be what you want to find. Geophysical methods work by measuring the physical
properties of the subsurface, but they are not ‘bone finders’ or otherwise specific to your target and so are subject to misinterpretation. If your geophysical results are not what you expect, don’t immediately dismiss all geophysical techniques as being useless, but engage with your geophysicist and the data to see if you can work out what’s going on.

- Good things take time. Don’t expect to dig your targets out immediately after a day of geophysics. The processing and interpretation of geophysical data takes much longer than the fieldwork, so, while it might be interesting to look at the GPR screen during the survey, don’t expect to get robust results immediately after (or during!) your fieldwork.

**Useful resources**


The Soil Analysis Support System for Archaeology from the University of Stirling (UK) provides a knowledge base and field tool for help in recording and analysing soils: http://www.sassa.org.uk/index.php/Main_Page.
CHAPTER FIVE

RECORDING SITES

What you will learn from this chapter

- What to do when you find a site
- Why you need to define a site’s boundary
- General principles of archaeological photography and illustration
- The diversity of pre- and post-contact Indigenous site types across Australia
- The range of historical site types across Australia
- The essential features to record for each site type

What is a site?

While we have alluded to some of the problems with focusing exclusively on the site as the sole unit of human behaviour in Chapter 4 (see also ‘Landscapes and intangible values’ on page ##), in general, most archaeological field projects are geared in some way towards finding and recording them. A site is a place that represents a particular focus of past human activity (Pearson and Sullivan 1995: 5). This activity may be related to past events, practices or beliefs and may or may not have left behind actual physical traces. The various landing places of Captain Cook, for example, have become important sites, even though they contain no physical evidence for these events. Likewise, many purely natural elements of the landscape are important Indigenous sites because they are the embodiment of creation (‘Dreaming’) stories. If you are working with Indigenous groups, you will need to take such sites into account regardless of whether or not
they have archaeological evidence. While a site may not be accompanied by physical evidence for past human behaviour, knowing its location and relationship to other sites in a landscape is essential to understanding past uses of the landscape as well as contemporary cultural heritage values. The material evidence may be buried, for example, and invisible unless excavated, or such a place may be providing information about what people chose not to do. Some places were actively avoided by people in the past, but are nonetheless still part of how they used and understood the landscape around them. It is always important to remember that an absence of material evidence is not necessarily evidence for the absence of human behaviour and that you need to understand absence as much as presence.

Archaeological sites are all of those places that still contain physical evidence of past human activity. This can take an enormous variety of forms, depending on the nature of the site and who created it—from actual objects (e.g. tools, structures, domestic debris) or traces of objects (e.g. posts or post holes) to the physical by-products of past activities (such as plough furrows or scarred trees). Almost anything can be an artefact because what we might regard as insignificant today may have had all sorts of meanings for people in the past. If it physically represents human behaviour in some way, then it is artefactual.

There are some standard site categories that archaeologists working in Australia commonly encounter. Historical site is a general term that is frequently used to refer to archaeological sites created by Europeans after colonisation, but more commonly is used to describe sites that are associated with the period after European explorers and settlers began to arrive. The timing of this varied, with some historical sites dating to the 1600s in association with early Dutch voyaging, but most of these sites date to after 1788. Importantly, these include sites created by people from outside Europe, such as the Chinese who had a major presence in many mining areas in the nineteenth and early
twentieth century. **Indigenous sites** (sometimes called Aboriginal sites) are those that are principally associated with Indigenous Australians. The term is commonly used to describe pre-contact archaeological sites such as shelters with rock art, shell middens or stone artefact deposits, however, here the term is used broadly to include other kinds of Indigenous sites including ethnographic sites and Indigenous historical sites. Ethnographic sites are places associated specifically with Indigenous cultural tradition or knowledge, including those linked to oral histories, cosmologies, resource places and so on. **Indigenous historical archaeological sites** include places that may or may not be associated with ethnographic sites, but will have a physical component associated with the history of Aboriginal people after contact.

For simplicity's sake we use ‘Indigenous sites’ to refer to all Aboriginal sites noted above, whether pre- or post-contact, and ‘historical sites’ to refer to all sites—European or those associated with other ethnic groups—that date to the period after European exploration and colonisation in Australia. This approach overcomes inherent limitations with arbitrarily classifying Indigenous sites as being either ‘prehistoric’ or ‘post-contact’ (e.g. Williamson 2004) and recognises that Indigenous people have a continuous history extending from the present day and back in time tens of thousands of years.

**Defining a site boundary**

Obviously some sites will have clearly defined physical boundaries (such as a rockshelter, or a stone arrangement), but identifying boundaries for others will be much more difficult. This is because most ‘sites’ are identified initially through the identification of archaeological materials on the ground surface, but the characteristics of this surface deposit reflect both the activities of people at that location in the past, as well as various taphonomic processes that may have differentially exposed the materials that you can see (see ‘Determining effective
survey coverage: what reveals, what conceals’ on page ##). In other words, surface deposits are often just a small ‘window’ in the landscape where archaeological materials are exposed by various taphonomic processes, such as animal burrowing and ‘treadage’ (e.g. on animal paths), erosion, or instances of very good ground visibility. For these reasons, it can be useful to consider the following questions before or during the process of mapping the boundaries of a site.

- Does the deposit exist simply because there is a gap in ground visibility? Examine the ground surface beneath the surrounding vegetation to assess whether the deposit continues beyond the extent of surface visibility (provided it is safe to do so!).
- Are the materials in situ—that is, in their original contexts, or have the archaeological materials been transported locally as a result of taphonomic processes (see ‘Recording taphonomic processes’ on page ##)?
- Is there a possibility that surface deposits signal the occurrence of buried archaeological deposits? This can usually be resolved to some extent by examining the site surface for evidence of burrowing or where erosion has created cuts exposing the stratigraphy of the site. Examine these features in order to identify potential buried deposits (see ‘Potential archaeological deposits’ on page ##).

Record your answers to these questions and discuss in your notes, providing as much detail as possible. How deep were the buried deposits? What materials were buried? What is the landform element that the site occurs on, and what type of surface vegetation is present (see ‘Describing landscapes’ on page ##)? Is the deposit in situ?
After finding a site, it is often the case that surveyors will begin walking off in different directions to investigate it, but it can also be useful to survey the site systematically and intensively (e.g. in transects with spacing of 1–2 m between surveyors) in order to define boundaries (see ‘Survey intensity’ on page ##). If time allows, a visual picture of the extent of the site and the number of surface finds can be rapidly generated if surveyors carry pin flags to mark finds as they go (see Figure 5.1). This, of course, works best for very discrete deposits where the boundaries are relatively clear and indicated by an abrupt drop in the frequency of archaeological materials. In such cases, mapping the boundary simply involves finding the edge of the deposit as indicated by the presence or absence of artefacts.

[[INSERT FIGURE 5.1 HERE]]

Figure 5.1

Mapping boundaries is much more challenging where archaeological materials are more or less continuous across a large area. One common approach is to create boundaries around the areas containing the highest frequencies of archaeological materials and to simply define the rest as ‘background scatter’. For instance, a simple criterion could be created, such as one artefact per square metre, or a minimum of 2 m between any two artefacts. The boundary is then drawn wherever this criterion is not met. This is an arbitrary decision as well as a pragmatic one, and will be decided upon as a result of the aims of your fieldwork and what questions you are trying to answer, as well as the environment in which you find yourself (Sullivan 1983: 6).

As a general rule, the most important thing to remember is to state your definitions and assumptions clearly in your write up so that, whatever definition you adopt, it will be obvious to others how this might have influenced your results. Importantly, in some projects the classification of site boundaries may not be useful at all—or at best, may simply be an initial step towards more
detailed work (see ‘Landscapes in archaeology’ on page ##). This is a much more involved approach, and will generate a more detailed picture of the true extent of the archaeology in a region than other methods.

**What to record**

Recording sites is a selective process. On some projects you will have ample opportunity to record every last detail, including completing detailed 2D survey plans and a comprehensive photographic record, while on others you will have limited time and may not be able to undertake such a thorough recording. Regardless of which situation you find yourself in, there are basic minimum requirements that must be recorded. This will ensure that, even if no further research is done—or, in a worst case scenario, if the site is destroyed before further research can be undertaken—there will be a sufficient record of it.

Essential information to be recorded for a site includes:

- A full grid coordinate, either taken using a GPS or plotted by hand from a topographic map (of at least 1:100,000 scale) (see ‘Obtaining coordinates’ and ‘Obtaining GNSS coordinates’ on pages ## and ##). If you are planning on using a GIS, then it may be useful to consider whether you wish to record the site as a linear feature or a polygon (see ‘Geographic Information Systems’ on page ##).
- The location of the site (i.e. what enabled you to see it in the first place— is it within an erosion scar? On a vehicle track? In a sparsely vegetated area? Beside a creek?).
- The visibility conditions on the site (i.e. how much of the ground surface is visible here?).
- The visibility conditions off the site (the comparison between this and the conditions on the site will help you to determine whether there might be more artefacts present than you can actually see).
- The site's basic characteristics, including type (e.g. midden, historical artefact scatter, stone arrangement), size (diameter, area, height) and environmental setting.
- Any distinguishing features of the site and its contents, including the range and frequency of particular artefacts (including size, colour, form or material), the presence of faunal remains (including species names and element types noted), and the particularities of any building remains or the shape and form of any landscape modification, such as mounds or depressions that are part of the site.
- The landform and vegetation. It is best to adopt consistent terms and classifications when doing this (see ‘Describing landscapes’ on page ##).
- Whether further research at the site is warranted, both in relation to your own research question and those of other, future researchers.
- A brief assessment of the condition of the site. Is it well preserved? Has it been damaged in any way? How much has been damaged? Is it in danger of being damaged in the future?
- A mud map of the site. This does not have to be measured accurately, but on the plan you should include an arrow indicating the direction of north, and some idea of the scale (otherwise the plan will be meaningless) (see ‘Mud maps’ on page ##).
- Photographs of the site and its contents that illustrate significant features, as well as some showing the site in its landscape setting (see Chapter 7).

Once you’ve located a site, there may be obligations to notify the relevant heritage authority within a certain timeframe (see ‘Working with the legislation’ on page ##). You may also have to fill out a site recording form and submit this to the same authority. Check with the relevant government department to find this out. Furthermore, if you are recording sites in the context of a heritage
management project then there may be specific information that needs to be recorded. This is dealt with separately in Chapter 10.

**What not to do**

Most of the advice about what not to do at a site is not only good ethical practice, but simple common sense:

- Don’t interfere with the site in any way. Signing your name, chalking in engravings at art sites, or digging or collecting artefacts without permission are irresponsible and illegal.
- If you’re working on Indigenous sites, don’t walk into or onto a site if you are not sure it’s fine to do so. This is particularly important if you are working with a community for the first time. Ask permission instead.
- Don’t pick up artefacts or move them around on the site.
- Don’t collect ‘souvenirs’, even to verify to state authorities that you’ve found a site. There might be some exceptional circumstances in which you should collect material from a site—such as when it is at risk of imminent destruction—but this would be highly unusual and not something we recommend for inexperienced field archaeologists. Take a photo instead.
- Don’t leave rubbish behind—take it with you when you go.
- Don’t make details of the site public without obtaining proper permission. Indigenous people in particular may wish to protect sites by keeping their details secret. This includes sharing images or information about the site on social media.

**Recording Indigenous sites**

The Indigenous occupation of Australia can be confidently placed at approximately 45,000 years (Hiscock 2008: 43). The many different ways in
which Indigenous people have interacted with the land, sea and each other over this long time period have left behind many physical traces. There are many different kinds of Indigenous sites, ranging from stone artefacts, open sites, shell middens and rock art, to carved and scarred trees, quarries, burials and stone arrangements, as well as many Indigenous historical and ethnographic sites.

[[INSERT FIGURE 5.2 HERE]]

Figure 5.2: The range of Indigenous sites in Australia

**Stone artefact deposits**

Accumulations of stone artefacts are one of the most common types of Indigenous archaeological site in Australia. This partly reflects the importance of stone as a raw material for Indigenous people, who used different kinds of stone artefacts for many day-to-day purposes, such as skinning and butchering animals, grinding seeds and nuts, manufacturing wooden artefacts and for hafting as axes, adzes, knives or spear points. Their commonness also reflects the fact that stone is very durable and, while there are some site formation processes that can alter individual stone artefacts, causing various forms of breakage, the complete destruction of stone tools via natural processes is actually quite unusual. Importantly though, stone artefact deposits are just as prone to modification via taphonomic processes, such as large scale erosion or burial that can transform and reshape stone artefact deposits within their landscape settings. Their durability means that a deposit of stone artefacts that has eroded from one landform and has subsequently been re-deposited on to another (e.g. eroding from a sand dune on to a clay pan) can be interpreted as being in situ, when the reality is that this is far from true.

Stone artefact deposits can range in size from isolated artefacts through to dense accumulations (also referred to as ‘scatters’ or concentrations) containing hundreds, thousands or even more artefacts. Importantly, these deposits include both tools that people may have used and the by-products associated with their
manufacture—often referred to as flaking debris (Holdaway and Stern 2004: 17).

While many types of stone artefacts occur, two of the most common are flaked stone artefacts and cores; flakes are generally smaller pieces of stone removed from a larger piece of stone via knapping—or striking it with another stone (often referred to as a hammerstone) (see ‘Stone artefacts’ in Chapter 9). Other common types of stone artefacts likely to be encountered in Australia include mullers and millstones, typically used for grinding seeds, as well as various types of edge ground implements, such as axes or adzes (see ‘Recording other classes of stone artefact’ on page ##).

Stone artefact deposits are frequently found on the ground surface (which is why they are often called stone artefact scatters or open sites), however, they can also occur in stratified deposits beneath the ground. They are also frequently found in association with other kinds of archaeological evidence, such as hearths, charcoal, shell, bone and even alongside European artefacts on some historical sites. Two general approaches can be taken to recording stone artefact deposits: recording the attributes of individual artefacts that comprise an assemblage, or recording general information about the assemblage as a whole. A range of factors can influence which approach to take, including the time available, your research questions and, of course, the size of the assemblage. Here, information about recording at the site level is discussed (see ‘Recording stone artefacts’ on page ## for more information).

**Recording stone artefact deposits**

It is often the case when surveying that the first sign of a large stone artefact deposit is a single artefact. Very quickly, more artefacts are found within your transect and in those of your colleagues. Before you know it, you have a deposit that extends over tens of metres or more. It is here that some thought is required in order to effectively determine the extent of the site—both at the surface and below the surface (see ‘Defining a site boundary’ on page ##). Once you have
worked through the various issues and established a site boundary, you can begin to record the site.

Importantly, one should not need to be highly experienced in stone artefact analysis in order to know how to record a stone artefact deposit. These kinds of features are such an important part of the Australian landscape that all archaeologists working in field scenarios should be competent in making an adequate recording of them. This requires becoming familiar with common stone artefact types, as well as general terms associated with recording these. For instance, it is not possible to record the number of cores or hammerstones on a site if you are not sure of the difference between them.

In addition to general information recorded for sites (see 'What to record' on page ##), the generic attributes to record for a stone artefact deposit include:

- Site dimensions, length, width and area. Record depth at which artefacts are observed where evidence of subsurface deposits exists (e.g. in animal burrows or on cuts created by erosion or disturbance).
- The types and numbers of artefacts that occur. How many flakes are there? How many cores? How many millstone fragments? Flaked pieces? Retouched flakes? (For more detail on how to record stone artefacts see Chapter 9).
- The range of artefact sizes and an estimate of the numbers within different ranges (e.g. 'more than 50 per cent are greater than 30 mm in length').
- A count of the number of artefacts on a site or an estimate of the size (length, width and thickness) of each artefact, or of a representative sample of the artefacts and their morphology. You need to make sure that you measure all artefacts consistently and that you write in your report exactly how you did this.
• The density of artefacts and how this varies across the site. If an estimate is made, be sure to note how you made it. This is often phrased as ‘X artefacts/square metre in the centre of the site, dropping off to X artefacts/square metre on the margins of the site’.

• The range of raw material types. You need to be able to recognise how many types there are, what they are and how many artefacts are made from each one. What is the most common? What is the least common? Can you comment on the possible sources (e.g. procured from a nearby quarry, or cobbles collected from an adjacent stream)?

• The presence of any other indications of human behaviour (i.e. charcoal, hearths, faunal material) in the concentration.

• Any potential for subsurface deposits.

**Isolated stone artefacts**

As the name implies, this refers to individual stone artefacts found by themselves in no obvious association with any other artefacts. Whether such artefacts were accidental or purposeful discards, they should still be recorded. Although an isolated stone artefact is not strictly a ‘site’, it is often what the archaeologist will encounter. Of course, it is possible that there were once other artefacts present that have since been removed, or simply that the visibility conditions prevent you from seeing them (see ‘Determining effective survey coverage: what reveals, what conceals’ on page ##). If you find an isolated artefact, make sure you search the area around it carefully to ensure that it is, indeed, isolated.

**Quarries**

Quarry sites are locations from which Indigenous people have extracted stone for making stone artefacts, or ochre for use in painting. Stone artefact quarry sources ranged from easily acquired loose river cobbles to large outcrops that had to be actively quarried. In general, Indigenous people preferred particular
kinds of stone when making artefacts. Very fine-grained stone not only makes the sharpest artefacts, but is also the easiest to knap successfully. Chert, mudstone, quartz, silcrete, quartzite and chalcedony were all preferred materials for stone artefacts and thus also for stone artefact quarries. A recording form for quarries or quarried stone outcrops is included in Appendix 3.

Checklist for recording quarries

Record the following:

• The material form of the quarry (Is it a rock outcrop? River cobbles?).
• The site location (e.g. is it on a hilltop? Beside a creek or river? On a slope?).
• The particular features of the quarry (e.g. can you see pits from quarrying activity? Are there flaking or knapping floors there? Are there other imported raw materials at the site? Can you see flake removal scars on boulders?).
• If there is surface artefactual material, some measure of the artefact density.
• Whether there are other stone artefacts present. If so, what are they? What is the percentage of cortex on these artefacts?
• If the site is an outcrop, an estimate of the percentage that is worked.
• Any potential sources of damage to the site.
• If known, the distance to isolated artefacts or sites in the vicinity.

Culturally modified trees (CMTs)

Culturally modified trees are those that have been scarred or modified through human activity. This can be for various reasons: to obtain bark or sapwood in order to create containers, tools, weapons or canoes; to access resources, such as possums and wild honey, that may be within the tree itself; to create toe holds to assist with climbing a tree (e.g. as a vantage point); and, finally, for the purposes
of artistic or symbolic expression and communication. In Australia, CMTs created by Indigenous people date to both the historic and pre-contact periods, while instances of modification by Europeans can be found in the form of various types of marks and engravings left by explorers, settlers and surveyors.

The most difficult aspect of recording CMTs is positively identifying them as the result of deliberate human activity. There are many natural activities that can produce similar scarring—the tear caused by the fall of a large branch, the development of a termite nest at the base of the tree, scarring from fires, insect or animal activity, and even poor soil. Natural scarring is much more common than humanly-caused scarring. As a general rule, scars made by people removing bark tend to be regular in shape and their lowermost portions do not interface with the ground. Furthermore, some will often show axe marks or other related evidence, and be aligned with the tree. Natural scars are often ragged and uneven, have peaked ends, are strangely placed (i.e. they might be very high up the tree), or extend down to the ground surface. The identification of humanly scarred trees is complicated by the fact that trees continue to grow after scarring, which means that the original edge of the bark around the scar close over and become less clearly defined. Unfortunately, the older the scar the greater its exposure to weathering and the harder it will be to interpret (Long 1998). In some cases, the scarring will be quite clearly of anthropogenic origin—for instance, where people have cut large toe holds or cut an aperture in order to access a hollow inside the tree, or where there are clear axe marks (e.g. Morrison and Shepard 2013).

Once a tree has been identified as humanly scarred, you then need to decide whether the scarring results from Indigenous or European activity. Early non-Indigenous settlers also used bark extensively for containers, shingles or roofs, and in these situations the scars may be indistinguishable from Indigenous scarring. Occasionally, archaeologists will argue that it is possible to distinguish
Indigenous from European scarring by the type of axe used—i.e. whether it is a metal or stone axe. It is important to recognise, however, that Indigenous peoples’ use of wood and wood products did not suddenly cease with the arrival of Europeans. In far northern Queensland, for instance, many thousands of Indigenously scarred CMTs have been recorded with obvious metal axe marks, dating them to the historical period, while primary documents and oral histories clearly illustrate a continuity in the collection of wild honey (commonly referred to as sugarbag) and the use of a range of wooden artefacts through the nineteenth and twentieth centuries until today (Morrison et al. 2012). A key means of determining the origin of a CMT, then, is to consider the local historical and cultural context. Are there Indigenous historical or ethnographic sites nearby? Did Aboriginal people remain in the region after colonisation, or were people forcibly moved away (e.g. to distant reserves or missions)?

[[INSERT FIGURE 5.3 HERE]]

**Figure 5.3: A comparison between steel and stone axe marks**

**Carved trees** are a particular kind of CMT that are generally easier to recognise, since they result from carving patterns into the heart-wood of a tree (e.g. see Buhrich et al. 2015). You should record the same type and range of information for a carved tree as a scarred one, bearing in mind that carved trees were often associated with ceremonial grounds or burial sites, so there may well be other archaeological evidence in the vicinity. You should also be aware that European surveyors occasionally marked trees with a half-oval or gothic arch (a surveyor’s shield), containing a broad arrow or carved figures and letters, and that carved graffiti on trees might also be present. These are immediately recognisable, but should still be recorded.
Recording CMTs

The type of tree. First ask yourself whether the tree species is one which is known to have been used for bark removal, or whether the nature of the bark is comparable to known species. Not surprisingly, Indigenous people used the bark of particular kinds of trees for a reason. In south-eastern Australia, for instance, box trees and river red gums were commonly used because the bark could be levered off in sufficiently large sections to be useful (Bowdler 1983a: 43; Edwards 1972; Rhoads 1992), while in northern Australian savannah woodlands, the relatively hardy Cooktown ironwood frequently preserves scars (Morrison et al. 2012). It is highly unlikely that Indigenous people would have scarred introduced tree species, or that relatively short-lived trees (e.g. those that live for less than 50–100 years) will survive long enough for a scar to survive today. So, always try to identify the tree species—a common name is better than none at all.

Scar morphology. The shape of a scar is very important to record, since this often indicates the purpose of the scar. If a scar has a regular outline consistent with a particular known artefact type (e.g. with rounded ends in the case of canoes or containers, or squared ends in the case of shelter slabs), it is likely to be authentic (Long 1998). Research on Indigenous material culture traditions can be very useful in identifying possible uses for bark and wood of a particular shape. Aperture scars can range from very small (<25 cm in area) through to very large scars 50–100 cm in length (or more) created with steel axes, so if the scar has cut through to a tree hollow then make sure to note the aperture size (that is, the size of the hole), as well as the area over which scarring occurs (see Morrison and Shepard 2013) rather than simply recording the extent of the dry face. Dry face area is often simply a reflection of the tree’s response to the scarring event.
The presence of axe marks. It is not always the case that axe marks will be preserved because of overgrowth around the margins of the scar. Sometimes upper and lower axe marks on a scar will be visible and these will look like single or parallel lines at the top and base of the scar. Bear in mind that axe marks from stone axes are likely to be less sharp, deep and clean than those from steel axes, because the angle at the point of a stone axe is less acute. They are also likely to be shorter in length. Typical stone axe marks will look like broad, asymmetrical ‘bludgeon’ marks, with possible crushing of the underlying sapwood. Steel axes, on the other hand, will leave straight, narrow and often quite deep incisions (Long 1998) (see Figure 5.4).

Figure 5.4: European and Indigenous scarring of trees versus natural scarring

The height of the scar above ground level. Many scars will have been created within reach of the ground, though this is not always the case. Many canoe scars, for example, extend 3–5 m up large trees and would have required people to climb the tree. Smaller scars associated with the manufacture of tools or small containers are more commonly found around chest height. Wild honey scars also commonly occur at this height, though not exclusively, as Indigenous people used a range of methods to climb trees, including leaning felled branches or small trees against a larger tree or by cutting toe holds.

The position of the scar. In the case of canoes and containers, bark was often removed from the convex side of the trunk or branch to give suitably upturned sides to the finished artefact (Long 1998). Some deliberate human scarring removed bark from the branches of the tree, so examine all convex surfaces, not just the trunk.
Shell middens

The term ‘midden’, which is loosely applied to any archaeological deposit that is predominantly composed of shellfish remains, originally derives from an early Scandinavian term for ‘dung heap’ or ‘muck heap’. In 1851, a committee of Danish scientists who were investigating shell deposits observed artefacts throughout them, and suggested that they were refuse from meals of shell, applying the term ‘kjökkenmödding’, or ‘kitchen midden’, to describe them (Álvarez et al. 2011: 1). The term ‘midden’ stuck, and by the 1950s this term was in use in Australia (e.g. Gill 1951). By the 1970s it had become widely used to describe shell deposits created by people (e.g. Bailey 1977), often working from the assumption that these were all refuse sites. Some have argued that there are problems with implying that all middens are refuse heaps, however, since it de-emphasises other possible interpretations of shell deposits—particularly their cultural and social symbolism—and instead invokes western ideas about refuse and applies them to other cultural contexts where we know little about the role or function of these sites (see Luby and Gruber 1999; McNiven 2013). While the term ‘midden’ is unlikely to be abandoned in Australia soon, an increasing number of archaeologists adopt the view that the role of particular midden sites needs to be demonstrated, rather than assumed, and prefer to use the term ‘shell matrix’ to avoid these connotations (e.g. Claassen 1998). Here we follow Australian convention and use the term ‘shell midden’, but emphasise that the use of this term need not mean that shell deposits were refuse in the way that we understand it today—and that understanding the role of these features should form a central part of research agendas into midden deposits.

Shell midden deposits of various kinds occur around the Australian coastline, including on terraces adjacent to estuaries, sand dunes, beach ridges, flood plains and escarpments. In stratified sites in coastal areas, such as rockshelters, it is not unusual to identify buried midden deposits. It is less well-known, however, that
middens also occur well away from the coast, around bodies of freshwater where various shellfish species were targeted by Indigenous people. Middens range in size from small, low-density surface deposits (or ‘scatters’) of shellfish remains through to large deposits extending over tens of metres or more, while in some parts of northern Australia, they can occur as distinct mounds up to 4–5 m in height or more in some settings. Shellfish species within midden sites often vary considerably, both between regions and sites, as well as within particular sites through time. In some regions, other kinds of archaeological evidence will be found in shell middens, such as artefacts made from stone, bone and shell, animal bone and, in some instances, human burials, though this is not universally the case. For these reasons, middens represent a major focus of coastal archaeological research in Australia.

**Recording shell midden sites**

The first task when recording a shell midden is to establish whether it is indeed a humanly created midden or a natural shell bed. This is not as simple as it sounds, because a variety of factors—such as the geomorphology of the shoreline, the location of the site in the landscape and the past land use history of the area—can affect the form and content of both natural and humanly created middens (Attenbrow 1992; Bonhomme 1999). There is no single criterion that positively identifies a midden site, but there are some generally accepted criteria that might be helpful in distinguishing a shell midden from other types of shell deposit (see Attenbrow 1992; Bailey 1999; Bonhomme 1999; O’Connor and Sullivan 1994) (see Table 5.1).

[[INSERT TABLE 5.1 HERE]]

When recording a shell midden, you need to record its form, dimensions, context and the numbers and proportions of different shell species which are
present, as well as any other artefacts which it contains. To understand how the midden relates to its environment, you should also take note of whether similar shellfish species are available nearby, and what the local estuary, river, rock platform or beach is like now (Sullivan 1989: 52). Shells are mainly calcium carbonate and, as they decay, they create a highly alkaline environment which sometimes helps to preserve bone and other organic remains quite well. This means that the excavation of a shell midden can be quite productive in terms of recovering a wide range of organic remains (see ‘Val Attenbrow’s tips for excavating shell middens’ on page ##).

### Checklist for recording shell middens

Record the following:

- The landform on which the midden occurs (e.g. does it occur on a foredune, levee, terrace or atop a scarp?). Specific information on landform elements is critical to evaluating both whether the site is natural or cultural, and if cultural, the degree of influence of coastal processes on it (e.g. storm surges).
- The morphology of the midden (Mounded? Level? Elongated? A low-density deposit?).
- Dimensions, height and minimum depth where this can be estimated (e.g. from eroded sections or animal burrows).
- Whether it has potentially excavatable deposits.
- The species of shell(s) to be found in the midden (you should try to record the full range of shells visible on the surface to species level if possible).
- The relative proportions of different species (calculated by number and/or weight).
- The size of different species and their relative proportions.
• An estimate of the rank and order of abundance of shell species (what are the dominant, rare and common species?).
• The nature of any other artefacts in the midden.
• Any potential sources of damage to the midden.

Stone arrangements

These can range from cairns (piles of rocks) to extremely elaborate arrangements covering large areas. Some stone arrangements were used in ceremonial activities to mark sacred or totemic sites and demarcate pathways through which people passed; sometimes these arrangements are in the shape of totemic species. Many others were constructed for more secular purposes, such as route markers, hut walls or fish traps in coastal areas (e.g. Rowland and Ulm 2011).

Recording stone arrangements

The methods you will use to record stone arrangements will be determined by how the stones are arranged. Some stone arrangements will be linear and some circular or oval. Some are very extensive and contain tracks, circles and other linked sections. When you are recording a stone arrangement, you need to remember that the stones may not be in their original positions. Often you won’t be able to tell, but sometimes moved stones will have a different pattern of weathering compared to others in the arrangement and sometimes the displacement will be clear, such as when a road has been bulldozed through the middle. In the latter case, you would record each part of the arrangement as a separate feature, but record in your notes your interpretation that these were once part of the one arrangement.

Checklist for recording stone arrangements

Record the following:
• A plan of the site.
• The type(s) of stones.
• The size of the stones.
• The assumed function of the arrangement (e.g. fish trap, ceremonial, etc.). This may not always be possible to work out.
• Anything unusual about the arrangement.
• Its proximity to other sites.
• Any sources of damage to the site.

Rockshelters

Many rockshelters in Australia will have been used by Indigenous people at some point in the past. Rockshelters are a place to rest, keep out of the sun, avoid rain, sleep and also as a position from which observations could be made. They are generally located in escarpment country, providing a safe and sheltered place with a view of the surrounding area. Those located near water are a favoured place for people to live. However, the fact that a rockshelter was inhabited by people in the past does not mean that there will always be archaeological evidence of such use. Surface evidence is often ephemeral and can erode, be washed away or be disturbed by animals.

Recording rockshelters

When recording a rockshelter, the first decision you will need to make is where the site's boundaries are. It doesn't really matter at which point you decide the shelter ends as long as you record the reasons for your decision. You may decide that a group of fallen boulders marks the end, or that it comes in sharply at a particular point which works to define the difference between inside and outside.
Checklist for recording rockshelters

Record the following:

- The aspect of the shelter (i.e. what direction is it facing?).
- The degree of slope leading up to the shelter (measured with a clinometer).
- Draw a plan of the rockshelter showing:
  - the shape of the rear wall of the shelter;
  - the shape of the front of the shelter;
  - the position of the drip line(s), or the limit of the dry area under the rock overhang (literally the line along which the rain will drip). This is particularly important to record as it may show you the areas most intensely occupied by people and the area outside the shelter where artefacts may have been disturbed by erosion;
  - the position of the limit of rock overhang (this may or may not, and usually will not, coincide with the drip line);
  - the location of major features of the site, such as large boulders, major rock falls, grinding grooves, or rock art panels;
  - the location of major rock art motifs; and
  - the location of any surface archaeological material.
- Draw a cross-section (side view) of the shelter showing:
  - the height of the roof;
  - the level of the floor;
  - the extent of the liveable area; and
  - the location of any major features, rock art motifs or surface archaeological material.
- If there is surface archaeological material, note:
  - the range of artefact types present;
  - the range of raw materials present;
  - the distribution of material across the surface (i.e. are there any obvious concentrations of artefacts which might indicate places for future excavation?); and
  - whether there is any evidence of animals regularly using the shelter (which could have disturbed the archaeological material and its patterning).
Rock art

The main challenge in recording rock art is to record the motifs accurately without damaging them. Rock paintings, in particular, are often frail and you will have to use recording methods that do not involve touching the art surface. The most effective way of recording rock art is through drawing the motifs in the field (see ‘Drawing rock art’ on page 302), or taking photographs and then drawing the motifs from the photographs (see ‘Photographing rock art’ on page 281). Photogrammetry has also become more popular (see 'Photogrammetry' on page ###), with distinct applications in rock art research (see Domingo et al. 2013). When photographing rock art it is especially important to remember to include a metric scale which incorporates a colour standard (such as the one supplied by the International Federation of Rock Art Organisations [IFRAO]), as this will help you to judge the authenticity of the colour of the paintings. Make sure you note the technique(s) used in producing the art (see Table 5.2), the location of the rock art panels and any sources of potential damage (Whitley 2011).

[[INSERT TABLE 5.2 HERE]]

**Checklist for recording rock art**

Record the following:

- The location of the panel or motifs within the shelter or rock outcrop (tied to a site plan).
- A general description of the rock art and the motifs.
- Detailed drawings of individual panels or motifs.
- The colours of the motifs (you can identify these using a Munsell colour chart, or a PANTONE® swatch set—see ‘June Ross’s tips for recording the colour of rock art motifs’ on page ##).
• The time of day you made the recording (since the quality of light hitting the rock surface at different times of the day can affect your ability both to see motifs and accurately describe their colours).

• Photographs of the panels and motifs.

• Any potential sources of damage (i.e. have wasps built their nests across the art surface? Is rainfall washing across the art surface? Have parts of the art surface flaked or fallen off?).

• The condition of each individual motif.

Photographing rock art

Photographs of rock art should be taken using a high-quality digital SLR (DSLR) camera, ideally in RAW format, with careful attention to both spherical aberration and perspective error (see ‘Taking good shots’ on page ##). This will increase image quality and accuracy, enabling images to be inspected at great magnification and allowing for much finer details to be identified later—often in more detail than you can visibly see on-site (Domingo et al. 2013: 1880). It can be advantageous to use a prime lens in rock art photography. This is a camera lens with a fixed focal range, unlike ‘zoom’ lenses that allow the focal range to be widened or narrowed depending on the shot in question. While prime lenses can be less versatile than a zoom lens, they result in high-quality images and often have a wider maximum aperture (that is, they can take images at a lower f-stop). Spherical aberration can be less severe on these lenses. Overall, they are more suitable if you are taking images for the purposes of photogrammetry or metrical recording.

When photographing rock art, take each of the following:

• orienting shots, showing the immediate environmental context;

• a close-up of each motif, which can be used as the basis for tracing;

• wide-angle images, which show the motifs in relation to each other; and
• close-ups of details, such as superimposition or areas of damage, which can be used in site interpretation.

Rock art in Australia is usually found within rockshelters or outdoors on boulders. Normally, there is sufficient light to take good photographs, though it can help to time your photography sessions to suit the light conditions. It is especially important to visit rock art sites at different times of the day to work out which is the best light for photography. Periods where a shelter is shaded are actually much better than when it is brightly lit, since the bright light can mask colours. As opposed to paintings, engravings are often located at open sites and can be difficult to photograph. The best time to photograph an engraving site will depend on that site’s orientation and location in the landscape, but as a general rule it is best to take photos in the early morning or late afternoon, when the sun is at an oblique angle and will reveal the engraved lines more clearly. Using oblique light in this way highlights the relief on the surface and can be very helpful in providing detail. This technique can also be useful for recording other hard-to-interpret relief surfaces, such as weathered gravestones or engraved graffiti.

Never use chalk, paint or any chemical to outline or emphasise rock art motifs, as this can cause permanent damage to the art surface. For the same reason, never remove graffiti, lichen or moss from the art surface so that you can see it better. Removing any such coverings is likely to cause unforeseen damage and you must have permission from Traditional Owners, as well as the relevant state authority. If you cannot manage to bring out the best in the rock art through the use of filters, oblique light or other lighting conditions, then you will have to rely on drawing the rock art panels to show their detail (see ‘Drawing rock art’ on page ##).
June Ross’s tips for recording the colour of rock art motifs

Recording the colour of art pigments is an important part of recording rock art. When you draw a motif or a panel of motifs, make sure you note the range of ochre colours on the pencil drawing. Analysing the colour of motifs can help you identify whether the same pigment has been used throughout, suggesting that the art was produced in a single episode, and can also be used to check the spatial distribution of distinctive colours.

• Remember that the consistency of pigment colour is often uneven, so ‘washy’ sections will appear lighter than thicker sections. Getting a repeatable reading is sometimes questionable because of this, but it may be necessary.

• Pigments are often poorly mixed, so each motif may need two or more colour readings.

• Identifying colours is a difficult task and many people don’t have an eye for it, so there can be many different readings for the same motif. For this reason, try to limit the number of people recording colour so that you can maintain some control over the colour recognition process.

• Colours will look different in different lights, so readings may be different at different times of the day. For this reason, you should always note the time of day you made your reading and write this on the drawing.

• Recording the colour of rock art motifs is usually done through the use of Munsell colour charts, although some rock art researchers have used PANTONE® colour swatches. The advantage of PANTONE® swatches is that the colour can be reproduced easily on your computer (although with scanning this has lost its value), and they are easy to use as you can hold the swatches right up to the pigment. Unfortunately, they are also expensive to buy and the colours are often too pure and don’t really match the natural earthy tones of rock art pigments very well. Munsell colour charts, on the other hand, have a much better range and grading of colours, but their format makes them difficult to use because the swatches are small and
always surrounded by a distracting white border. They are nevertheless the best way
to document the colour of rock art motifs.

**Drawing rock art**

Drawing is a particularly important way of recording rock art. First, sketching a
rock art panel in the field makes you focus closely on the motifs, working out
what is really there and which motifs overlap. Many rock art panels contain an
apparently bewildering variety of motifs drawn around, on top of or through
each other, and are often confused further by natural striations or planes in the
rock itself. A photograph of this alone would be unlikely to help you sort out
what was and wasn’t art, and may result in you confusing or not recognising a
certain proportion of the motifs. The analysis involved in drawing each part of
the panel by hand, which often seems impossible to begin with, will actually
force you to sort out each motif and give you an understanding of how the whole
panel works together and the time spent at the site will give you a better
understanding of how the art operated in its local environment.

Drawing is essential for establishing patterns of superimposition (where one
motif covers another), which is the major non-destructive way of dating rock art.
Sometimes, however, what appears to be overlap is actually the result of micro-
erosion in that part of the rockshelter, so you need to look for a pattern of
overlap to establish regular superimposition. These patterns can then be
interpreted in terms of sequences of painting events. You must be very careful
when undertaking these analyses, as differences in superimposition could be the
result of time differences of one minute, one year, one thousand years or ten
thousand years. As a result, to make decisions about which motifs are older and
which are younger, you will also need to take into account the differential
weathering of motifs when you are developing a superimposition sequence.
Inés Domingo-Sanz’s tips for digitally drawing rock art

In the last two decades digital imaging technologies have revolutionised rock art recording methods worldwide. Today the graphic documentation of rock art is mainly produced by 2D digital recording techniques, combining digital image enhancement (such as decorrelation stretch, principal components analysis or digital enhancement tools available in different digital image editing software, such as Adobe Photoshop or Gimp) with colour selection, painting and drawing tools available in different digital image processing software (Photoshop, Gimp, etc.). The aim is to reproduce digitally individual motifs, compositions and scenes to scale for scientific, conservation and dissemination purposes. In addition, digital photogrammetry and/or 3D laser scanners are increasingly used for the volumetric reproduction of motifs and the rock surface, providing a more realistic volumetric assessment of a site (for further details see Domingo et al. 2013). So far, digital technologies are offering more objective and accurate results than traditional methods, both for motif recognition and for the metric reproduction of the motifs and the rock surface. Furthermore, since they are non-invasive, they have minimised the physical impact of rock art recording processes. The methods are accurate but slow, as they involve a meticulous process of deciphering and continuously checking the tracings against the original images. Here, I will describe the process to produce 2D individual tracings.

In the field

• Identify motifs. Check whether previous documentation on the site exists. If it does, check previous recordings to identify motifs and assess the damage suffered since the site was last documented. If there is no previous documentation, draw a sketch of the motifs, including their location and numbering, to get an initial understanding of how the panel works and to help you plan the documentation process.

• Draw a site plan. It is important to draw a plan of the site, recording dimensions, the main structural features and indicating the location of the rock art. The more detail
the better. If you are planning to use digital photogrammetry and/or a 3D laser scanner to record the site, the site plan will not be necessary since it can be produced from them.

- Take photographs. To trace a motif using digital images requires high-resolution photographs. To minimise perspective distortion, keep the optic axis of the camera as parallel to the motifs as possible. This is not easy, particularly for curved surfaces. The use of calibrated digital cameras that can correct lens distorting effects is also recommended. For tracing rock art, three kinds of photographs are necessary:
  0 close-ups of each motif: these will form the basis of the tracings;
  0 close-ups of details of motifs, such as areas of superimposition, which you can refer to later for clarification; and
  0 wide-angle pictures, which show the motifs in relation to each other.

- If the site includes engravings the use of oblique lights (natural or artificial) to facilitate the identification of the grooves is highly recommended. If the grooves are very thin and difficult to identify in daylight conditions, it will be more effective to take the photographs at night using artificial oblique lights.

- Record measurements of each motif and the distances between them in order to reproduce the motifs and panels with a reference to the scale. The use of digital photogrammetry and/or a laser scanner will facilitate this step.

- Identify the colour range of each motif. This process can be conducted manually by using a Munsell colour chart, or electronically, using colour measurement technologies.

**In the lab**

- Download and label the high-resolution images.

- The first step is to produce individual records for each motif. Trace the motifs using Adobe Photoshop or a similar program, as follows:
  0 open the digital photo containing the motif you want to trace (Figure 5.5a).
• Painted motifs will be recorded using colour selection tools, while engravings will be recorded using painting and/or drawing tools.
  o To record a painted motif, click on one of the two available colour selection tools (the ‘magic wand tool’ or the ‘colour range’ command) to select surfaces of similar chromatic range. The width of the range depends on the tolerance values given to the selection. Adjust the fuzziness values or the tolerance option to small units in the dialogue box to select more homogeneous colours.
  o To achieve better results, it is advisable to select and manipulate small portions of a figure at a time using the Lasso tool, instead of trying to select the entire figure at once (Figure 5.5b).
  o Copy and paste the areas selected into a new layer (Figure 5.5c).
  o Return to the original image and select a new area to trace (Figure 5.5d).
  o Repeat these steps until you’ve traced the whole figure.
  o Sometimes Adobe Photoshop will include pixels from shadows, cracks in the wall or the adjoining rock surface as part of the selection because these can have similar chromatic ranges to the motifs. You will have to erase these manually by comparing the tracings against the original images (Figure 5.5e).
  o Since each selection will generate a new layer you’ll need to fit them together to see the tracing of the entire motif (Figure 5.5f).
  o To record an engraving, open the image and create a new layer to draw on it. Use the painting (brush or pencil) or drawing (pen) tools to draw the motif manually. The same sort of drawings can also be produced using other software, such as Adobe Illustrator, Freehand, Corel Draw, etc.

• Once you’ve finished the tracing process, scale the figure to its real size (which you know from your original measurements).
• Check the accuracy of the tracings. Once the individual tracings are complete, return to the site to compare them with the original motifs.
• Assemble the whole panel. You can assemble the completed traced panel in Adobe Photoshop or Adobe Illustrator. Make sure all tracings are scaled to their original size, have been saved at the same resolution and are oriented correctly (Figure 5.5g).

[[INSERT FIGURE 5.5 HERE]]

Figure 5.5: Using digital technology to record rock art
Burials

Treatment of the dead by Indigenous people occurred in both historical/contact contexts (i.e. on campsites and missions) and in archaeological contexts (in deposits which may be exposed by erosion, development or excavation). Such sites hold great significance for Indigenous people, and the disturbance of burials or burial places is a very sensitive issue (for more information see 'What to do if human remains are encountered' on page ##).

Identifying Indigenous burials

*The Skeleton Manual* (Thorne and Ross 1986: 32–3) sets out some criteria for identifying whether or not a burial might be Indigenous:

- Is the grave small, shallow and/or oval in shape?
- Is the grave outlined by salts from contact with local ground water (indicating that it may be very old)?
- Has it been dug into hard deposits but without any evidence for metal tools having been used?
- Is it associated with other Indigenous cultural material (such as stone artefacts, ochre, animal bones or shell)?
- Does the burial occur within an ancient landscape or is it associated with a known Indigenous burial site?
- Does the grave contain bones from more than one individual?
- Are the bones in a flexed position (i.e. are the legs drawn up to the abdomen or chest, or are the arms folded against or across the chest)?
- Have the bones been made into a relatively small bundle (i.e. are the legs, arms and torso very close together)?
- Are the bones hard and mineralised, encrusted with carbonate or other salts, or discoloured from long contact with the soil?
Answering yes to any of these questions may mean that the burial is Indigenous.

**What to do if human remains are encountered**

Indigenous burials can be located in many different contexts, from coastal, inland or desert sand dunes to middens, rockshelters, caves, clay lunettes on lake margins, or even in rock clefts (Thorne and Ross 1986: 9–10). For this reason, it is possible that you might encounter them during fieldwork. If you do, it is imperative that work ceases immediately until a positive identification of the remains (first, as definitely human—you would be surprised at how many sheep bones are initially misidentified—and second, as Indigenous) can be made. Under no circumstances should you remove the remains or interfere with the surrounding soil matrix in which they occur.

In some cases, it may be possible to determine whether or not the remains are Indigenous by a careful but non-intrusive examination of the grave and any associated features.

If your answer is still inconclusive, however, you will need the help of a specialist physical anthropologist to examine the bones. Remember that, if the bones are human, they will be protected by legislation (either coronial or heritage) and if the burial is recent it will immediately become a police matter. *Either way, any unauthorised disturbance of the skeletal remains or the burial will be illegal.* If the remains need further identification, you should contact the police and the relevant government authority for Indigenous heritage immediately.

**Hearths**

Hearths, or former fireplaces, are frequently recorded in many parts of Australia, particularly in semi-arid and arid landscapes, and often occur within, or near, surface stone artefact deposits or in rockshelters. **Heat-retainer hearths** are
distinct concentrations of stones (Figure 5.6a) or balls of clay (Figure 5.6b). These materials were placed into a shallow depression in which a fire was lit and food placed inside. The depression was then covered with vegetation or sediment, with the intention of retaining heat to assist with cooking. In most cases, when hearths are exposed at the ground surface it is because the surface deposits covering them have eroded, which leads to their destruction.

As Holdaway et al. (2002) have demonstrated, careful excavation of in situ hearths can provide a good source of in situ charcoal for radiocarbon dating and, as a result, they have successfully been used to understand the chronology of occupation in landscapes where little other dating evidence exists. Some of the charcoal in hearths can be detrital, however—i.e. occurring in small flakes and pieces that are scattered throughout the deposit. Detrital charcoal is not good for dating purposes, since you cannot assume that it is associated with the human activity you're attempting to date in the first place (Allen and O'Connell 2014: 87–8). Allen and O'Connell have noted that almost half of the available radiocarbon data in Australia derive from detrital charcoal rather than clearly in situ features, such as hearths, and therefore must be interpreted with much less confidence.

To identify a hearth, first make sure that you're looking at a feature created by people. Surface deposits of charcoal alone are a very poor indication of a hearth site, as they can be the result of natural fires. Similarly, the burning of trees down to ground level can sometimes bake clay at the surface and below it, as well as leave large accumulations of charcoal. These will also often have large amounts of charred (not properly burnt) wood, however, and can be distinguished as a result. Heat retainer hearths can be distinguished by the presence of distinct heat retainers, such as fist-sized clay balls (or the remnants of these) or stone (see Figure 5.6), which, depending on the raw material, may or may not be heat shattered. Small flecks of charcoal, the presence of ash or
Sediment that is stained orange or white as a result of firing may also be associated with a hearth. Because exposed hearths are usually at varying stages of destruction, they can be quite discrete features—with stones or clay concentrated within a very small area (commonly a roughly circular feature less than 1 m in diameter), or, if in the final stages of destruction, quite dispersed and difficult to distinguish at all.

Figure 5.6: Hearth features

Checklist for recording hearths

Hearths are quickly and easily recorded, and where it is practical to do so their individual locations should be recorded. Record the following information.

• The location of the hearth.
• The type of landform element it occurs on (see ‘Describing landscapes’ on page ##).
• The types of heat retainer material that are present, if any.
• Size classes of heat retainer material (e.g. <50 mm, 51–99 mm, >100 mm), and the frequencies of heat retainers within each class.
• Whether there is charcoal present, and if so, the general size range of individual fragments.
• The presence of artefacts or faunal materials within the hearth.
• Since most hearths at the ground surface are eroding, it can also be useful to measure:
  o the maximum diameter of the area of dispersed hearth material (heat retainer material, charcoal); and
  o the diameter of the main concentration of hearth material.
Indigenous historical sites

Indigenous historical sites are simply places that feature archaeological evidence of Aboriginal and Torres Strait Islander people that postdates the arrival of non-Indigenous people in Australia. It is important to stress that Indigenous historical sites do not only relate to interaction between Europeans and Indigenous people. There were periods during the nineteenth century when the population of northern Australia included more Chinese than people of British origin or descent. Similarly, there was contact between Indigenous Australians and various French and Dutch mariners as early as the 1600s (e.g. Sutton 2008), and Afghan people were integral to the exploration and settlement of central Australia throughout the 1800s (e.g. Parkes 2009). In northern Australia, Indigenous oral histories suggest visitation from mariners from Island South East Asia during the sixteenth and seventeenth centuries, as well as contact between Indigenous peoples and Macassan fishermen from Indonesia during the eighteenth and nineteenth centuries (Wesley and Litster 2015).

A wide range of Indigenous historical sites have been subject to archaeological research in Australia. They include early contact sites, which are often the result of engagement between Indigenous people during the initial, often exploratory, phase of colonialism—the timing of which varied from region to region. These can include existing Aboriginal occupation sites, such as rockshelters, where artefacts obtained from non-Indigenous peoples or adapted or manufactured from European materials, have been incorporated. Contact rock art sites have been recorded in many parts of Australia and feature images of ships, rifles, horses and so on (e.g. Cole 2010). Sites associated with conflict are another type of contact site, and are often associated with exploration and the initial waves of settlement.

More permanent settlement saw different kinds of sites created. In remote settings, such as pastoral stations and mining settlements, Indigenous people
sometimes established social relationships with non-Indigenous people and exchanged their own food or labour for desirable resources, and often lived nearby to these locations. For example, Indigenous people were critical to the establishment of the pastoral industry across much of Australia, due both to the provision of labour and their knowledge of local landscapes. Another type of Indigenous historical site are those associated with the interference of governments and Christian groups in Indigenous peoples’ lives, which often resulted in settlements and reserves being established specifically for Indigenous people, including missions. Finally, Indigenous people also established their own settlements at the fringes of townships and cities, although these places are often written out of local historical accounts. Across all of these contexts there is a rich archaeological record associated with the lives and experiences of Indigenous people in the historical period, which has much to offer in expanding our existing knowledge of Australian history (e.g. Harrison and Williamson 2002; Lilley 2000). This research is particularly fruitful when collaborative in nature and incorporating oral histories and Indigenous knowledge (e.g. Byrne and Nugent 2004).

**Recording Indigenous historical sites**

Until recently, the archaeological potential of Indigenous historical sites was vastly under-rated, because there was an often implicit assumption that Indigenous behaviour since contact was not ‘traditional’, or that Indigenous ways of life in the recent past were not intrinsically interesting (Harrison and Williamson 2002). Some Indigenous historical sites are relatively easy to identify—for example, settlements or places such as missions or fringe camps. It is here that collaborative work involving Indigenous peoples’ knowledge and oral histories can be crucial, since if non-Indigenous people didn’t bother to make note of these places (or didn’t know about them), then it is unlikely that
they will appear in the historical record (see ‘Recording Indigenous oral histories’ on page ##).

Using material culture alone to identify Indigenous historical sites is more complicated. In contact sites, materials sourced from Europeans or others—such as glass, metal or ceramic—may have been adapted in distinctive ways or been incorporated into deposits that are clearly Indigenous in origin (e.g. a shell midden). Where this is not the case, however, things become much more difficult because of the complexities of cultural change, as well as the simple fact that Indigenous people elected (or were forced) to use European material culture: metal tools eventually replaced flaked stone or glass; glass, metal and ceramic vessels were used; dwellings were made from corrugated galvanised iron and milled timber; European domesticated animals and bottled and tinned foodstuffs were consumed; and other European items such as beads, toys, clothing, ovens and so on, became common. If, in a survey, you identify a scatter of metal, ceramic and glass pieces, what is there to indicate that it is Indigenous at all? You could start by looking for other types of material evidence. Are there stone artefacts or scarred trees close by? Does the site seem to be meaningfully located in relation to these? There may also be more subtle signs that a site is of Indigenous origins—the presence of food remains that are possibly Indigenous, such as certain shellfish species. There are no easy solutions in these cases, and you need to remember that it is very difficult to prove a meaningful association between artefacts in a surface assemblage, as these materials could have been left behind at very different times. This demonstrates the importance of thorough historical research, as well as collaborative work with Indigenous custodians, so that the origins of a site can be considered in relation to the broader history of the region.

While Indigenous historical sites will be recorded using the methods suited to the particular site type in question, and will draw heavily on the methods
outlined for historical sites (see 'Recording historical sites' on page ##), there are some additional factors you need to keep in mind:

- It is often extremely difficult to distinguish between glass which has been flaked intentionally and glass which has flake scars from being hit by a bulldozer, or crushed by some other means. Unless you are an expert at the identification of flaked glass, this is something that needs to be assessed critically in terms of the site location (e.g. in the middle of isolated bush versus beside or on a road) and against other material that is found at the site (i.e. is there flaked stone there as well?).

- A contact site can also be indicated by the use of material in a different context to that in which it is normally found. For example, some of the churches in northern Australia have a mixture of both Christian and Indigenous imagery.

- It is important to record kinds of sites that resemble 'pre-contact' sites. For instance, middens, scarred trees or stone artefacts are commonly found on or near historical Indigenous sites, and one should not assume that these are necessarily pre-contact. This, instead, should be demonstrated.

**Indigenous ethnographic sites**

Ethnographic sites are those places in the landscape that are important or valued by Indigenous people due to their association with specific cultural traditions, knowledge, historical events or experiences, and might include the following:

- Locations where ceremonial or ritual activities took place in the past or where such places are valued or used today.
• Dreaming or Story places where potent and potentially dangerous forces are concentrated in the landscape, often as a result of a link to the activities of ancestral beings.

• Important or notable locations known for abundant resources or for having particular aesthetic or other culturally desirable qualities.

• Oral history sites, where particular events or activities occurred that feature in oral history accounts.

• Personal sites, such as those where individuals were born, buried or cremated.

These places may be either modified sites/features (e.g. a significant well site that is kept free of vegetation) or natural features within the landscape of high importance (such as rock outcrops or water sources). Sites that are natural features of the landscape may have few, if any, tangible traces to indicate to non-Indigenous people that the place is of special significance. In many cases, only Indigenous people with appropriate knowledge will be aware of these places and the details about why they are important, so collaboratively working with Indigenous communities is essential for the identification of all such places.

Recording ethnographic sites is generally the domain of anthropologists who are trained in such methods, but, in general, it is good for archaeologists to know how to make a preliminary recording of ethnographic sites. In some cases, there may be no anthropologists involved in a project, and documenting the location of ethnographic sites may be of critical importance (e.g. in a heritage management context). In other cases, certain types of ethnographic sites, such as places associated with events mentioned in oral histories, can be a central part of a research project—for example, if you are investigating Indigenous historical sites. It is also important to be aware of ethical guidelines for working with Indigenous communities; key here is the basic point that if an Indigenous
participant in a project does not want to disclose information to you, then you should respect their decision and not pressure or attempt to coerce them (see ‘Working with Indigenous communities’ on page ##). Furthermore, you should not write information down without first checking that it is permissible to do so, and if you intend to use information shared with you in the context of a research project, or share it with others (e.g. a client), then it is particularly important that you adhere to the Guidelines for Ethical Research with Indigenous Communities developed by the Australian Institute of Aboriginal and Torres Strait Islander Studies (AIATSIS). A key principle here is that of **free prior and informed consent**, which means that a person’s decision to participate in research is voluntary, and is based on the research providing ‘sufficient information and adequate understanding of both the proposed research and the implications of participating in it’ (NHMRC 2015: 16). These guidelines are designed to protect and assure community members who are participating in any form of research (see ‘Archaeologists and ethics’ in Chapter 1).

When recording ethnographic sites, record the following information:

- Who provided the information, or, if it was derived from documentary sources, what is the source?
- What names are used to describe the place, including European names or language names?
- Can you identify a general coordinate for the site and, if so, can you comment on the size or extent of the site?
- What type of place is it? Does it fall within one of the major categories listed above? Can you provide a more specific categorisation?
- Does the site relate to other sites? For example, is it part of a Dreaming or Story that involved the activities of an ancestral being moving through the landscape or conducting activities at different places? If so, it is well
worth documenting the broader story, since these are critical to understanding the significance of named sites.

- Is there a video or audio recording of Elders or other community members recounting the story? If so, note down file names, archival locations and other information that can help with locating this information later.

- What restrictions have been specified in terms of sharing the information or accessing associated media? If the site is restricted, then reconsider whether you should record anything at all—or instead, whether a culturally safe version could be recorded. It is best to discuss this with people you are working with from the outset.

- Detail the information about the site that has been shared with you in as much detail as possible. Key to recording ethnographic information is the use of either audio or video recording equipment to record what people say, allowing you to transcribe this later. In some cases, this may not be permitted—and you should never record people without explicit, and, ideally, written permission. If this is the case, then take extensive short-form notes (jottings) that can capture the essence of a conversation. Later, and as soon as practical, convert these into more detailed descriptions. Writing up field notes is one reason that anthropologists often work late into the night, so that they can expand their jottings while they are still fresh in their mind (see ‘Field journals and notebooks’ on page ##).

Emerson et al. (2013) provide an excellent summary of this technique and other methods of importance in ethnographic research.
Recording historical sites

What are historical sites?

Sites from the historical period relate to the European, colonial past of Australia—the time after non-Indigenous people arrived and for which written documents exist. While the majority of these sites will date to the period after the 1770s, some will be older, such as those associated with early Dutch exploration, or shipwreck sites that predate the arrival of the First Fleet. Others will be relatively young, and can include modern material culture from the twentieth century. Historical sites are usually (but not always) studied under the specialist area known as historical archaeology.

Historical sites obviously represent a great diversity of activities, all part of the many ways in which European and other non-Indigenous people have attempted to explore and exploit the Australian continent. The main categories of historical site often reflect the different kinds of industries which have been established over the last two centuries, such as mining, pastoralism, agriculture, commerce, whaling, or timber-getting. These kinds of explicitly work-related categories, however, tend to exclude the historical contributions of those other than adult males and ignore common site types, such as houses, schools, hospitals or cemeteries. In reality, there are as many different types of historical site as there are different types of past human behaviour, and in a sense there is little point in trying to separate them according to function. One distinction we have drawn is between standing structures (i.e. any built feature which exists substantially above the ground) and sites which have been reduced to surface or subsurface traces only. This reflects the slightly different recording methods necessary for each, rather than any hard-and-fast distinctions in site use (for more information, see ‘Recording standing structures’ on page ##).

[[INSERT FIGURE 5.7 HERE]]
Investigating historical sites is similar to investigating any other site type, in the sense that archaeologists still set out to answer a similar range of questions:

- What activities were people doing here and why?
- When were they doing it?
- Did they succeed?
- When and why did the activities cease?
- What was life like for these people and why did they make the choices they did?

The chief difference between historical and other kinds of archaeology lies in the alternative sources of information that documentary records can provide about past human behaviour. Historical archaeology therefore is as much about researching the documentary evidence for sites and artefacts, or for the wider social processes and issues that surrounded people’s lives at certain times, as it is about recording and analysing the archaeological evidence (see ‘Using historical documents’ on page ##).

Despite having access to sometimes quite detailed written evidence of past events or behaviours, historical archaeology still aims to be more than just ‘history with artefacts’. One of the main reasons for consulting historical records before carrying out archaeological research is to make sure that what you want to know can’t just be discovered from the archives. The primary emphasis of historical archaeology is always on relating the documents to material (archaeological) evidence, and understanding just what the limitations of this process might be. Documents are always created for a purpose and are not necessarily objective, and all of them have their own inherent biases. They are also fragile things which often do not survive and are, in any case, not created around every facet of human life. Most of the ordinary people who settled
Australia were either unable or disinclined to write down the daily details of their lives, leaving enormous gaps in our understanding of the past. The material (archaeological) record goes some way towards filling these gaps: it is far more durable and was created by all kinds of people as a result of their day-to-day activities. Historical archaeology must always be a search for the many aspects of human behaviour which we could never know from documents alone.

Most recording of historical sites follows the standard pattern for any site—i.e. locating, surveying and mapping them—however, more specialist knowledge is required if you are recording standing structures, dating historical artefacts or using documentary or oral sources to complement the archaeology. Buildings, in particular, are a particular type of archaeological ‘site’ which require their own system of recording (see ‘Recording standing structures’ on page ##).

**Recording industrial sites**

As a specific class of historical archaeological site, industrial sites also require a particular approach to research and recording. An industrial site can result from extractive, manufacturing or processing activities, including mining, whaling, shipping, milling, factories and railways. To record an industrial site adequately, you will need to know how the site operated—that is, what industrial processes went on there, what equipment may have been on site, how different parts of the site may have been used for separate aspects of the overall process, or how the technology or the process changed over time. This will help you to understand both what occurred there in the past and the location and nature of the archaeological remains which you can see in the present. This information can sometimes be found by researching the specific history of the site, although for smaller, less well-known sites there may be little or no specific documentation. When working on any industrial site, you should make yourself aware of the
potential occupational health and safety issues of contamination from industrial by-products and take the necessary steps to minimise exposure (see ‘Work health and safety’ on page ##).

How safe is your soil? Wayne Johnson’s occupational health and safety tips for working on historical archaeological sites

You should never assume that the soil on your site is non-toxic. Soil contamination can take many forms, from heavy metals and chemical residues to bacteria and other harmful residues. Many of these potential toxins are the result of chemical processes developed since the advent of the Industrial Revolution and are more common than you might think.

Industrial sites can be particularly toxic. For five millennia, industrial activities have involved the processing of metal ores which usually leave residues in the soil. Arsenic and lead mines are in themselves hazardous owing to the nature of the material extracted, let alone processed. The secondary stage of metal-working, making alloys or using chemicals as flux, will also produce toxic residues which may have been casually disposed off—usually buried as fill or in disposal pits on site. Gold mining has long used arsenic as part of the process of separating the metal from quartz. The toxic residue was then washed away, to settle either in the surrounding soil or more usually down a waterway. In harbour cities, many industries were clustered around harbour sites with ready port access. On such sites, oils, diesel and other liquid fuel spills seep into the soil where they remain as residues. Remediation of such sites is expensive and may not necessarily have cleared the site of all hazardous substances. In addition, seemingly innocuous metal-working industries, such as blacksmiths and iron or brass foundries, may have used fuels such as coal with a high tar content containing toxic trace elements.

Potential health hazards can occur even on ordinary domestic sites. Sheets of asbestos insulation, or ‘lagging’, were commonly wound around pipes leading from
machinery such as steam boilers. Over the years, this ‘lagging’ degrades, releasing fibres into the air which also settle on the ground in confined spaces. Between the 1910s and the end of the twentieth century, asbestos fibrous-cement sheeting (‘fibro’) was used extensively in the domestic building industry. Although relatively stable in sheet form, if broken it too will release fibres into the air. Lead-based paints were commonly used on domestic houses throughout the twentieth century. Wherever there has been a regime of scraping off flaking paint prior to repainting, there is a danger of high lead levels in the surrounding soils and building interiors. Likewise, for most of the twentieth century, lead-based petroleum was used to fuel cars, escaping into the atmosphere via exhaust systems. Since lead is relatively heavy, it does not tend to spread far from the source of the emission, and tested levels are found to increase closer to busy roads or in the roof spaces of buildings located close to busy roads.

Pest control within domestic structures has attracted the use of chemical poisons for at least the past two centuries. Rodents were particularly targeted with baits laid beneath floors in an attempt to eradicate the nuisance. Nineteenth century city dwellings are often characterised by the extensive archaeological deposits that accumulate beneath floorboards, often attributed to the purposeful sweeping of refuse into the void beneath. Sampling of soil samples from the Cumberland Street site in Sydney’s Rocks district, for example, indicated high arsenic levels in at least one sub-floor deposit dating to the mid-nineteenth century. Owing to their porosity, animal bones were particularly susceptible to absorbing this poison. Because arsenic can be absorbed through the skin, rubber gloves had to be worn by archaeologists working with the artefacts recovered from these deposits.

Even organic fertilisers can contribute to toxicity in the soil. At the 1994 Cumberland Street excavations, tens of thousands of animal bones were recovered from a large area that had served as a butchery from 1809–29. The discarded limbs, horns and skulls were used as part of fill layers to build up soils above the rocky outcrops that gave the area its name. As a result, the soils in the vicinity are particularly high in phosphates. The butcher
responsible for this activity, George Cribb, was inadvertently poisoning his own well, located amidst the buried detritus. Even today, more than 170 years after the event, water pooling on this part of the site, including in the re-excavated well, is quickly covered with blooms of blue-green algae (Cyanobacteria). The water becomes dangerous to drink, the algae producing neurotoxins and hepato-toxins which can cause paralysis, liver malfunction and death. It may have been for this reason that Cribb filled in his well around 1818 and dug another on higher ground to the south-west. On other parts of the site, with low phosphate levels, the algal blooms do not develop.

As an archaeologist you need to be aware of such health hazards and, if necessary, take steps to minimise direct contact or prolonged exposure. In particular, you should be aware of the recent history of your site to minimise potential threats to your own and other people’s health. Wherever possible, make sure you investigate the history of your site in detail before you begin fieldwork to assess what potential toxins might be lurking in your soil.

Nineteenth and early twentieth century technical manuals or engineering works written for the industry are another invaluable source of information and are unparalleled for details of industrial equipment and processes. Any of the major state libraries will have good collections of such manuals which should be readily available. You could also try comparing the industrial archaeology of your site to archaeological reports for similar sites elsewhere. In addition, specialist journals were published for almost every major profession and trade throughout the nineteenth and twentieth centuries. For the mining industry, for example, the *Australian Mining Standard* (1888–), the *Australian Mining and Engineering Review* ([1908–17] afterwards known as the *Chemical Engineering and Mining Review* [1918–60]), and the *Engineering and Mining Journal* (1869–), all provide first-hand descriptive and technical information about many aspects of the general industry, as well as specific machinery, processes and sites. Examples for
other industries include the *Australian Storekeepers’ and Traders’ Journal* (1895–1936), the *Australian Brewers’ Journal* (1882–1921), the *Australasian Coachbuilder and Saddler and Liveryman’s Journal* (1892–1901), or the *Australasian Ironmonger, Builder, Engineer and Metal Worker* (1886–90, but afterwards called the *Australasian Ironmonger, Engineer and Metal Worker*). It is well worth investigating what collections are available in your nearest major library, or online through portals such as Archive.org or Project Gutenberg.

**Recording standing structures**

Not all archaeologists excavate and the study of standing structures is one example of how detailed archaeological information can be obtained without excavation. A ‘standing structure’ may be anything from a building, such as a house, barn or church, to a feature such as a kiln, jetty or bridge—in short, anything originally created to serve some human need in a relatively permanent location which now exists substantially above the ground (cf. Davies and Buckley 1986: 86). When recording any standing structure, your goal should be more than simply to describe it. A proper recording should provide enough information to recreate the sequence of construction and identify any changes in use and form, and, from this, to reconstruct in some measure its evolution across the changing lives of the occupants or users. In other words, your goal should be a chronological *analysis* of the structure, not just a description of its parts or contents.

Recording standing structures follows a similar process to recording any other type of archaeological site in that you need to ask the same range of questions: When and how was it constructed? What material was used and where did it come from? How was the structure altered through time? To do this, record four sets of complementary information:
1. The nature of the individual elements that make up the structure (i.e. the walls, the floor, the roof).
2. How the elements are put together (i.e. their construction and manufacture).
3. Details of any surface treatments (on the walls, the floor, etc.).
4. The overall condition of the structure and its individual parts.

The two least altered parts of a building will usually be the spaces in the roof and under the floor, so make an effort to investigate these whenever possible. Details can give you an excellent guide to the construction sequence of a building, even if all of the internal elements have been replaced (see Figure 5.8). Sometimes not all elements of a structure will remain in situ. In this case, it may be equally important to know what might have been there (if there is any physical or documentary evidence of the element’s existence) and what could have happened to it. Questions to ask of each set of information are included in Table 5.3 (which is by no means exhaustive).

[[INSERT TABLE 5.3 HERE]]

One of the main things to be aware of is how much the structure and its components may have been affected by later activities. This is an assessment of the integrity of the place and will be particularly important if you are also assessing its cultural heritage significance (see Chapter 10). As you record the individual components of a building and how they have been put together, look for signs of how the structure might have evolved or been altered over time, or for signs of the re-use of materials from older structures.

[[INSERT FIGURE 5.8 HERE]]

Figure 5.8: Two roof timbers from the same building
Describing structural components

As with all archaeological recording, consistency is the watchword when describing the physical components of a building. Always aim to use standard terminology, particularly when describing construction techniques and methods. We have only included the basics here, drawn largely from the Museum of London’s descriptive standards for timber and masonry construction. More detailed descriptions of particular architectural features can be found in Apperly et al. (1989) and Stapleton (1983).

Denis Gojak’s tips for recording standing structures

An orienteering compass provides a quick and easy way of drawing a complex (i.e. non-right-angled) structure with all the walls correctly oriented. Simply lay the side of the compass along the wall or alignment to be measured, then turn the graduated compass circle so that the inscribed mapping lines correspond with the north arrow. Lay the compass on the drawing page with the same bearing relative to north at the top of the page—that is, so that the north arrow again lines up with the inscribed mapping lines. I have found this useful in drawing quite accurate floor plans of defence structures with complicated designs. If you want to be doubly clever, align the north arrow to an offset bearing that is equal to the difference between magnetic and true north.

People surveying old buildings should arm themselves with an inexpensive flat metal 150 mm steel rule, with imperial/metric divisions. These are ideal for getting exact measurements of timber (the 3 × 4 inches that is really 68 × 110 mm) and for checking whether floorboards are butt-boarded or tongue and groove. If a floor is butt-boarded, the ruler will slide straight through. If it stops about 5 mm in along a sample of boards, then they are tongue and groove. Also, a steel rule (if properly sharpened) is perfect for scraping paint, gouging divots from walls to examine what’s underneath, cleaning fingernails and lifting lino to read the old newspapers.
Carlotta Kellaway’s tips for researching the history of a building

The key to successfully researching a building is to make sure you go armed with as much information about its location as possible, including its street address, the location of any neighbouring buildings and landmarks (such as churches, police stations or schools) and cross-streets. If possible, find out the allotment and section number for the block on which the building sits as well. The three best sources for information are:

- post office directories and almanacs;
- rate books; and
- Titles Office records.

Researching all three follows the same procedure: find a recent volume in which your building appears and then work backwards methodically, following the site through its various owners and occupants as far as you can.

Directories can be found in state library and archival collections. When working through directories make sure that you stay on the track of the right building. The street numbering system changed often throughout the nineteenth century, as did the names of streets and houses (not to mention the creation of new streets following subdivisions). The best way to combat this is to continually note down the names of landholders on either side of your building and to keep matching the pattern of occupiers to be sure you are documenting the right property.

Rate books are also found in state archival and library collections and sometimes also in local or municipal council collections. Coverage for some states is sparser than
others. Rate books will often describe a property, as well as give you information on who was occupying it and how much the place was worth to the council in rates. Look for changes in the description of a building or set of buildings, the name of the owner or occupier and any changes in the value of the property. In historical archaeological terms, marked changes in the value of a property might indicate that a building has been constructed or enlarged (or demolished if the rateable value drops dramatically), or that some other improvements have been carried out.

**Titles Office records** are held in government repositories in each state. Titles will give you a sequence of ownership for the land and sometimes information on the purchase price, any subdivision of the land and mortgages taken out by the owner. To search for these records, you will need the Crown allotment number for the property, as well as the section number and the name of the Parish and County. One thing you should be aware of is that the title system has changed from the Old System, which operated until 1862, to the present Torrens System. Under the Old System, title documents are called Deeds; under the Torrens System they are called Certificates of Title. Before conversion to Torrens title, the Old System recorded all successive transactions for an allotment from the name and date of the first purchaser. Often, the record of a mortgage having been taken out on a particular piece of land will indicate the construction of a building on that site and the size of the mortgage will provide a fairly reliable guide to the size and construction material of the building. Note that in South Australia you will need written permission from the owner of the property to access title records relating to their property (Kellaway 1991).

**Dating structures from their components**

In general, dating a structure from its components alone is very difficult. Even if you can find evidence of a manufacturer’s mark, trademark or patent number (the most ‘dateable’ information), materials may have been stored for a considerable time before use, may have been recycled from an older structure, or
may simply have been manufactured over a long period of time. At best, you will probably only be able to narrow it down to a date range, or to before or after a certain period.

Table 5.4 contains a rough guide to some major changes in building materials and construction techniques throughout the nineteenth and twentieth centuries. This is not intended as a list of all the ‘fashionable’ changes in various materials, but only as a guide to those inventions or technical developments which may be useful for assigning a rough date range to a building. Bear in mind that these dates are mainly ‘firsts’ and won’t be exact for all areas (innovations will have taken longer to reach regional areas, for example). If you can find them, trademarks or manufacturer’s marks may provide a finer resolution of date.

Many construction materials are less helpful in this respect than you might wish. For example, there was no standardised size for bricks throughout the nineteenth century, so changes in brick dimensions are not particularly useful for dating purposes. Prior to the 1850s, bricks were manufactured exclusively by hand and tended to be slightly smaller in size and thinner, measuring around 21.5 × 10 × 6 cm (Jeans 1983: 103). Handmade bricks will also exhibit a range of other distinctive marks, such as creases and folds (but not cracks) along the stretcher sides where the wet clay has dragged down the mould, a raised parallel ridge, known as a hack mark, also on the stretcher sides, caused by being stacked for drying and sometimes thumb prints caused by pushing the brick out of the mould.

After the introduction of machines for mass producing bricks in the 1850s, brick shape became more regular and sharper and their size slightly larger, until, by the 1880s, most bricks were machine-made (Freeland 1988: 188). In some places, such as South Australia, handmade bricks were still common well into the 1880s and in use probably until after the First World War (Bell 1998: 16). Freeland (1988: 146) suggests a standardisation in size to 22.5 × 12.5 × 7.5 cm
after 1900, but brick size can also vary considerably even between bricks made from the same mould, as a result of differential shrinkage in the kiln. [[INSERT TABLE 5.4 HERE]]

In theory, a cultural landscape can be analysed at any scale, but in practice it is usually viewed at a manageable level, such as within drainage basins or other well-defined geographic regions. This is mainly an administrative decision, taken to limit the potentially limitless notion of a cultural landscape.

Once you have decided on the sequence of construction for a building you can represent it using the concepts of the Harris Matrix, by assigning a context number to each element and then plotting them into a matrix path (see ‘Interpreting stratigraphy–The Harris Matrix’ on page ##). This is a sophisticated means of presenting both your data and analysis together in a single diagram (Figure 5.13). [[INSERT FIGURE 5.13 HERE]]

Figure 5.13: Presenting data from a structural analysis in a Harris matrix form

Photographing standing structures

The conventional approach to architectural photography requires a measure of technical skill and a camera or lens that can be adjusted to correct for converging vertical lines. At their best, these pictures convey the proportions, textures and colours of a building. When you are photographing the outside of a building, try to visit it at different times during the day so that you can view it in different lights. Then choose the lighting angle that best shows the shape and texture of the materials. When photographing the inside of a building, use available light wherever possible, but if this is insufficient, try bouncing a torch from a ceiling or wall, or using a reflector.

To record perspective accurately, it is necessary to keep the back of the camera parallel with the subject. When you photograph a building from ground level, however, it is usually necessary to tilt the camera back so that you can
include the top of the building in the frame. This means that the bottom of the building will seem larger than the top, and the sides will appear to converge. The easiest way to deal with this is to stand well back or use a telephoto lens so that you will not have to tilt the camera.

When photographing a standing structure:

- Always take orienting shots which show the building in its context, including the surrounding landscape and other buildings.
- Take external shots of the façade with a normal or telephoto lens, and then individual shots of the details on the façade.
- If you’re taking many shots of the exterior or interior of a building, note the direction and location of each shot on a photographic plan. Draw a sketch map of the building or site and indicate the physical location of each shot tied to the exposure number and the approximate direction you were facing for each shot with an arrow.

Photogrammetry has many useful applications when recording standing structures, and is well worth investigating as a method if you require a detailed photographic record. This could be used to create models of specific parts of a structure in both 2D and 3D detail, or even the entire building (see ‘Photogrammetry’ on page ##).

Useful resources

Bricks and Brass House Dating Tool: While this is a UK site, the online house dating tool provides a guide to period houses focusing on the Victorian and Edwardian periods. http://www.mileslewis.net/australian-building/: Professor Miles Lewis’ excellent collection of original works on various aspects of Australian buildings provides a wealth of useful information for the historical archaeologist trying to identify or date various architectural elements or identify construction methods or features.
CHAPTER SIX

ARCHAEOLOGICAL SURVEYING

What you will learn from this chapter

• The basic principles of survey
• How to produce quick and accurate 2D site plans
• How to keep your errors to a minimum
• How to set up and use an automatic (‘dumpy’) level
• How to set up and use a total station

The basics

Maps and plans are both scale drawings, but they are slightly different. While a map is a generalised representation of a particular part of the Earth’s surface showing visible surface features, a plan shows much more specific detail over a much smaller area—that is at a much larger scale. While both represent spatial relationships between things, plans are used for different purposes: in civil engineering, for example, plans form the basis for planning and zoning, engineering or construction; in archaeology, plans are used to show details of the physical layout of sites and the relationships between site elements. They are also used to depict sites in profile, particularly in order to illustrate the features revealed through an excavation. A clear and accurate site plan is the simplest and most effective way to record spatial information about a site and is usually necessary when recording a site.

Increasingly it has become common practice in archaeology to create digital plans from survey data. This ranges from digital enhancement and editing of
scanned paper maps through to fully digital workflows where spatial data recorded in the field are imported and edited using Geographic Information Systems (GIS) or cadastral mapping software. This allows you to produce plans from the same data at a variety of scales, to change what is included in the plan and how it is illustrated, and to view or establish the various relationships between types of spatial data.

**Surveying fundamentals**

Surveying is fundamentally about the recording of coordinates, or groups of coordinates, to varying degrees of positional accuracy in order to depict features at scale on a plan. These scale plans, whether in paper or in digital format, provide a basis for analysis and visualising the spatial relationships observed in the real world. Having the ability both to collect coordinates and create the resulting plan are essential archaeological skills. Methods for both have changed a great deal, particularly since the 1970s when a range of new techniques were developed. The two simplest and least technical methods for creating a site plan are:

- compass and pacing; and
- baseline and offset.

The advantage of these is that they require little in the way of equipment: simply pack several tape measures, a compass and drawing equipment and you are ready to survey. This has obvious advantages if you have to carry your equipment a long way to reach a site. There are disadvantages, too, in that these methods will not allow you to collect coordinates with much spatial precision, and work best in small, simple sites rather than across large complex sites. Furthermore, they will only collect coordinates in 2D space, and so the 3D
geometry of the features you see in the field (the rise and fall of the land, the drop in elevation from the top of a wall to the ground below, the depth of an excavation pit) will be ‘flattened’ on to a 2D surface. Your resulting plans can still show changes in elevation through careful use of various conventions for illustration (see ‘Drawing horizontal surfaces (plans) by hand’ on page ##), but if accurate elevation data is important then these are not the techniques you should use.

More advanced methods for site planning aim to capture this third dimension by using tools such as:

- an automatic (‘dummy’) level;
- a total station;
- a Differential or Real Time Kinematic (RTK) GPS; or
- a terrestrial LiDAR scanner.

These have steeper learning curves and also require that more equipment is carried into the field. Furthermore, beyond the dumpy level, other techniques require that you adopt a fully digital workflow in order to edit, manage and visualise your survey data. While this can be daunting, there are many benefits to learning these techniques—above all, they will give you much greater flexibility in the field. The middle ground is the dumpy level, which requires no batteries or computers and which allows you to draw your plan as you collect the data in the field. Despite being somewhat old technology now, we feel that it is still of sufficient importance in archaeology to warrant discussion here. They remain the default option for recording levels on many excavations.

The ultimate choice of which method to use will come down to time and resources, although it is also important to consider how detailed your final plan needs to be. If you were mapping a site that was going to be destroyed, then you would want to record everything in minute detail, as this may well be the only
recording ever to be made of this site. In this case it would be best to use a total
station or an RTK GPS, perhaps coupled with a terrestrial LiDAR scanner and
photogrammetry, since this will give you highly accurate detail of topography, as
well as the features on the site. If, on the other hand, you wanted to produce a
simple plan showing the main physical features of a site as part of the public
record or for publication (bearing in mind that most plans are greatly reduced in
size for publication and that, as the scale becomes smaller, the ability to depict
finer units of measurement decreases—for more information see ‘Mapping scale’
below and ‘Drawing horizontal surfaces (plans) by hand’ on page ##), then it is
probably more effective to use a simpler and less time-consuming technique like
baseline and offset. Whatever method you choose, it needs to be linked clearly to
the type and scale of data required for answering your research questions.

Mapping scale

When creating site plans, the first decision that needs to be made is the scale at
which you plan to record your data. This is sometimes referred to as mapping
scale: that is, the largest scale at which features will be recorded in the field. This
is important, because it is easily possible to collect spatial information with too
much or too little detail for your research questions. Generally speaking, your
choice will be determined by either the scale at which you want to draw your
final plans, or the scale at which you wish to conduct your analysis. Two general
principles should help you decide on the best mapping scale. First, choose a scale
that is large enough to record the smallest feature you wish to depict accurately.
If you need to display the location of buildings together with the precise position
of small glass or ceramic artefacts located near them, then you will need a
mapping scale that is large enough to show the coordinates of artefacts that are
less than 10 cm in size (so a suitable scale might be 1:100 or even 1:50). This
would become the scale at which you record all features in the survey. Even if
you don’t need this level of precision for all features (e.g. larger buildings), by recording all of your data at this scale your final plans can accurately show the relationships between your buildings and the recorded artefacts. If the location of small artefacts wasn’t important, however, you might choose a different scale, but it will still be based on the smallest feature you want to record.

Second, your drawing scale can be smaller than your mapping scale, but it should not be larger. If a feature is recorded at a mapping scale of 1:500, its scale can easily be reduced (e.g. to 1:1000) in order to be redrawn. If you were recording artefacts at a scale of 1:100, as discussed above, then you would definitely struggle to create a plan of a large site (e.g. 200 m²) at this scale because it would take up a very large sheet of paper. By reducing your scale to a suitable size to suit your final plan size (e.g. 1:1000), you can generalise data about artefact locations (e.g. by drawing a boundary around a surface scatter, or by not showing them at all) and show the broader detail that you wanted to depict in your plan. Importantly, though, if you chose to record your data in the field at a scale of 1:500, you will not be able to enlarge the scale (e.g. from 1:500 to 1:100) because to do so will distort your data.

So, always choose a mapping scale that is large enough to record the finest spatial details you are interested in depicting or analysing later. You can always reduce the drawing scale when creating plans, but it is not possible to increase the drawing scale later without re-recording your data. The best scale is the one that allows you to capture enough detail to answer your research questions. Thinking through these details is important, because it will help to increase your efficiency in the field by ensuring that you are only recording the detail that you are interested in. To a large extent this will determine your choice of survey method.
Spatial precision

Spatial precision (also known as positional precision) is the level of spatial exactness that can be achieved when collecting or analysing spatial data. This term is commonly used in archaeological surveying when referring to the degree of measurement exactness achievable with a specific measurement tool. For example, when using a consumer-grade GPS handset for recording a point, the device might estimate that it has a spatial precision of 5 m. This effectively means that the real recorded coordinate will be within ±5 m of the coordinate that the device has measured. You can try and visualise the effect of spatial precision when recording coordinates in the field by imagining a circle with a radius of X m around the point you are recording, where X is the degree of spatial precision. High spatial precision would see the size of this circle reduced to a few centimetres in diameter, while low spatial precision would see it increased to metres or even tens of metres. Spatial precision is sometimes referred to as an error, though this can be a misleading term because in all surveying applications your spatial precision should be decided upon before any recording commences and so, rather than being an error, it is more a trade-off about the level of precision you require in your data (or the degree of imprecision you are prepared to accept). The term ‘error’ should instead be used to refer to mistakes made when surveying.

Spatial precision will be influenced by both your mapping scale and the equipment you have available to conduct a survey. Sometimes, it is necessary to record with as much spatial precision as possible. For instance, during an excavation it can be important to plot the coordinates of artefacts, samples, levels or features as accurately as possible as a basis for your subsequent analysis. Similarly, if you are conducting a survey with the intention of managing your data in a GIS or cadastral software package, then your data can be displayed at any scale you choose. In both of these cases, it is important to decide what
degree of precision you’re aiming for, in terms of your field recording. Depending on the size of the feature to be recorded, a technique like a tape and compass survey could achieve spatial precision of ±50–100 cm, while a baseline/offset within a small area (<10 m) could easily achieve a spatial precision of ±10–20 cm. Generally, high-precision recording in archaeology means sub-decimetre spatial precision, that is, to within the nearest 10 cm, but it is possible to achieve sub-centimetre precision (within the nearest 1 cm) with some tools. For example, a total station can reliably record plot points at sub-centimetre precision.

Mapping scale and spatial precision should be explicitly described when writing up your survey methods. Your decisions will be ultimately influenced by your research question, and directly influenced by your answers to two questions: what is the smallest size of the features that you need to depict or analyse (i.e. mapping scale)? And what spatial precision is required to achieve this? The first depends on what, specifically, you wish to depict or derive from your field data, while the second is fundamentally about the choice of survey technique necessary to achieving the first.

Creating a survey framework

The most important element in an accurate survey is to ensure that the location of all features can be tied together in such a way that there are no ‘floating’ measurements and therefore the sources of error can be kept to a minimum. Obviously you can’t just go and make a series of totally unconnected measurements and then expect to be able to use them to draw up a coherent site plan. It is no use knowing that the barn is 5.8 m from the fence if you have no idea where the fence is in relation to anything else. Or knowing that the fence and the barn are 5.8 m apart if you didn’t measure how long the fence was or where, precisely along its length, the barn was located. Even if you made sure to
measure the position and dimensions of every feature by moving systematically around the site (‘the house is 12 × 8 m, the fence is 3 m from the south-east corner of the house and is 25 m long, the barn is 5.8 m from the ninth fencepost from the northern end’), if you have made one mistake at any point in this sequence, then every other subsequent feature measured in relation to this will also be out of position. At the end of the exercise you will still not be able to create an accurate site plan and all your time will have been wasted.

Tying measurements together can only be done through the use of a site datum: a fixed reference point that your entire survey is related to, and from which all measurements are derived. This should be something that you or others can find again in future, so that additional measurements can be made. Ideally, the site datum should be a permanent survey marker that has been established by a licensed surveyor (see ‘Surveying in geodetic coordinates’, below); unfortunately, it is not commonly the case that these are located near archaeological sites—particularly if you are working in areas away from surveyed roads. You can take measurements to orient your survey in relation to these markers, though sometimes the distances between your site and the survey marker can mean that this is not worthwhile. A fixed feature on or near the survey area can serve as a good alternative: things like concrete foundations or monuments, metal structures, prominent posts, or even large stones can be used—provided you can find a distinguishing feature on them, less than about 5 cm in diameter, to use as the basis for your survey. Metal, plastic or wooden pegs, or even nails can also be easily placed at convenient locations, though keep in mind these are easily removed by fires, mowers, animals and people.

In many cases a system of secondary points around your site can provide convenient points from which to measure in detail. These are sometimes referred to as control points or temporary benchmarks, reflecting the fact that they are more temporary than your datum and will often be removed as soon as
your survey is completed. Whether these are established is really dependent upon the size of the area you're surveying. They would be unnecessary if using baseline and offset or a total station to draw a plan of the foundations of a small cottage, but if multiple cottages, other built structures and artefact scatters existed over a larger area you would need to think about how you could layout control points in order to survey the entire site. The placement of control points must be planned before the survey commences. Here are a few other basic rules to keep in mind:

- Use as few lines between control points as possible to keep your errors to a minimum (any form of quadrilateral is ideal, but this will vary with the nature of the site—see Figure 6.1 for a more complicated example). You do need to make sure that each of your control points can be seen from at least two other locations, however, so that each point can be triangulated (see point three below).
- Make sure that the framework is ‘rigid’—in other words, that your starting point is also your end point.
- Make sure that you check the accuracy of your framework before you begin by accurately surveying in each control point before any details are recorded. When establishing a survey framework, you need to measure not only the length of each ‘arm’ of the outside perimeter, but also the diagonals between control points. This is why surveyors commonly divide a survey area into triangles, then measure all of the sides (Hobbs 1983: 44–5). Triangulating each of your control points via these diagonals will provide essential checklines to keep your framework rigid.
- Try to keep the angles of the triangles in your framework between 30° and 120°. If your angles are greater than 120°, it is easier for errors to creep in.

[[INSERT FIGURE 6.1 HERE]]
Figure 6.1:

If you are working in a location where there are no permanent survey markers, but you would still like to align your plan to geodetic coordinates (see ‘Surveying in geodetic coordinates’ on page ##), you will need to use a global navigation satellite system (GNSS) handset to obtain a coordinate. Unless you are lucky enough to have access to a high-accuracy GNSS device, you will be bound by the error of your handset (±5 m, at best) (see ‘Obtaining GNSS coordinates’ on page ##). This means that you can only take one coordinate, which will ideally be at your site datum. If possible, leave the handset for a few minutes to let it average the coordinate being calculated. If you want to increase the precision of the coordinate, do this several times and average the results—even over several days. There is no point using the handset to obtain coordinates on control points, since the spatial precision will be much less than that of most other methods for recording their position. Keep in mind that, in some cases, a site datum is not in a good enough position to enable an accurate coordinate to be obtained (for example, if located beneath thick vegetation, within a rockshelter or adjacent to a tall building) (see ‘Positional errors with GNSS handsets’ on page ##). Where this is the case, create a control point in an open area and obtain the position for that, then survey back to your datum to create the survey framework.

Minimising errors when surveying

Regardless of the type of survey you are undertaking, there is always a potential for errors to creep in. This can include simple things like incorrectly setting up equipment, misreading tape measures, compasses or other equipment, forgetting to record important points or neglecting to write down critical information clearly in your notes. It is important to be aware that survey errors are typically human errors (rather than the fault of the equipment we use), and so some attention to developing good practices can
significantly minimise these. Common practices that you can use to help minimise errors include:

- Placing control points and instruments at locations that are free of obstacles. Unsurprisingly, a field assistant’s preoccupation with avoiding a rusty barbed wire fence or an ant-infested tree can lead to errors in setting up or using different types of equipment. It also slows things down.

- Placing control points and instruments on level ground. A slope that is greater than 5° can make it more difficult to set up equipment, to stand still and can sometimes make it easier for people to slip over (possibly taking out an instrument station as a result!).

- Not assuming that everyone is familiar with the technique being used, even if it seems very simple to you. If you are organising a survey, spend as much time as possible working with your team members to make sure that they are comfortable and confident with the task you have asked them to do. If you’re a team member unsure of how to do something, make sure to ask—it’s much less embarrassing than making repeated mistakes all day!

- Delegating specific roles to specific people. While rotating individuals through different roles is important, moving people between jobs too frequently can introduce errors. The more experience people have at any task, the less likely it is they will make mistakes. So give people enough time to become confident with a task.

- Double or even triple checking critical measurements, such as those taken when setting up control points or instruments. It can sometimes be beneficial to have several people take important measurements, just to double check. It is always a good discussion point where different people taking the same measurement generate contradictory results.

- Not using orienteering compasses for surveying, unless there is no other option! Instead, use a sighting or prismatic compass to obtain your bearings, as these allow
you to narrow your focus on your target and obtain readings with much greater precision (see ‘Compasses’ on page ##).

- Taking periodic measurements to your site datum or control points during the day, and comparing these against your original measurements. If you notice an error, stop and investigate the cause before recording more data.

- Being consistent and detailed in taking notes. Never assume you will remember minor details later. Keep a separate notebook for logging survey data, and always ensure that you write your notes so that they can be understood by others. Also, include sketches of everything you survey, showing the location of the points recorded as well as other important measurements. These should be cross-referenced to both your log of measurements and the data recorded on your survey instruments, where applicable.

- Photographing each page in your survey notebook and associated plans or sketches at the end of each day, so that you always have a backup. If any of these are lost, it can render your other data useless!

- Correcting field errors as soon as possible. It is more difficult (if not impossible) to correct errors in survey data once the survey is completed.

**Surveying in 2D**

**Tape and compass surveys**

Distance and bearing measurements are the basis of most surveying techniques, and while not widely employed in practice, we include it here because it helps to illustrate how these measurements can be used to construct a survey plan. The tape and compass technique uses a tape to measure distance and a compass to plot direction. Its great advantage is that it enables two people to create a reasonably accurate plan of a small area relatively quickly. Tape and compass surveys become impractical, however, when measuring over a distance of more
than about 30 m, as the tape can become unwieldy and difficult to keep taught. Creating a survey framework with control points spaced around the perimeter of the site can greatly extend the range of your survey. The key to doing this successfully is ensuring that the control points are carefully measured in to begin with to create your survey framework (see ‘Creating a survey framework’ on page ##). Before you start, you will want to set up your plan at the scale you wish to use. Here, we will use the example from Figure 6.1 (see page ##):

2. Work out a framework for your survey and find a site datum. Peg out your control points and number them consecutively (e.g. CP001, CP002, etc.). Make sure that each control point can be seen from at least two other control points.
3. Beginning at the site datum, take a compass bearing (see ‘Compass tips’ on page ##) to Point A by aligning the compass on the point (ideally, a person holding a range pole), then observe the bearing.
4. Extend a tape measure from you (holding 0 m) to your destination. This should be kept straight and pulled taut to prevent any bends forming. Bends will introduce minor errors.
5. Fill out your notes as appropriate (e.g. ‘Origin’ Site Datum; ‘Target’ Point A; ‘Bearing’ X°; ‘Distance’ X m; ‘Description’ Control Point 001).
6. On your plan, draw in your site datum. Then, using a protractor, plot the angle from the Site Datum to Point A, and mark it lightly with a pencil. Using a scale rule, measure the distance between the two points, placing a mark at the measured location. Label the points appropriately in small, neat text.
7. Continue this process as you work your way around your control points until you arrive back at your starting point (site datum).
There are numerous opportunities for error here, with the most obvious being that, if one distance or bearing measurement is in error, then all subsequent positions will be in error as well. These will be very obvious when the measurements are drawn on the plan, since when you plot the final measurements for your site datum, it will not be in the same position as the original starting point. This is called an error of closure and can be represented in your plan as a line between the original point and the measured point, which can usually be labelled with a small 1 in superscript (e.g. site datum\(^1\)) to show it is different to the original site datum. You should always aim to minimise this error of closure. You can do this during a survey by taking a back bearing from each target point to the origin point. Remember that the difference between your foresight and your backsight should equal 180° (see ‘Compass tips’ on page ##), although an error of plus or minus 2° is perfectly acceptable. If the difference is concerning, then take your bearings and distance measurements again. This is the major advantage of drawing your plans while still in the field—that obvious errors can be quickly identified and corrected.

Once you have established the survey framework, you can get on with the task of recording the detail. Start with the large features—major buildings, fences, vegetation lines and so on. Having these recorded first can be useful when it comes to completing the finer details. Take measurements from control points or the site datum out to features that you are recording (as per steps 1–6, above). To increase your accuracy, you can also take measurements from several control points to the same feature. Although there are ways to correct an error of closure, we recommend simply getting it right in the first place in relation to the scale at which you are working—that is, minimising the error until it is too small to see on your plan. If greater precision is important, then choose a technique that allows for this.
Pacing it out

If you need to draw a quick plan and are prepared to accept trade-offs in terms of accuracy, or if you’re just drawing a mud map of a site, then it is possible to replace a tape measure with pacing. Pacing is simply the distance of a natural step when walking comfortably on flat ground, and is measured between the back of your back heel and the tip of your front foot. A pace should be seen as a unit of measurement only where you are walking in a relatively normal manner—it certainly does not mean taking exaggerated steps to try and step out a metre or the longest distance you can reach, since the point here is to aim for a reproducible and consistent step distance. To calculate your pace, you will need an area of relatively flat ground. Measure out a length of 10–20 m, then place one heel at the 0 m mark and naturally walk along the tape, noting the measurement for your final step (measured at your toe) and the number of steps you took. Average your step size by dividing the final measurement by the number of steps (e.g. 9.8 m/12 steps) and write this down. Repeat this 5–10 times and average the results so that you can obtain the best possible estimate of your pace. Memorise your pace length, as you will find in archaeology that there is always a need to know how to pace out distances accurately! When you want to use it, simply pace out the distance and note the number of paces you took. Convert your ‘pacing unit’ to metres by multiplying by the number of paces you took. If your pacing unit was 0.80, for example, then a feature which you measured to be 6.5 paces in length would be in reality 5.2 m long.

The key to this technique is always to maintain a comfortable walking pace as you pace out your measured length and whenever you use your pacing unit to measure sites or features. If you exaggerate your steps you will never obtain an accurate or replicable measure of your pace. Also be aware that, because your pacing unit is the average length of a single step, it will vary depending on whether you’re walking uphill (when your pace will be shorter) or downhill (when your pace will be longer). It may even vary at the beginning and the end of each day according to how tired you are. For this reason you
should also perform this exercise on sloping ground (on around a 15–20 per cent slope) to give you a unit for measuring up or down hills.

**The baseline/offset technique**

This technique uses the same principles as a tape and compass survey, but offers the opportunity to attain greater accuracy by minimising the potential for making errors when taking bearings. It requires little more in the way of equipment than a couple of long and short tape measures. It requires a minimum of two people, though three would be better. It is subject to the same limitations as a tape and compass survey in that using the method over distances of 30 m or more becomes difficult to achieve because you are constrained by the need to take measurements at right-angled offsets from a baseline. A **baseline** is an arbitrary line that you establish through your site for the purposes of survey. Any measurement from a baseline to a feature is called an **offset**.

Your baseline may be a long tape measure or a string-line of known length which you have fixed to pegs. Where you place it will depend on the size and shape of your site; because it is an arbitrary line which you are using for convenience, it doesn’t matter where in the site it is located as long as you can plot most or all of the features from it. If you are recording a stone arrangement, for example, you might choose to fix the baseline through the centre of the arrangement so that you could conveniently plot all of the stones on either side of it. Similarly, if you are recording a collection of farm buildings, you may be able to use a fenceline (provided you have measured it first) as your baseline.

If your site is particularly large or spread out, you may need to establish more than one baseline to be able to reach all features. In this case, you could use the position of the first baseline to establish the position of the second and so on, but bear in mind here that if you have made any errors in establishing the position of the second baseline, then any subsequent baselines will also be out and there is a
real likelihood that your errors will be compounded. To try to control this
process of cumulative error, the most reliable means of surveying an area is to
set up a series of baselines around the perimeter to form a survey framework
which encases the site (see Figure 6.1). For example, in Figure 6.1 (page ##), it
would be quite feasible to lay out the control framework as per the guidelines for
tape and compass surveys (see ‘Tape and compass surveys’ on page ## above),
and then place baselines between control points. In reality though, a dumpy level
or other technique is better suited to surveying over larger distances and would
be more effective. Despite that, the baseline/offset method has its uses: it is an
optimal method for recording features that are less than 30 m in diameter, and
the smaller the survey area the greater the degree of precision you can achieve
with it. It can be used to draw very high-quality plans of discrete structures,
artefact scatters and even to record detailed features at a very large scale (e.g.
1:10, 1:50)—such as stone work.

Set up a baseline/offset survey as follows:

- First lay out a baseline. A long tape measure is best for this, as the
distance along the baseline can easily be read off the tape as the survey
progresses. The 0 m mark should be placed on a control point or the site
datum. Give careful consideration to where you lay out your baseline—it
should be aligned in such a way that most (if not all) of the features can be
measured from it without having to lay out another one. The baseline
should ideally be placed on the ground, and be kept straight and
horizontal. It is possible to raise a baseline above the ground, for example,
by pegging it to a piece of taught builder’s string with a string level, but
this can be very time consuming and raised baselines tend to stretch and
sag.

- Once the baseline is fixed, don’t move it until all of your measurements
are complete.
• Set up your field notes with the following rows: ‘Point’; ‘Baseline’; ‘Offset’; and ‘Description’.
• Set up a plan at an appropriate scale, plotting in the 0 m mark (again, ideally at a datum or control point).
• Take a compass reading from the 0 m point along the baseline. Note this in your field notes, along with the length of the baseline. It can be useful to take a back bearing along the baseline to verify your forward bearing.
• Draw your baseline on your plan (which will be drawn using graph paper) orienting it along a graph line. Be sure to indicate north and label the points at the beginning and end of your baseline.

You can now measure offsets from the baseline to the various features of the site. The most important thing to remember about a baseline/offset survey is that all features must be measured at right angles to the baseline. In other words, you must keep all offsets at 90° to the baseline to ensure that you are measuring the shortest distance between the baseline and the feature. If your angle varies above or below 90°, then the distance you are measuring will also increase or decrease, giving you an inaccurate measurement. When recording, measure your baseline measurement first, followed by your offset. The 0m point of the offset measure should be held by the person at the offset point, rather than at the baseline. This allows the person working at the baseline to judge accurately when an offset is at the correct angle. For anything over 30m, you will have to use a different technique (see ‘Methods for measuring right-angled offsets’ below).
Methods for measuring right-angled offsets

1. Bisecting an arc

To use this method, get one person to hold the end of a tape measure firmly on the point which is being measured, while you stand at the baseline and swing the other end of the tape measure over it in a short arc. As you swing the tape measure over the baseline, you will notice that the distance increases as the tape reaches either end of the arc, but lessens towards the centre of the arc. It is this shortest distance which you are looking for, because this will indicate when the tape measure is at a right angle to the baseline. If you are not confident that you can work this out by eye, then mark each end of the arc where it crosses the baseline, measure the length of this distance on the baseline and then divide it in half. This halfway point marks the corner of the right angle.

[[INSERT FIGURE 6.2 HERE]]

Figure 6.2: Bisecting an arc

2. 3–4–5 triangle

This method relies on the 3–4–5 ratio of a right-angled triangle (see Figure 6.3) Basically, if the measurements for each side of a triangle are always kept in units of 3, 4 and 5, or any multiple of these (for example 3m–4m–5m), then the angle between the two perpendicular sides of the triangle will always be 90°. For example, you want to lay out a second baseline perpendicular to your first. At the offset point on the first baseline (where the second baseline will begin), you fix the end of one tape measure. You measure along the first baseline for a distance of 3 m. This will be the base of the right-angled triangle. Holding the end of a second tape measure over this point, you give the ends of both tape measures to another person who moves away from the baseline until they are standing at roughly 90° to the offset point. You already know that for the triangle to be a right-angle these two measurements must equal 4 m and 5 m respectively, so keep adjusting both tape measures until you have them at the correct
length. The point where they cross at the correct lengths is the other end of your right-angled offset. Note that a right-angled measurement using this technique will be more accurate when using longer measurements (3, 4, 5 m rather than 30, 40, 50 cm), so make them as long as possible.

[[INSERT FIGURE 6.3 HERE]]

Figure 6.3: 3-4-5 triangle

Make absolutely sure that you always record your measurements in the same order—that is, reading along the baseline first, and then along the offset to the feature. If you confuse the order of these readings at any time, you will not be plotting features in their correct locations. Also, it is much easier to draw a baseline and offset survey to plan as you go along—in other words, to have two people measuring (one always at the baseline and one always at the features) while a third person simultaneously plots the position of each feature on to graph paper and constructs the plan (see ‘Drawing horizontal surfaces (plans) by hand’ on page ##). The draftsperson has the responsibility of keeping a sharp eye on how the plan is progressing because they’re in the best position to notice if distances seem wrong or if features don’t plot where they should. This means that, if you are the draughtsperson, don’t just blindly trust the measurements being given to you. You must keep a sharp eye on how things look on the ground versus how they are being depicted on your plan. The measurers have no overall scheme in front of them to see the relationships between each point, but you do. Evaluate each measurement in the context of the plan as it is progressing and don’t be afraid to ask for measurements to be repeated or for extra measurements to be taken if something doesn’t look right. In this sense, it is really the draftsperson who directs the survey, not the other way around.

The baseline and offset technique is most accurate on level ground, so wherever there is any slope you will need to take care to keep your baselines and offsets horizontal. In these cases, you will need to hold the offset tape measure above the baseline so that it is above the location of the feature being measured.
and use a plumb-bob dropped below the offset tape to find your exact position (see Figure 6.4).

[[INSERT FIGURE 6.4 HERE]]

Figure 6.4: Using a plumb-bob to establish your position on the baseline

The baseline/offset technique is simple, effective and accurate over small areas and is therefore a standard part of archaeological field methods. It can also be adapted to vertical surfaces, such as standing structures or, for example, to create a cross-section through a rockshelter (see ‘Recording rockshelters’ on page ## and ‘Drawing vertical surfaces (sections) by hand’ on page ##). In these cases, instead of your offsets being measured horizontally from a baseline to a feature, they will be measured vertically above or below the baseline. Once again, you will need to give careful thought as to where you place your baseline to ensure that all of the major measurements can be made from it. You also need to make sure that your baseline is kept horizontal and that all measurements above or below it are kept as close to vertical as possible.

[[INSERT FIGURE 6.5 HERE]]

Figure 6.5: Hypothetical use of the baseline and offset technique to create a cross-section of a rockshelter

[[INSERT FIGURE 6.6 HERE]]

Figure 6.6: Hypothetical use of the baseline and offset technique to create a vertical ‘plan’ (or elevation) of a wall

Surveying in 3D

For a baseline/offset or tape and compass survey, you will be minimally recording X and Y coordinates for each point. If you are using a total station or automatic dumpy level, you will be recording X, Y and Z (or height) coordinates for each point. The X and Y positions give you your 2D position (that is, the
position on a flat surface), while the Z coordinates give you the height or depth of that position in 3D space (i.e. both horizontally and vertically). 3D data are essential to an understanding of landscape and site topography, as well as the recording of the excavation process, so at some point are crucial for almost all archaeological projects.

**Surveying in geodetic coordinates**

One of the first decisions to make on any survey is whether—and indeed, how—you might align your coordinates to a wider geodetic coordinate system or a grid projection (e.g. the Universal Transverse Mercator [UTM] grid). There are some good reasons to do this:

- Do you intend to edit and store your data in a GIS, or share your data with someone who does?
- Do you wish to know the geodetic coordinates of features you’re recording? For instance, if you’re creating a database of recorded artefacts and need to ensure that the geodetic coordinates of each artefact form part of the record (e.g. for archiving a dataset).
- Is the relationship between the features you’re recording and other plans important (for instance, in terms of determining where a property boundary is in relation to your site)?
- Is there a need to have accurate elevation data that is related to a national height datum (e.g. the Australian Height Datum 1994)?

If your answer is ‘yes’ to any of these questions, then it’s essential to take steps to survey in geodetic coordinates, or at least to record enough information so that you can later make the necessary corrections to do this. If, however, you simply aim to create a 2D static plan to document and communicate the spatial relationships on a site, then it is probably not necessary.
The automatic dumpy

One of the most widely used methods of collecting 3D survey data in archaeology is to record levels, or the changing height of the ground across the site (Drewett 1999: 66). The principle of levelling is very simple: it involves projecting an imaginary horizontal plane across the site and measuring the height of the ground above or below this. Surveyors refer to this as the line of collimation. It can only be measured with the proper equipment, however, such as an automatic level, or dumpy. Dumpies are no longer regularly used by professional surveyors, though you may have seen builders using these and similar equipment—they are designed to be set level on a solid tripod, and the height at various points across the site read off a stadia rod (a telescopic staff with units of height marked in alternate red and black segments) through the telescopic lens of the level (see Figure 6.7).

Figure 6.7: The major components of an automatic level

The main difference between using a dumpy level and any other kind of 3D instrument is that the data from a dumpy must be recorded by hand on to a level booking form (see ‘How to fill in a level booking sheet’ on page ##). This means that a plan drawing from the data also needs to be completed by hand in the field as the spatial data are collected (see ‘Drawing horizontal surfaces (plans) by hand’ on page ##). This information can be digitised, but this comes after the collection of field data.

Dumpy levels are used in several common ways in archaeology to:

- create plans over a larger area than 2D techniques can easily cover;
- create plans that record the rise and fall of the land; and
- record depth against a benchmark during an excavation.

They can appear daunting, but are only slightly more complicated than conducting a baseline/offset or a tape and compass survey, and, despite the
proliferation of digital surveying tools like total stations, dumpy levels have their advantages.

**How to set up an automatic or ‘dumpy’ level**

*Step 1: Establish the location of the instrument.* This is important, because ideally you want to be able to take as many readings as possible without having to move the instrument. Try to find a centralised spot from which all parts of the site are visible. Ideally, this would be on a control point within a survey framework. Once you have decided on this, set up the level. First erect the **tripod** (the telescopic legs which form the base). If you’re working as part of a large group, you should erect the tripod to the height of the shortest user. In any case, make sure the tripod is at a comfortable height for constant use, and lightly but firmly tamp the legs into the ground. Don’t make them immovable yet, however, because the next step will be to make sure that the instrument itself is perfectly level. Make sure that the head of the tripod (where you will be shortly attaching the instrument) is roughly level and doesn’t have an obvious tilt in any direction. If it helps, use a spirit level placed on the head of the tripod to assist.

   Now attach the instrument. The level will have a base plate (see Figure 6.8) that can be screwed into the top of the tripod. Don’t screw this in tightly at this stage, but make sure that the level is firmly fixed to the tripod and can’t slide off. Now you have to level the instrument. As long as you have only lightly screwed the instrument in place, the slightly convex surface that is the head of the tripod will allow you to slide it around in a tight circle. Note the effect this has on the levelling bubble (Figure 6.8) and see if you can get the instrument close to horizontal. All surveying equipment will have such a visual means for you to judge how level they are—usually a centrally located air bubble inside a marked ring on the circular base of the instrument. You need to get the dumpy at least close to being level at this stage (i.e. the bubble needs to be almost within the circle if not completely inside it), then tighten the screw holding the level in
place. This will probably change the level of the instrument slightly, but don’t worry as you can adjust this next. If you can’t get the instrument anywhere near level at this stage you will have to rethink the positioning of the tripod legs and check whether any need lengthening or shortening. One of the ways to adjust the gross level of the instrument is to tamp the individual legs of the tripod more firmly into the ground. Keep an eye on the levelling bubble as you do this.

[[INSERT FIGURE 6.8 HERE]]

**Figure 6.8:**

Most automatic levels use a combination of three large foot screws (Figure 6.8) at the base of the instrument to make them perfectly level, although some may have an internal levelling mechanism. These foot screws are designed to be used in pairs (imagine a triangle underneath the instrument that can be raised or lowered on each side). Align the telescope so that it lies parallel with one pair of foot screws and, using both hands, turn these two screws *outwards* (i.e. in opposite directions towards the edges of the instrument). Note the movement of the bubble as you do so. As long as you had the instrument approximately level in the first stage, you shouldn’t have much trouble getting the air bubble in the centre of the bull’s-eye circle now. Swing the telescope through 90° so that it lies directly over the third foot screw and make sure the bubble is still perfectly centred. Swing the telescope over each foot screw and check that the bubble remains centred.

*Step 2: Once the instrument is steady and level, mark the location with a permanent fixture, such as a wooden peg.* This must be located directly beneath the instrument, so you will need to tie a plumb-bob to the hook underneath the centre of the tripod head and position the peg directly underneath it. Mark the top of this peg with an indelible cross. This is your first **survey station**.

*Step 3: Measure the height of the instrument* above ground with a tape measure and record this in your field notes.
**Step 4: Focus the telescope.** If you look through the telescope you will see one vertical and one major horizontal cross-hair, with smaller horizontal check marks above and below the major horizontal cross-hair. In most models, the eyepiece will be surrounded by a rotatable dial that focuses these cross-hairs (Figure 6.7). Use this to make sure that all cross-hairs are sharply defined.

**Step 5: Sight on the staff in preparation for the first reading.** Use the peep-sight on the top of the telescope to approximately align it with the staff and sight on the staff through the eyepiece. Once you can see the staff through the telescope use the focusing knob on the right-hand side of the telescope’s body to bring both the cross-hairs and the face of the staff into perfect focus (Figure 6.7). The horizontal fine motion control knob (or pair of knobs) on the telescope’s circular base will allow you to shift the telescope incrementally left or right until the vertical cross-hair is perfectly aligned with the centre of the staff.

**Step 6: Begin taking readings.** Your readings will take into account both the horizontal and vertical cross-hairs: the horizontal cross-hair represents the line of collimation and, by reading the changing height of the staff along this line, you are reading whether the ground is rising or falling.

[[INSERT FIGURE 6.9 HERE]]

**Figure 6.9: Surveying the changing height of the ground across a site**

**Recording levels**

The first reading you will have to take must be a **backsight (BS)** to the site datum to establish the height of the line of collimation. Hold the staff at the datum, take the reading at the central horizontal cross-hair and then add it to the known height of the datum. If the site datum has a value of 60 m above sea level for instance, and the reading gives a height of 1.4 m for the staff, then the height of the line of collimation is 61.4 m. If you don’t know the precise height above sea
level of your datum then you will have to assign an arbitrary height to it (for instance, 100 m. Don’t make it zero or you’ll end up with negative numbers). The sum of the first reading and the datum height is the value for the line of collimation (otherwise known as the **height of the instrument [HOI]**).

An automatic level also has the facility to read degrees from north so that each reading can be aligned to a particular compass bearing. As part of your first backsight, and *before* you move the telescope for the next reading, take a compass reading on the staff along the same axis as the telescope to determine a bearing for the backsight. For example, this might be 270°. Rotate the large circular dial at the base of the instrument so that its reading in degrees aligns with your compass bearing (i.e. so that you can read 270° through the index window underneath the eyepiece) (see Figure 6.7 on page ##). When you’ve realigned the telescope for the next reading, you’ll be able to read the bearing for that position by simply reading the degrees shown in the index window. Always try and use a sighting or prismatic compass, as an orienteering compass will be difficult to obtain a precise reading over the instrument and will introduce an error into your survey.

Once you have taken your backsight, all subsequent readings (to various features on the site) are called **intermediate sights**, or **inter-sights (IS)**. For each inter-sight, subtract the reading at the central cross-hair from the height of the instrument to give you the reduced level (RL) for that spot. You can also use an automatic level to measure distance as well as height and so give you a plan of a site. Inside the dumpy’s telescope you will see two smaller cross-hairs above and below the major cross-hair denoting the line of collimation. If you subtract the height of the staff at the lowest cross-hair from the height at the highest cross-hair and multiply by 100, this will give you the distance from the level to the staff in metres (see Figure 6.10).
Traversing

If you find that it is impossible to cover the entire site from one position (e.g. if there is heavy vegetation cover, or the site rises or falls too steeply for it all to be equally visible), then you will have to move the level to a new location. This is called traversing. Ordinarily, you would first complete a traverse around a site to create a survey framework and a series of control points. This follows the same setting up principles as before, with one additional step. The last reading you were able to take from the present survey station will become your first foresight (FS). Don’t move the staff from this location while the level is being moved. The rule is that the staff must remain stationary while the level is being moved and the level must remain stationary while the staff is being moved (Casey 1972: 15). This is often a mistake made by novice users: you should resist the temptation to retreat to a shady tree while a new survey station is being set up!

Move the level to the new survey station (obviously you will have chosen this carefully so that you can see new parts of the site from the new location, but are still within sight of the last foresight). Set it up again following steps 1–3 and then take a backsight to the location of the last foresight. If you don’t take this reading you will be unable to tie the different parts of your survey together in the final plan. Calculate the new line of collimation for the second survey station by adding the reading for the backsight to the reduced level for that spot (which you calculated from the previous foresight reading). Continue your survey.

Checking for errors

You can use the upper and lower cross-hairs visible through the dumpy’s telescope to check the accuracy of your survey readings. The difference between the value of the lower cross hair and the centre cross hair should be the same as the difference between the value of the centre cross hair and the upper cross hair. For example, if the reading at the centre cross hair is 1.275, and at the
lower cross-hair 1.240, then the reading at the upper cross-hair should be 1.310. Each is 0.035 m distant from the centre cross-hair and they need to agree to within 0.005 m or better. If you can’t get your readings to agree, you’ll have to take them again and check for potential sources of error. Is the person holding the stadia rod holding it vertical (see Figure 6.11)? Are you reading the staff correctly? If you’re new to using a dumpy you should check your readings regularly to minimise errors. The person who is filling in the booking sheet should calculate this on all points, particularly where they are points associated with setting up a new survey station.

**How to fill in a level booking sheet**

This is relatively straightforward and lets you keep track of your readings as you go along. A sample level booking sheet is included in Appendix 3. The first column on the sheet is a description of the location of the dumpy level (these are your survey stations). This assumes that you may have to move the instrument, so the various positions it is set up in can simply be designated 1–100 or A–Z. Note the height above sea level of your survey area (if you know it) in Column 8. If you don’t know this, choose an arbitrary level of 100 m (so you don’t end up in negative numbers as the ground falls). This will be your first reduced level.

Remembering that the first reading after setting up a survey station will always be a backsight (either to the site datum or to the point of the last foresight), this is entered in Column 2. There will only be one backsight per survey station, so don’t enter any further readings in this column unless you have just moved the level. Don’t make the common mistake of writing the foresights in this column—this will only confuse things later. The backsight will establish the line of collimation (i.e. how high the instrument is), which you calculate by adding it to the reduced level (in this case the site datum) to get a height in metres. Place this figure in Column 7. Align the dumpy to the correct
compass bearing for the backsight (see ‘How to set up an automatic or “dumpy” level’ on page ##) and note the bearing in Column 11.

The next readings you will take will all be inter-sights to the various features of the site you wish to plot. Place the staff on a feature and take a reading on the central (major) horizontal cross-hair. Place this figure in Column 3. The difference between this figure and the height of the instrument in Column 5 will give you the reduced level for that location. Record this figure in Column 8. Enter the value for the upper cross-hair in Column 4 and for the lower cross-hair in Column 5. Enter the bearing in Column 11.

Calculate the horizontal distance to that spot, so that you will be able to plot it on to your plan later (subtract the value of the lower cross-hair from the value of the upper cross-hair and multiply by 100). Place this figure in Column 10. To check the accuracy of your survey, subtract the sum of the foresights from the sum of the backsights. Then subtract the last reduced level from the first. The answers should be the same. If you’re taking many readings and using several pages of the booking form, you can check each page separately by making sure that each begins with a backsight and ends with a foresight. If an inter-sight comes at the end of a page, enter it as a foresight on that page and as a backsight on the next (Hobbs 1983: 53).

[[INSERT FIGURE 6.10 HERE]]

Figure 6.10: How to fill out a level booking form

**Tips for successful levelling**

- The most important point is to make sure that the instrument is properly level before you use it. If it isn’t, then none of your readings will be accurate.
• Once you have levelled the instrument, don’t kick or disturb the tripod. If you do, you’ll have to re-level the instrument before you continue, including taking a new backsight to the site datum and calculating a new line of collimation.

• If you're holding the staff, then you have several responsibilities. First, you need to make sure that you're holding it vertical and upright. By looking through the telescope, the surveyor will be able to see if you have tilted it to the right or left and can indicate to you in which direction to move it. They won’t know whether you have tilted it forwards or backwards, however. To compensate for this (it can be very difficult to know whether the staff is truly upright when you are holding it), you can rock it slightly backwards and forwards so that the person at the dumpy can take the highest reading (which will be the horizontal). This will increase the time for each reading, however, so you can also use a small carpenter's line level, held against the back of the staff to judge when it is upright (see Figure 6.11). Staffs for electronic distance measurers (EDMs) and total stations have a built-in air bubble so you can make sure they are level. Second, you will have to ensure that you have not rotated the face of the staff away from the telescope. Watch the direction in which the staff is facing and be prepared to adjust it if the surveyor can’t read it clearly.

[[INSERT FIGURE 6.11 HERE]]

Figure 6.11: Using a spirit level to check whether the stadia rod (levelling staff) is vertical

• If the surveyor can’t see you or the staff (for example, if vegetation is in the way) then you’ll have to move until it becomes visible. This is where walkie-talkies are invaluable. Sometimes only a slight adjustment will be necessary, but take care that, as you move the staff, you keep it upright and vertical. This is most easily done by moving the staff in small
increments (sometimes only centimetres) in a given direction until the surveyor tells you to stop.

- To produce a contour plan, you need to grid the site and take spot height readings at each point on the grid. You then need to decide on the contour interval (the distance between contours) and join points of equal height across the site.

**The total station**

A total station is a surveying instrument that combines a rotating telescope for measuring vertical and horizontal angles (a theodolite) with an EDM. To a large extent, total stations have surpassed the dumpy level in archaeology because they are more flexible to use in a field scenario, can achieve much higher spatial precision with measured data, and the data are easily integrated into GIS or cadastral software. This is because they allow the user to take a range of measurements relative to the instrument’s telescope, including the distance as well as the horizontal and vertical angles, and are not constrained by a need to work with levels and lines of collimation. Moreover, computer processors built into total stations take measurements and use these to calculate 3D coordinates for measured points. These coordinates can be logged to the device’s memory and can be displayed on a small screen while you’re still surveying. Recorded points can be coded into different categories to assist with data management and manipulation. Once a survey is complete, these points can be downloaded and the files can be viewed on a computer, for example, using a spreadsheet or GIS software. The automatic calculation of coordinates is a real boon for field archaeologists, because, unlike a dumpy level, it is possible to focus more on what is being measured rather than on the task of surveying. There is also less potential for human error to influence measurements, although total stations require careful attention to detail when setting up. This is because total stations
do not automatically calculate their starting positions or the direction of north, and so rely on people manually entering this information. Herein lies the major source of error in total station surveys: if the user enters an incorrect starting position for the instrument, or inputs an incorrect bearing, these errors will be present for the remainder of the survey. By adopting good surveying practices, these errors can be entirely prevented.

**Parts of a total station**

[[INSERT FIGURE 6.12 HERE]]

Figure 6.12: Components of a total station

**Tribrach**

This is the removable base to the instrument that sits directly on the tripod. It has a circular ‘pea’ bubble that can be levelled using the three foot screws and a clamp to secure it to the instrument body. It may also have an optical plummet (separate to the one on the instrument body itself) to set up the instrument over a survey mark (e.g. if setting up on a datum or control point), or to place a survey mark beneath the instrument (e.g. if you want to establish a control point beneath the instrument). If it doesn’t have an optical plummet you can use a plumb bob to do the same thing.

**Instrument body**

The instrument body comprises the telescope within its housing—which rotates vertically—as well as the broader body which rotates horizontally. At the bottom of the body is an integrated optical or laser plummet. An optical plummet will have focus rings to sharpen the view of the ground surface and the internal centre mark, while the laser plummet will direct a beam of light onto the ground at right angles to the instrument body. This supplements or replaces the plummet on the tribrach, and allows one to precisely position the instrument over a survey mark (e.g. a site datum on control point), or to establish a survey
mark where the instrument has been set up. This, of course, depends on the instrument being level. To assist with this, many units will have an external pea bubble or tube bubble for quickly levelling the instrument body on top of the tribrach. These are usually supplemented by a very fine electronic level for precise levelling, also known as electronic tilt. Together, these serve to enable the user to set the instrument up so that it is horizontally level over a precise point and accurate to within a few millimetres if desired.

The entire instrument body can rotate horizontally a full 360°, while the telescope housing can be rotated 180° vertically. Together, these enable the telescope to be oriented so that any position within line of sight can be viewed, except positions immediately beneath the instrument itself. Quick sights are often located at the top and bottom of the telescope housing. These can be used to orient the telescope to approximately the correct location before you look through the telescope itself. The telescope is oriented towards the point to be measured by manually moving the housing and instrument body. Within the telescope there will be cross-hairs, the position of which can be finely adjusted using a system of clamps and slow motion tangent screws. There are also two focus rings on the telescope’s eyepiece: one to focus the cross-hairs, the other to focus the main telescope. If no cross-hairs can be seen, it is usually because one of these focus rings has been adjusted too far.

**Reflecting prism**
In order to obtain measurements, the total station emits a pulsed laser light from the instrument body towards a target. This is reflected back to the instrument and then measured. A reflecting prism is a commonly used target, which is mounted on a pole of known height. The person holding the prism holds it steady directly above the point being measured, while the person controlling the instrument aims at the reflector and measures the point. The distance between the instrument and reflector is measured by the time it takes for the light to be reflected back to the instrument. When holding the prism, make sure to hold it
upright over the point being surveyed using the built-in pea bubble, because when reading a measurement the total station assumes that the reflector is directly above the point being recorded. You can also survey without a prism (called reflector-less surveying), although this is sometimes less accurate, as the light beam is reflected in different ways from different materials. Reflector-less surveying can, however, provide a fantastic way of quickly recording coordinates for features that are high (e.g. wall profiles), or for obtaining profile data in difficult to reach locations (e.g. recording the profile of rockshelter ceilings).

**Setting up a total station**

*Step 1: Set up the tripod.* Decide where to place your survey station and unlock the legs of the tripod using the leg screws. As with any levelling instrument, if measuring as part of the group, get the shortest person in the group to hold the top of the tripod at chin level and drop the legs to the ground. Relock the legs.

*Step 2: Holding two of the legs firmly, push the third leg away from you* using one foot (you might have to practice this step!). Ideally you want the three legs of the tripod as close as possible to an equilateral triangle, but note that on a slope your triangle is more likely to be an isosceles. If you are on a slope, stand on the downhill side while you do this, since you are going to need to position two legs downhill and the third uphill. Make sure that the head of the tripod is roughly level and doesn’t have an obvious tilt in any direction.

*Step 3: Attach the tribrach to the tripod and level it using the foot screws.* If you need to make coarser adjustments (e.g. if the head of the tripod wasn’t very level to start with), you will need to raise or lower the legs of the tripod. Holding a leg in two hands, unlock the leg screw and carefully raise or lower it until the bubble is close to level. Fine tune this using the foot screws until the tribrach is perfectly level. Your tribrach may or may not contain a built-in optical plummet. If it does, you can use this to mark the position of the survey point on the ground. If it doesn’t, every total station includes a plummet (either optical or laser) and will do the same thing.
Step 4: Using two hands (one holding on to the top handle and the other the base), attach the instrument to the tripod. Lock it in place using the catch on the side of the tribrach. Make sure it is locked before proceeding any further. Your instrument now needs to be levelled. There may be two parts to this: a level that is shown as an external bubble on the instrument’s body (see Figure 6.12), and an electronic level that is accessed through the instrument’s own set up process (this is called electronic tilt).

Step 5: Level all externally visible bubbles using each pair of foot screws. Unlock the clamp screw to allow the machine to swivel and align the back of the total station parallel to one pair of foot screws. Relock the clamp screw and use your thumbs to turn the foot screws to raise or lower the instrument. Unlock the clamp screw and repeat for both other pairs of foot screws. Check the pea bubble in the tribrach to make sure that it is still level. If not, then you will need to adjust it until both the tribrach and the instrument are level.

Step 6: Adjust the electronic tilt. Turn the machine on and navigate to the correct screen. Again, using your thumbs, adjust each pair of foot screws until the machine is perfectly level—this may be shown as X and Y axes that need to be as close to zero minutes and seconds as possible or by a tick against each of the foot screws (see Figure 6.13). Note that electronic tilt adjustments should only be very subtle at this point, so turn the foot screws very carefully. Check the pea bubble in the tribrach to make sure that it is still level. If not, then you will need to repeat Steps 5 and 6.

Step 7: Measure and record the height of the instrument and the prism staff. This information should always be written down in your surveying notebook.

Step 8: Establish a survey point (optional). It is not always necessary to set up the total station over a survey point, or to create one below it. This is because the unit can calculate its own position in relation to other known points in the local area (see ‘Surveying with a total station’ on page ##). If you do need to do this, for example, in order to establish a fixed survey point, then use the instrument’s built-in plummet to fix the location of the central point beneath the tripod. Hammer in a peg at this point and
mark the top with an indelible cross. Allocate an identification number to the point in your notes (e.g. Control Point 001).

[[INSERT FIGURE 6.13 HERE]]

Figure 6.13:

**Setting up a total station over an existing survey point**

This assumes that you have an already established survey point (e.g. a site datum or control point) over which you want to set up your level.

*Step 1: Start with all legs of the tripod the same length*, leaving about 10 cm overlap at the joint, and the leg screws in the centre of their run (i.e. halfway between tight and loose). Again, if measuring as part of a group, let the shortest person determine the length of the legs.

*Step 2: At the survey point, hold two of the tripod’s legs firmly and push the third leg away from you a comfortable distance* so that it is roughly set up over the survey point. Make sure the head of the tripod is roughly level and adjust if necessary. Again, you want a roughly equilateral triangle over the survey point, unless working on a slope. Use the plummet on the tribrach to ensure it is as close as possible to being centred over the survey point.

*Step 3: Attach the total station to the tribrach*. If you are using a laser plummet to establish its position, turn the machine on and activate the plummet. Alternatively, use the optical plummet to see how far away you are from the survey point. If using a laser plummet you will see it as a red dot on the ground. Do not tamp the legs into the ground because you may have to move some of them in the next step in order to centre it correctly over the survey point. Think about which direction you need to move the instrument in. If it is centred over the survey point, skip Step 4.

*Step 4: Place the toes of one foot immediately behind the survey point and take hold of the tripod so that you can lift it by two of its legs*. Adjust the position of the instrument by moving these two legs at the same time in the required direction until you can see
that the laser/optical plummet is at, or very close to, the point. Do not move the foot marking the position of the survey point while you do this. Repeat as necessary with each pair of legs if necessary to get the instrument close to the mark.

*Step 5: For finer adjustments to the machine’s position, use the tripod’s leg screws to shorten or lengthen the appropriate legs slightly* until you have the instrument in the correct position. Always use two hands when you do this so that the machine does not move too far and/or the tripod leg does not collapse.

*Step 6: Level your instrument*, beginning with the tribrach and then moving on to any external bubbles. Finally adjust the electronic tilt (see ‘Setting up a total station’ and Figure 6.14). You will need to take care that the alignment of the machine above the survey point does not change. If it does, you will need to repeat Steps 5 and 6.

*Step 7: Measure and record the height of the instrument, as well as the survey point details.*

[[INSERT FIGURE 6.14 HERE]]

**Figure 6.14: Setting up a total station over an existing ground point**

**Surveying with a total station**

As noted above, user error tends to creep into a total station survey at the time that the instrument is set up, rather than when taking measurements. It is possible to reduce the likelihood of this occurring by drawing on the same surveying principles described earlier in this chapter.

As with any form of site survey, you need to begin by identifying a site datum and deciding whether to conduct your entire survey from this point, or instead, whether you need a survey framework. Keep in mind that there are fewer constraints when using a total station, and so if you have good visibility, you could feasibly conduct a survey across a large area extending hundreds of metres from your site datum without having to move the instrument at all. We recommend creating a survey framework even if this is the case. Doing so can simplify the process of setting up the total station because there is no need to
establish the instrument station directly above a survey point, which can be time consuming for people who are new to using the equipment (see ‘Resections’ below). Furthermore, a survey framework can be advantageous if the site datum is not close to the features being recorded, as it makes it simpler to establish instrument stations near the work area (e.g. if conducting detailed recording or excavation work). If there are visual barriers between your work area and the datum, then you will have no option but to establish a survey framework or conduct a traverse (see ‘Traversing with a total station’, below).

You will find that you can establish a survey framework with many fewer movements of a total station than is required with a dumpy. This is because the vertical and horizontal movement of the telescope means you are not as restricted by the rise or fall of the ground, except where these form visual barriers (e.g. low hills). Vegetation is also frequently a problem, though the light pulses from a total station will often effectively reflect through small gaps in vegetation, allowing you to obtain measurements in places where you would have no hope of obtaining three visual readings on a stadia rod when using a dumpy.

At a minimum you should always set up three control points (this can include the datum, if it is close to your work area). This allows you to use more advanced functions for establishing a new instrument station (see ‘Resections’, below) and also provides a good check on the position of the instrument, as you can take measurements to two other known points very easily. Try and position the control points in an equilateral triangle formation, but if you need more than three points it is generally enough to place a series of points around the perimeter of the survey area (see ‘Creating a survey framework’ on page ##) and possibly one in the middle as well, creating a network of triangles.

To create a survey framework, follow these steps:
• Decide on where your control points will be, keeping in mind that the total station does not have to be placed on top of them. While this is possible, it is simpler to use them as reference points to help set up the instrument where you need it. So, when thinking about the placement of your control points, think about where you will need to place the instrument when recording (that is, where your instrument stations need to be). Place enough control point positions so that you can see a minimum of three control points from each instrument station.

• In your survey notes, draw a sketch map of the entire survey framework, showing the locations and labels for your control points and site datum. As you survey, you can add in instrument stations and recording points using supplementary sketches at a larger scale where necessary. This is particularly important when collecting coordinates to draw site plans, and in such cases it is better to draw too many of these sketches than not enough, since they represent the primary record of what features were being recorded with the total station. When you download the data, it will simply be a lot of points plotted on a blank page and difficult to interpret without this visual reference.

• Measure the location of the first control point to be recorded (in this example from Instrument Station 1 [STN01] to Control Point 1 [CP01]), then view the distance and horizontal angle measurements generated by the instrument. Check the bearing with a compass (taking into account whether you are using magnetic, true or grid north) (see ‘North’ on page ##), and check the distance by pacing (see ‘Pacing it out’ on page ##). If these values seem correct, write down the coordinate in your notes and on your sketch.

• Assuming that you can see other control points, continue to do this until you have surveyed in as many control points as possible, always taking
care to check that the bearings and distances are approximately correct and updating your notes and sketch drawing as you go. Only move the instrument if you have to, at which point you need to conduct a traverse (see below).

- If you can set up your control framework without moving the instrument, then you will not know if there is an error in the control framework until you move the instrument. So, to double check the survey framework, you need to set the instrument up at a new location, ideally over a control point that you have already surveyed in. Once you have done this, take a measurement back to your site datum. Write down the measured coordinate.

- Check the measured position of the site datum against the original known position for the site datum. Is it the same? The difference between your original and measured X, Y and Z coordinates is the error, and there will almost always be a slight (<2 – 5 cm) one.

- Decide whether the error is tolerable, and if so, skip to Step 9. If the error is unacceptable, you need to first determine what is causing it: was it the first instrument station set up on the datum, or the second instrument station set up at CP01? You can decide by checking that the instrument was set up correctly at your current position. Leaving it in its place, turn off the machine and re-enter all of the information needed for a station setup. Once done, repeat Step 6. If you still find there is an unacceptable error, then the problem is likely to have been your first instrument station. Go back to Step 3.

- If the error is acceptable, you can now move on with checking other points. It is not necessary to set up a new instrument station on every control point, or to check each control point you have measured in, since if you have the first position correct then others should be as well. Even
so, check the accuracy of at least one other control point by measuring it in from your second instrument station. Knowing the error on the first control point, compare the measured coordinates with those you recorded and decide if the error is acceptable. Once done, you can begin recording the detail.

**Traversing with a total station**

In many cases you will not be able to establish enough control points for a survey from your site datum, or the datum may be some distance from the location of the survey framework. In these situations, it is necessary to conduct a traverse. Just as with dumpy level surveying, traversing with a total station involves moving the instrument through a series of positions (instrument stations), using a previously recorded point as the origin point for establishing a subsequent point. They can be useful for establishing a survey framework or if you want to establish a new local site datum in relation to another fixed point, such as a permanent survey marker. To conduct a traverse, follow these steps:

1. Follow Steps 1–3 in 'Creating a survey framework', above, to identify the most convenient locations for your control points and set up the station at the site datum.

2. Decide on the traverse route. Aim to complete the traverse via a series of steps from a known to unknown points. Figure 6.15 illustrates an idealised traverse to establish a survey framework using the example shown earlier in the chapter.

3. Measure in the first control point. Record it in your survey notes and sketch. Be sure to place a survey marker at the location of the control point. This would become CP001.

4. Move the total station to the planned location for CP002, and from there, take a backsight to CP001. Follow the instructions on your total station model to calculate its position in relation to a measurement to CP001.
This would involve using a specific software routine that allows the position of CP002 to be calculated by taking a measurement and bearing to CP001.

5. Once a measurement has been recorded, verify using pacing and a compass that the measurement seems correct. If you can see a recorded control point from your location, record a check measurement and compare against the measurement that was originally recorded when you set up that point. This may not be possible, because often the point of a traverse is to maximise the distance the instrument is moved in each leg. Regardless, do not move on with the traverse until you have an acceptable error margin! The problem with traverses is that your accuracy is reliant upon taking manual bearings, so be sure to get these correct. Furthermore, the error compounds at every instrument station—so a 10 cm positional error on five stations means that your final control points will have a half metre error. Once you are happy with the position, place a survey peg beneath the instrument using the plummet.

6. You can now follow Steps 3, 4 and 5 to take a series of foresights and backsights as shown in Figure 6.15.

7. Take the final measurement to your datum. Note this down and compare with the original coordinate you began your traverse with.

[[INSERT FIGURE 6.15 HERE]]

**Figure 6.15: Traversing with a total station**

Once you have set up a total station a few times, you will quickly see that it is much simpler to place a survey marker at the correct location under the instrument using a plummet or plumb bob than it is to move the total station to within a few millimetres of a fixed point. Sometimes this is unavoidable, but if you can avoid it, do so.
It is essential that traverses are always closed, which means that you always survey in enough points so that your final foresight is at the traverse's starting point (usually the datum). This should be undertaken even if you only need to conduct a traverse to establish a new datum some distance away, and do not need to establish control points around a site, even though it will take up extra time. The reason this is important is that, without closing the traverse, you have no way of knowing what your error is—and you are really only guessing that there are no smaller errors in the traverse. This is often referred to as an open traverse.

**Resections**

Setting up a survey framework can be a little time consuming, but once done it is possible to use the resection method to quickly set up the total station at any point within the framework. Resections are one of many advanced functions available on total stations that involve using two to three known coordinates (e.g. in your survey framework) to calculate the 3D coordinate for an unknown point (i.e. a new instrument station). While this can be done with a dumpy level, the geometry required to do the calculations can be a little onerous, and so few archaeologists would bother. This is not a constraint when using the total station, however, simply because the instrument has built-in software routines that will do the maths for you. Simply set up the total station at a central point within a survey framework, ideally near the centre of an equilateral triangle of known points. Follow through the steps on the instrument to measure in three known points. Once you have enough points, you can make the software calculate your position, along with an estimated error margin. There are few sources of error on a resection provided that the known points have minimal error. Usually the main sources of error relate to problems with the control point coordinates, instrument height and the height of the reflecting prism (e.g. entered incorrectly on the instrument). Using a resection is a great way to
survey, because it cuts out the time involved in setting up the total station over known points and also gives you much greater flexibility in where you place the instrument.

**Recording the detail**

The various steps outlined up until this point are necessary to set up the instrument so that you can record in the detail. This might be surveying in features to draw a site plan, recording the locations of artefacts being recorded or collected, or even for recording coordinate data on an excavation. The following steps outline one way of surveying in the detail:

- Set up your survey notes with the following row headings: ‘Station’; ‘Target Point ID’; ‘Description’. On the adjoining page, draw a careful sketch plan of the feature (or features) to be mapped.

- Set up the total station using one of the methods outlined in this chapter (e.g. either on a known point or using a resection within a survey framework).

- Begin to record your points, filling out your notes and taking care always to draw the location of points recorded on your sketch plan. Allocate meaningful labels to assist with interpretation later, always ensuring that the point identification numbers on the total station are the same as those being written down in your notes. Importantly, do not write down full coordinates while you survey— you can easily retrieve and write down this information later, and it speeds up the recording process.

- At set intervals, for example, every 30–50 measurements, record a ‘check’ measurement to one of your known points (datum or control point). Make sure to note whether the measurement was a check point or the datum, and write down the coordinate in your notes. Compare this with the original measurement for that point. Small errors (e.g. less than 5 cm) are common and will reflect how the prism was held (e.g. if it was slightly
tilted, or not on the precise location of the original point reading). Errors greater than this (in either the X, Y or Z dimensions) should be investigated. Sometimes they are caused by a problem with the reflector (e.g. it being set at the wrong height), but in other cases it means that the total station has been bumped. If all is good, then keep surveying.

- Finally, before you move an instrument station, always take a few minutes to record a check point—for example, back to your site datum or a control point. This further helps to minimise error.

**Minimising errors with a total station**

There are many advantages to using total stations over other methods, but their flexibility and simplicity can easily create a false sense of confidence about the data being logged to the device’s memory—potentially leading to mistakes. The key to this problem is that when a set of coordinates are viewed on a screen, it is not immediately obvious if there is a small error, for example of a few metres, or whether the position is very precise. With all other techniques discussed up until this point, the survey data are drawn on to a plan as it is collected (or very soon after), which means that errors are often obvious because points will be plotted in locations that simply don’t make sense. While drawing your plan as you record your data is slow, it is recommended that you attempt to visualise your data in the field. You can take out important coordinates and plot them on a scale map, or import them to a GIS and create a working scale map there. Do not leave this until the end of a survey or field period, because minor errors can lay waste to hours, or even days, of work. Newer total stations generate an interactive map of your point data on their display, which is a very useful function when you want to visually check your data while surveying.

It also needs to be emphasised that you can never have enough check points when using a total station. Take them seriously, as they can save hours of wasted time caused by an accidental bump to the station, or worse, an incorrect
instrument station. Never start recording points with a total station without checking that the station is correctly set up by comparing a measurement from it with at least one known point, recorded earlier. Always check the station if there has been a break in recording, particularly if the machine has powered down during that time. Your check points can easily be deleted once the survey is completed—or in a worst case scenario, can be used to identify problematic data. At the end of each day, be sure to download a backup copy of recorded points and photograph your survey notebooks. If either of these are lost, then your data may well be irretrievable.

Other common sources of error when using a total station include:

- entering coordinates into the machine incorrectly;
- taking incorrect bearings when using a compass to set up an instrument station (remember, never use an orienteering compass!);
- incorrectly measuring the height of the total station;
- incorrectly entering the height of the reflecting prism on the staff, or failing to update the height on the instrument when the staff height has been altered;
- looking up the wrong coordinate when using the automated routines for setting up an instrument station; and finally
- incorrect placement of the prism staff (for example, not placing it at a consistent position on a control point during a survey).

Rob Koch’s tips for total station surveys

- Many members of the public will mistake the total station for a camera and want to be in the movie—don’t discourage them.
- Do not change face (rotate the telescope 90°) during the survey, as this may result in a mirror image of what you want (i.e. everything will be reversed). It is worth drawing
a fine arrow pointing ‘up’ on the telescope’s housing, so users know which way to keep the telescope oriented.

- Always have a 3 m tape with you to measure the height of the instrument, the backsight and the length of the prism staff.
- Use a pea bubble on the prism staff to keep it vertical, otherwise very close points may be recorded in the wrong place.
- Eliminate parallax error in the telescope by pointing the telescope at the sky (nowhere near the sun or it may be a singular experience) then make the cross-hairs as black as possible using the diaphragm focus ring. Check by focusing on a nearby object and then move your head from side to side—if the cross-hairs move against the object, repeat. This is a personal setting and should be checked for every user.
- Know the coordinates (easting, northing, height) of your initial station and backsight points before you start.
- Select station points to give maximum visibility of the site, but remember that it takes only a minute or two to put in, and set up, an extra instrument position if needed.
- Make a mud map of the stations and keep a record of each setup, including station and backsight numbers, height of instrument and backsight reflector, etc.
- Wherever possible use point numbers that relate to the entity being measured, e.g. not ‘p1’, but ‘axegroove1p1’. This can avoid much confusion later when you download the information.
- In very windy weather you may need to peg down the tripod legs or place rocks on them to prevent it blowing over—it does happen and can be very expensive to fix.
- Measurements made to a prism are the most accurate. Aim the telescope at the target mount (the striped or arrowed attachment that fits around the prism), not the centre of the prism.
- When changing the height of the prism staff to accommodate for changes in slope take two shots on a single well-defined point—one before the change and one after.
This will guarantee that you do not forget to enter the change in height or at least will give you a data point that allows for editing subsequent points later.

**Drawing horizontal surfaces (plans) by hand**

Site plans are one of the most common types of archaeological illustration and can convey spatial information about a site quickly and easily. Plan drawings can use the measurements taken from a baseline and offset, compass and pacing survey or dumpy level survey and convert these to a suitable scale to fit on to a sheet of graph or drawing paper (see Appendix 1).

The first step is to decide on the level of accuracy you require in your measurements—a decision which will largely depend on why you are recording the site in the first place and what it is you want to know. For any site survey, there are acceptable levels of error which you should note. For a plan plotted at a scale of 1:100, for instance, it is perfectly acceptable for measurements to be taken to only the nearest 50 mm; for a plan at 1:1000, measurements need only be to the nearest 500 mm. As the scale becomes larger, the level of accuracy increases, so at 1:10 you should try to keep your measurements to the nearest 5 mm, for example (see Appendix 1).

The level of accuracy will have a bearing on the final scale at which you can draw your plan. Because sites are rarely if ever drawn at a scale of 1:1, the first and most important thing to consider is the most appropriate scale. Obviously the drawing can’t be so large that it won’t fit on to the paper, but by the same token, there is no point in drawing it so small that you can’t see any of the details. The relationship between the scale of your drawing and the smallest measurement you can literally draw is different from the standards for accurate measurement given above. Even though a plan drawn at 1:100 scale should be measured to the nearest 50 mm, anything which is this small will only end up being 0.5 mm on your final plan—almost impossible to draw. Given the difficulty
of drawing something which is half a millimetre long, the standards for drawing are somewhat broader (see Appendix 1).

The following steps can be used to draw up a horizontal plan from baseline/offset, dumpy level or even total station data.

- Decide on the most appropriate scale *before you begin*. There is nothing more frustrating than getting halfway through a plan before you find out that part of the site literally will not fit. To work out the scale, measure the longest distance that you will be required to plot and work out a scale that will fit this on the drawing (see ‘Mapping scale’ on page ##).

- Work out roughly where this measurement will be located on your drawing to ensure that you can fit the other elements of the site around it (i.e. if the longest measurement is running through the middle of the site, there is no point placing this to one edge of the drawing).

- Mark the baseline or the edges of the planning frame *lightly* on to the drawing, and indicate the measurement gradations.

- Work out where north is with a compass and convert this to a north arrow on your plan using a protractor. To do this, first take a compass bearing from one end of your site’s baseline. Then orient your protractor over the drawn version of the baseline on your graph paper from the same point so that it faces the same direction. If you took a compass reading of 90° from the southern end of the baseline, for example, you would position the centre of your protractor over the southern point of the drawn baseline so that the 90° mark lined up with the baseline. From this, you would mark the direction of north (0°) at the edge of the protractor and then draw a short solid line capped with an arrow to represent north. While it is the convention for all plans and maps to be oriented with north to the top of the page, because you will have established your baseline according to where it is most useful to record
archaeological information you probably will not have the luxury of being able to automatically place north at the top of your field plan. In this case, don’t worry. When you draw the final version, you can simply rotate the whole plan so that north will face the top of the page.

- Use the same method to plot any other directional compass bearings made to features during the survey on to your plan.
- Draw in the larger, dominant features first. This will help to position the smaller features around them and may save time if you’re running short. If all else fails, provided you have the dominant site features accurately plotted, then you can always draw in the lesser features by eye.
- Clearly label the drawing with the site name, your full name, the full names of any people who have measured for you and the date.
- Always draw the scale of the plan as a linear (bar) scale, rather than just a scale ratio (1:10, 1:100, etc.) and make sure you note what units of measurement the scale refers to. If the scale is in centimetres, mark it with a ‘cm’, if in metres mark it with a ‘m’ and so on. There is absolutely no point in drawing a beautiful, accurate scale if nobody knows what units it represents.
- If drawing a very large or extensive site, it may not be possible to fit the entire area on to a single page and still preserve the detail (but you will have thought of this from the beginning, when you first worked out your scale, so it shouldn’t come as a last minute surprise). In this case, you may need to break the site down into discrete parts which can be drawn separately, but you will also need to draw an overall plan of the site showing each part in relation to the others. If your plan is running across two or more sheets of paper, make sure that you note how they fit together and that you write this on both sheets. One way to do this is to make sure that the adjoining parts contain the matching halves of a single
symbol (such as a circle, square or solid line) so that you can literally put the two halves back together again. Another way is to number the sheets and mark the adjoining edges ‘Plan 1 adjoins Plan 2’ and so on. If you adopt this latter method, make sure that someone else will know precisely where they join up: there is no point noting which plan joins which, if there is no other indication of which edges actually join.

- When you come to draw the final, publishable version of the plan, always remember to include the scale and your north arrow marked with the letter ‘N’.

There are various conventions for indicating the nature and degree of a slope on a plan. A 2D drawn plan makes the distance between any two points appear horizontal, as if both were at the same level. In reality, of course, your site may include various kinds of slopes, such as hills, gullies or mounds. You indicate different types of slope by using hachures, or short lines which indicate the top of the slope with an arrow and the length of the slope with a line (see Figure 6.16).

[[INSERT FIGURE 6.16 HERE]]

**Figure 6.16: Conventions for illustrating slopes**

**Useful resources**

The Land Surveyor Reference Page, www.lsrp.com, contains a range of online resources, including links to professional publications on the topic.

For **Electronic Total Station Resources:**

http://geomechanics.geol.pdx.edu/Courses/TotalStation/. This site contains information on using total stations, including instructions for surveying procedures, as well as field sheets and software.

www.sli.unimelb.edu.au/planesurvey/prot contains an introduction to the basic principles of surveying and the main features of automatic levels, theodolites and total stations. Online activities let you practise reading a staff, and take you through the process of setting up a level.
The University of Sydney's Field Methods videos on YouTube let you watch various field methods in action, including the process of setting up a dumpy, reading a compass and conducting a baseline/offset survey: https://www.youtube.com/user/ARCAUSYD/videos.
CHAPTER SEVEN

PRINCIPLES OF ARCHAEOLOGICAL PHOTOGRAPHY

What you will learn from this chapter

- How a camera works
- How a digital camera works
- The importance of depth of field
- How to produce high-quality photographs for archaeological purposes

Photographs have always played an important role in archaeology and can constitute important historical documents in their own right. This visual record can also be used to fill in some of the gaps that every archaeologist occasionally finds in their field notes or to revisit troublesome problems. In the case of contested finds, a detailed photographic record may become the ultimate verification of your field technique.

There are many publications detailing the essence of good photography; here we will just point out that a ‘good’ archaeological photograph is not the same as a ‘good’ artistic one. Because archaeological photography has a particular and quite narrow aim (to document a site or artefact in the necessary technical detail), it is much more analytical and precise than simply snapping shots. For this reason, while you will still need to follow some basic rules of composition and lighting, archaeological photography has its own standards. The three basic elements of archaeological field photography are:
1. Learn enough to ensure you can take photographs which show sufficient technical detail in a range of situations (see ‘Taking good shots’ on page ##).

2. Always include a scale, because there is no point in photographing a site or artefact without also indicating how big or small it is (see ‘Scales and information boards’ on page ##).

3. Always record the details of every photograph on a written recording form, as well as recording it as part of the metadata attached to each digital image file. Because all photographs will (or should) ultimately become part of the permanent site archive (see ‘Data management plans’ on page ##), it is important that no detail of any photograph is lost.

**How a camera works**

A camera works by capturing reflected light. Regardless of whether it is film-format or digital, a camera has a lens to focus the light, an aperture that allows a fixed amount of light to pass through the lens and a shutter which opens and closes to allow the light in for a specific period of time. All of these mechanisms are designed to control the amount of light so that the final picture will neither be under-exposed (as a result of too little light) nor over-exposed (as a result of too much light). The other light control mechanism is called ISO—for film cameras this was the ‘speed’ of the film, for digital cameras it is the degree of amplification that is given to the light values being received by the camera. Some key terms that are useful to know with photography include:

- The **aperture**, which is the adjustable opening through which light passes in the lens. The aperture controls the **depth of field**, or the area of a photograph that will be in focus (see ‘The importance of depth of field’ on page ##). Correct depth of field will be critical for many
archaeological photographs, as it allows the right amount of foreground and background to be in focus. The \textbf{f-stop} describes the size of the aperture. A larger f-stop is indicated by a smaller number, such as f/1.4, f/2 or f/2.8, as these lower values mean that more light is permitted to enter the lens. Conversely, a smaller f-stop is indicated by larger number—such as f/8 or f/22—as less light enters the lens. Each time the f-stop number increases, the area of the aperture decreases, so that moving one f-stop will either double or halve the amount of light allowed through the lens.

The \textbf{shutter speed}, which is the amount of time that the shutter remains open to allow light in. The speed of the shutter is measured in fractions of a second: 1/2, 1/4, 1/8, 1/15, 1/30, 1/60, 1/125, 1/250, 1/500, 1/1000 and so on. Shutter speed is closely related to aperture and one of the main rules of photography is to make sure that you have the right balance between them. If you are increasing the size of the aperture (i.e. moving down through the f-stop numbers and allowing a greater area of light into the lens, for example from f/11 to f/8.0), the amount of time that the shutter remains open will need to decrease (for example, from 4 seconds to 2 seconds) to maintain the same exposure. In other words, a faster shutter speed (a shorter length of time for the shutter to remain open) will be paired with a smaller f-stop number. Conversely, if you’re making the aperture smaller (moving up through the f-stop numbers, for example from f/16 to f/22), you will need to slow down the shutter speed to allow the smaller amount of light coming through the iris in for a longer period of time. In archaeological photography, particularly small artefact photography, you should always choose the aperture before you choose the shutter speed, because it is the aperture which controls the depth of field (see ‘The importance of depth of field’ on page ##). [[INSERT FIGURE 7.1 HERE]]
How a digital camera works

While an understanding of basic camera principles is essential, there are also three other factors you need to be aware of when using digital cameras: the size of its sensor (the digital equivalent of the film frame), the number of pixels it can capture and the size of those pixels. Image quality, in essence, depends on the size of a camera’s sensor, how many millions of pixels can fit on it, and the size of each one of those pixels. A camera with a larger sensor will be able to capture more light to create the image (which means less noise and better contrast and colour depth), as well as record more of the scene in front of you (smaller sensors will crop out more of the scene). Digital SLR (DSLR) cameras typically have sensor sizes that range from 40 per cent to 100 per cent of the surface of old-fashioned 35 mm film (a ‘full frame’ digital sensor is slightly larger than a 35 mm film frame, but is also more expensive and heavier to carry); all compact digital cameras will have much smaller sensors and therefore compromise image quality in different ways. A full frame camera may be useful in a more controlled environment such as a laboratory, or for situations where images of the highest standard are required—such as in rock art research or photogrammetry.

Pixels are the individual units of information in a photograph: the more pixels (expressed in millions, or megapixels), the more detail there will be to an image. A large megapixel count sounds good, but the number is actually less important than their size. Think of it this way: while the number of megapixels in a camera’s sensor is a measure of quantity, their size is the measure of quality. A camera with a larger sensor and larger pixels will be able to collect more data (electrons) and create a better quality photograph.
Just as for film cameras, the higher the ISO setting on your digital camera the more amplified the signal being received by the camera’s sensor will be, enabling photographs to be taken in lower light conditions. Unfortunately, higher ISO settings also introduce more noise to the image, meaning that your photographs will have a grainier texture. Because DSLRs have larger sensors and therefore larger pixels than compact cameras, they will create less noise at higher ISO settings. Newer cameras will also have better built-in technology for noise reduction (every digital camera processes every image to minimise noise, it’s just a question of how your camera does this), which again means better quality photographs at higher ISO settings. If your camera has an auto ISO setting you can use this to vary the ISO according to the shutter speed and improve the quality of the image.

**Taking good shots**

The direction and intensity of lighting can make all the difference between a great and a poor photograph. Very directional light, such as through a window, can maximise textures, cast strong shadows and reduce the mid-tones. It can also create shadows, however, and obscure the outlines of objects. Very bright or harsh light can create deep shadows and intense reflection, washing out details and making some parts of the photograph over-exposed (very bright) and others under-exposed (very dark). Very dim light will be too dark and will not reveal enough to make the outlines of any object clear. Because of the softer lighting, the best times for taking field photographs are early in the day (preferably just before sunrise), or later in the afternoon at evening or twilight. Obviously you will not always be able to control the lighting conditions or wait until the perfect time to take a photograph. In these cases, you will simply have to make the best of the circumstances, but if you have a basic working knowledge of what is
important in taking a good photograph, you should know enough to be able to avoid the worst.

The main principle in taking a good photograph is to even out the highs and lows so that all the detail of the bright and dim areas can be captured. All good cameras will allow you to regulate the amount of light coming through the lens via combinations of shutter speed and aperture to achieve the correct exposure. If your camera is set to automatic, these decisions will be made for you, although this does not mean that your photos will always be perfect. Part of the problem with light meters in cameras is that they tend to average the amount of light using the middle 30 to 50 per cent of the scene. This means that the light reading which the camera will then use to determine the aperture and shutter speed may not actually be reflecting off the subject and you may run the risk of under- or over-exposing your shot. This is particularly a problem if you are trying to photograph artefacts on a black background, as it is very easy to include too much of the background in the meter reading (Howell and Blanc 1995: 24). Photographers often use a grey card (a piece of poster board with a neutral grey tone) to counter this problem and to determine the correct exposure for photographs. An exposure reading taken from a grey card provides a mean reading between extremes that will allow you to capture the detail in both the highlights and the lowlights.

You can also try physical solutions to problems of too much light or shadow. One way to remove shadows is to use a reflector to brighten the darker areas. If you don't have a commercial reflector, you can use almost any bright object which comes to hand, even something as simple as a large sheet of white paper, a space blanket, windshield reflector or aluminium foil taped to a flat surface. The reflector should be placed on the shadowed side and moved just close enough to lighten the shadow so that you are able to record detail in those areas. If you are using artificial light, this should be shone directly at the reflector, which can then
be positioned so that it reflects the light on to the precise spot you want illuminated.

A diffuser will spread the light and minimise both shadows and highlights. This is particularly applicable when photographing in bright sunlight. Photographs taken without diffusion in direct sunlight will have high contrasts, with the light areas very light and the dark areas very dark, and are unlikely to show details well. This may not be necessary if the day is overcast, or if the light is shadowed or hazy, because cloud cover is actually one of the best light diffusers you can have. If you can’t wait for an overcast day (or a passing cloud), however, and don’t have a commercial diffuser on hand, try improvising with a large piece of paper, a white cotton shirt or sheet, the lid of a white plastic container, or even a sheet! Experiment with a diffuser to work out the best effect before you take the photograph. If you have no other option, then use a tarpaulin or some other non-white item. The aim really is to place the entire frame in an even shadow, and you can compensate for this by adjusting the camera to be more sensitive to light (e.g. decrease shutter speed and use a larger aperture). Being able to make such adjustments is one of the distinct benefits of learning how to use a DSLR camera; it gives you much greater flexibility across a variety of photography scenarios.

Tips for taking good archaeological photographs

• Always keep the plane of the camera (its back) in the same plane as the subject to avoid distortion. This may mean using a spirit level to make sure. This will be particularly difficult when photographing long or deep trenches or upright features, such as buildings, so see ‘Photographing standing structures’ on page ## and ‘Photographing excavations’ on page ## for more information.
Always take light meter readings from your subject rather than the background or foreground. If you can’t get close enough, take a reading on something that’s a similar colour or is in similar light.

Try to diffuse the light wherever possible, or use reflection to reduce contrast in dark shadows.

Always include a scale (see ‘Scales and information boards’ on page ##).

Always record the details of each photograph in a log book or on photographic recording forms (or both).

Photograph your notes and particularly, your photographic log book or recording forms, so that if they are lost, the original downloaded image files will contain details of what you photographed.

Make sure there is no extraneous material intruding on your shot (apart from being messy, a yellow backpack or a red folder off to one side can be very distracting in the final photograph).

Always take twice as many photographs as you expect to use, since photography is far cheaper than the costs of returning to a site.

If there is a budding photographer on your team, be sure to encourage them to take photos. You’re probably not the only one who can use a camera.

If you are in doubt that your choice of aperture and shutter speed will give you the correct exposure, try bracketing your photographs. This is the photographic equivalent of an insurance policy. Take one shot at the exposure which you think is correct, and then take additional shots either side of this to give more and less exposure. If you took one photograph at 1/125 of a second at f-stop 8, for example, then you would also take one shot at 1/125 at f/5.6 and one at 1/125 at f/11.

For low-light digital photography C. Wayne Smith (2009) advocates shooting in sports mode (i.e. high speed). This will enable sufficient light to be captured while at the same time allowing the photographer to shoot at a shutter speed that is fast enough to eliminate the need for a tripod.
The importance of depth of field

Controlling depth of field is an important way of concentrating attention on particular features and is also essential for maintaining sharp focus over a range of distance. A shallow depth of field means the focus point for the image is on an object or feature in the foreground, while the background is less focused and often slightly blurry (Figure 7.2). A shallow depth of field will be fine for artefact photography (where the object is close to the camera) and can add an appealing blurred background effect if you are taking shots of people or want to intentionally obscure what is in the background of your shot. A larger depth of field means that the shot is in focus to a greater depth (i.e. extending from the foreground to the background), and has the effect of ensuring that the background is clear and in focus. This can be useful if you are photographing along the length of a trench, for example, or across a landscape or site. Rock art photography often benefits from a larger depth of field to ensure that the camera does not accidentally focus only on a point that is nearer to the photographer, blurring parts of the art in the background. Depth of field is particularly important when you have content that is both near to, and far from, the camera and want to have all of it in focus. The depth of field is influenced by three factors: the focal length of the lens (how long or short the lens is); the distance the photographer is from the subject; and the size of the aperture. For a large depth of field, select a small aperture (a large f-stop number). For a shallow depth of field, select a large aperture (a small f-stop number). A simple rule to remember is that the smaller the aperture (the larger the f-stop number), the more narrowly the light coming through the lens will be focused and therefore the greater the depth of field will be. Most DSLR cameras have an ‘aperture priority’ mode (or something similar) which makes adjusting the depth of field relatively straightforward. This is a good place to start. Experiment yourself by trying to replicate Figure 7.2, below, with a subject of your choice.
Figure 7.2: The effects of varying depths of field on the sharpness of a photograph

When you’re photographing artefacts, getting them into sharp focus by maintaining the maximum depth of field is one of the most difficult things to do. A general rule is to follow the one-third rule, which suggests that you focus on a point that is one-third of the way into your composition (see Figure 7.3). The depth of field in a photograph extends from approximately one-third in front of the point of focus to two-thirds behind. If you focus on the background, this will waste the one-third that is behind the point of focus and give an image that is blurred for one-third in the front. Remember that you can’t see this zone of sharpness through your camera viewfinder, so you’ll only find out which parts of the object are out of focus when you look at the photograph. If you’re photographing an artefact, for instance, and have only focused on the very front of it, you might find that the sides and rear edges are blurred. Using the one-third rule, however, you would focus approximately one-third of the way back from the front edge, bringing both the foreground and the background into sharpness.

Figure 7.3: One-third rule

Holding the camera

The quality of your image will depend on how you hold the camera. The stiller it is, the sharper the resulting image will be. How steady the camera needs to be to take a good photograph is directly related to the shutter speed. In other words, if the shutter needs to be held open for a longer period of time to let in more light, then the camera needs to be held steady for a longer period of time. Very few people can hold a camera steady at a shutter speed of 1/60 or lower, so if your exposure time will be long, you’ll need to use a tripod (see ‘When to use a tripod’ below).
When taking a hand-held photo:

- If standing, make sure you’re relaxed and comfortable. If you place your feet slightly apart and tuck in your elbows, this will help distribute your body weight more evenly and provide a secure platform for supporting the camera.
- Try bracing your body on a solid object, such as against a tree, table or the side of a building.
- If squatting, steady the camera by supporting your elbow on your knee.
- If kneeling, distribute your weight evenly.
- If lying down, use your camera bag or case to support the camera.
- Try holding your breath when you press the shutter release button. Do this by breathing in and out several times and holding your breath on the second or third exhale. That’s the time to shoot.
- Press the shutter release button softly to avoid sudden movement.

Always review your images as you take them, rather than once you leave the field. Many mistakes can be easily corrected at the time by making adjustments to the camera settings—but if you don’t look at your image, you won’t realise your mistake until it’s too late. This includes reviewing the image after it is taken as well as downloading your images and reviewing them at night. If something has not come out well, make a note to return and retake the photo, if that is possible. With excavations or other situations where you only have one chance to take a photo, it is best to be a little paranoid and take many more images than you think you will ever need.
When to use a tripod

A tripod anchors the camera in a way that is impossible for the human hand. You will need to use a tripod if you are taking photographs:

- with long exposures at night or in very low light;
- in close-up, where any camera movement will have a serious impact upon the quality of the image;
- with a very small aperture (a high f-stop) to allow for maximum depth of field.

A highly flexible tripod, particularly one with individually and highly adjustable legs (see Figure 7.4) will be able to cope with just about any situation. Remember to use a cable release to take tripod pictures so that you do not have to touch (and thus jar) the camera with your hand. If you don’t have a cable release, or if you lose it, you can also use the self-timer built into the camera to avoid unnecessary camera movement.

Figure 7.4: The advantages of using a tripod to photograph archaeological sites

Camera pole photography

An increasingly common piece of equipment on archaeological projects are camera poles. These devices vary in design, but commonly feature a standard camera mount plate with 1/4 UNC thread that enables a photographer to elevate a camera so as to take shots from a higher vantage point. These are useful in a range of scenarios, including taking photos from an oblique, ‘birds-eye’ or plan, or even orthogonal perspective. This can be very useful for obtaining a different perspective on an archaeological subject, for acquiring images suitable for photogrammetric processing, or for minimising perspective error in an image (e.g. in rock art photography). A key requirement with pole-mounted cameras is
the ability to remotely trigger the shutter release button. This can be achieved with a wired or wireless control for your camera.

**File formats**

When taking digital photographs, it is important to set your camera up to take images in the most suitable format for your project. Generally speaking, this means higher image quality. The best option in this regard is to take photographs in **raw image format**, because the resulting file is basically uncompressed (i.e. ‘raw’) image data, and the resulting photograph contains all of the data that the camera sensor has been able to capture. This gives you maximum flexibility when it comes to post-processing later. Not all digital cameras have this option, though most new DSLRs should. Even though file sizes for raw images are very large (often 100 mb in size or more), which might dissuade some, the benefits of being able to make a wider range of image edits via post-processing means that this file format should be seriously considered, especially if you are using your images for any kind of subsequent analysis. For example, post-processing a raw image can often correct instances where a shot has an inappropriate exposure due to the conditions and/or subject being photographed. It does require specialised software, but support for raw files is increasingly common in photo editing and management applications. If purchasing a new camera, be sure to ask whether it supports raw mode if you think this will be important to you in future. Raw formats are superior quality to all other file formats available at the time of writing. Importantly, though, many camera manufacturers use their own proprietary raw image format, which can pose problems when sharing or archiving your data. One raw image format that is more open is **Adobe Digital Negative Format**—or DNG—files, which include all of the necessary raw image
data, together with image metadata and other information in a well-documented and open format, which means it is ideal for long-term archiving.

The next best option is to take your photographs as **TIFF files (Tagged Image File Format)**. Like the DNG format, TIFF is an openly documented file type which is usually uncompressed (that is, its quality is not reduced to save space), which makes it easy to share and archive. While TIFFs are less flexible than raw images, they are still better than other options and should be considered the minimum standard for file quality on archaeological projects. Some cameras and image editing software will try to convert your uncompressed TIFF files to a smaller, compressed type of TIFF file. Always try and choose uncompressed options when working with TIFF images on your camera or when saving to a computer. The default file format on many cameras is to save image data as a **JPEG** file format, a widely adopted standard created by the Joint Photographic Expert Group. The smaller file size on JPEG images means that they are often chosen by people who are new to photography. Archaeologists should avoid using JPEG, however, since this is what is known as a ‘lossy’ format, which means that a lot of the image data is averaged in complex ways, reducing the image quality. Critically, this additional image information is never captured, so you have lost image data the moment the image is taken, and you cannot remedy it later. These file types are much less flexible when editing because they contain much less data in the image file itself.

One very useful resource to read before your next archaeological field trip are the Archaeology Data Service and Digital Antiquity’s Guides to Good Practice on creating raster images (Niven and Pierce-McManamon 2011). This discusses a wider range of file formats and highlights other considerations when thinking about archiving image data.
Image distortion

In some cases, archaeologists take photos in order to derive metric data from the image at a later point, for example, in metrical photogrammetry (see ‘Photogrammetry’ on page ##) and in rock art photography (see ‘Photographing rock art’ on page ##). The first of these is perspective error, which occurs when the position of the camera is not truly perpendicular to the subject, and means that features closer to the camera will appear larger than those further away. In effect, this causes the scale to vary across the image, and so measurements or tracings from one part of the image will be at a different scale to others, resulting in warped or skewed data. Generally, perspective error can be minimised by ensuring that the camera is orthogonal to the subject—in other words, that the line of the optical angle of the camera is at a right angle to the plane of the feature being photographed (Domingo et al. 2013: 1880). Photogrammetry can also overcome perspective error by taking multiple overlapping images and rendering these into orthophotos, which are simply images that have been geometrically corrected so that they are in an orthographic projection. This involves adjusting the image so that the 3D surface being photographed is projected or depicted in 2D at a uniform scale across the image. This is much the same as the way topographic maps uniformly depict landscapes in 2D.

Spherical aberration can also cause distortion in an image. This occurs when light refracts or reflects when passing through a spherical camera lens, and particularly where light passes through it near the edge of the lens. The effect is that an image will appear rounded at its margins, though the extent of this depends on the lens being used. These errors not only limit the precision of measurements, but also make it difficult, if not impossible, to join multiple images together seamlessly to create panoramas or when using photogrammetry software. Spherical aberration can be avoided by purchasing aspherical lenses, which have a lens surface that is subtly curved to minimise aberration at the
time the photograph is taken. These can be expensive, however, and are probably not necessary for casual archaeological photography. Instead, a number of photographic software packages exist to allow for the degree of spherical aberration on particular lens models to be corrected when post-processing your images.

**Scales and information boards**

All archaeological photographs for technical purposes must include a scale, irrespective of what is being photographed. Ideally, you should have a variety of scales to suit any circumstance, but each one must have the unit of measurement clearly marked on it (e.g. millimetres, centimetres or metres) and, if possible, at least one—if not more—major length divisions (e.g. 10 cm, 15 cm, 50 cm, 1 m). A suggested scale for site photography is a 2 m range pole or tape with 10, 20 or 50 cm sections in alternating colours (e.g. red and white). A common scale for object photography is 10 cm, marked in 1 cm sections in alternating black and white, though a range of smaller scales can be used for smaller objects.

[[INSERT FIGURE 7.5 HERE]]

**Figure 7.5: Scale in use**

The most important principle when using a scale is that it should not overwhelm, or detract attention from, the object. Never place a scale on top of an artefact, even if you feel that it does not obscure essential information. The scale should be placed to the right or left of the object or centred across the bottom or top of the framed image. This allows it to be cropped out later and a simpler (digitally created) scale bar to be added in its place. Because distortion is an inherent part of the photographic process, make sure you align the scale parallel to either the horizontal or vertical frame of the photograph. This means making sure that it is not leaning at an angle or facing away from the camera. If you happen to be caught without a scale, then include some other object for the same
purpose. A person (of average height) is acceptable for larger features or site photography; for small items or areas, use a relatively common and recognisable object, such as a lens cap or pencil, but remember always to include a note of the length of the object in your field notes and figure captions.

An information board is also useful, as it provides a basic record of the photographic event which can be checked against other records. A small child’s blackboard or whiteboard is not only effective, but cheap and easily reusable. Information boards should be marked with the project, date, site and any other useful information. If photographing an excavation, you should also include information on the unit, square, context or trench. Such photographs are not always attractive, so if your aim is to produce images for publication in articles or reports, it can be an idea to take two photographs: one with and one without the information board. Images with an information board are indispensable when filing your images later.
CHAPTER EIGHT

SURFACE COLLECTION AND EXCAVATION

What you will learn from this chapter

• Principles for surface artefact collection
• What is a potential archaeological deposit
• How archaeologists excavate
• Techniques for subsurface sampling
• Standards for describing soil
• How to use a Harris Matrix to interpret stratification
• Basic procedures for sieving, recording, bagging and labelling
• Basic conservation measures for protecting excavated finds
• Tips for surviving an excavation

The basics

This chapter deals with the collection of archaeological materials from a site, regardless of whether they are on or under the ground, including artefacts, ecofacts, sediments or other kinds of archaeological evidence. The removal of these materials is often warranted in order to address research questions and to generate new knowledge, or required as part of cultural heritage management planning, but this removal is also inherently destructive. As a result, both activities usually require legal permission from the appropriate authority (see ‘Working with the legislation’ in Chapter 1) and, for Indigenous sites, there are
ethical requirements that community members approve of such activities. While there may be some instances where it is unavoidable (such as when the place is in imminent danger of being destroyed, or when Indigenous custodians wish to collect items from sites within their country), in general it is both illegal and unethical to remove artefacts without the appropriate permissions. If you find a particularly interesting or unusual artefact, by all means sketch it or photograph it (or both), but leave it where you found it.

A key requirement when recording or collecting surface materials or excavating sites, is managing spatial data relating to the artefacts or features being investigated. Once information about where an artefact, sample or feature comes from is lost, then the information recorded or materials that have been recovered become significantly less useful (if not entirely useless) in terms of archaeological analysis. This is because a large part of the analysis of archaeological materials involves understanding spatial relationships; for example, the positions of artefacts in the ground in relation to structures or other artefacts; patterns in the distribution of artefacts at the surface; and finally, information about the depth from which samples were collected and their relationships with chronological information (e.g. radiocarbon dates). Hence, it’s critical that we make sure that we collect accurate spatial information in the field—particularly where we are removing archaeological materials—and that we take care to maintain relationships between this information and both the recorded data and the archaeological samples. This needs to occur in such a way that the original spatial information is preserved in as much detail as originally recorded.
Working at the surface

Finding and recording sites is often not enough to address research questions and so we need to adopt methods that allow us to obtain more specific information about the features we have found. This does not necessarily need to involve excavation, since surface archaeological deposits can be a rich source of information in their own right (e.g. Holdaway 2015). Two common techniques should be evaluated as a first option prior to excavation: in situ recording and surface collection.

In situ recording

In situ recording means simply that we record things in their original context without removing them (recording them ‘in position’). This can involve recording information about an artefact or feature without moving it at all, or, alternatively, placing pegs, flags, nails or other markers so that artefacts can be temporarily picked up and properly recorded. There are many good reasons for in situ recording, including:

- it might be all that you need in order to address your research question;
- it might be the option preferred by Traditional Owners, community members or the heritage authority (e.g. on a highly significant site), since it significantly limits the degree of disturbance to a site; and
- it might be impractical or impossible to curate a collection of collected materials properly, particularly over the long term.

Indigenous and historical artefacts are commonly recorded using some form of in situ technique. The widespread availability of mobile data recording systems has made this much easier, since data can be recorded digitally—removing the possible errors caused by paper-based recording and manual data entry (see ‘Mobile apps’ on page ##).
Surface collections

There are many situations where in situ analysis is insufficient as a recording technique, and where it is necessary instead to collect materials from the surface. Critically, surface collection involves the controlled collection of archaeological materials—and is absolutely not about haphazardly picking up items of interest and walking away! Controlled collection means that the collecting activity is planned and methodical, both in terms of the kinds of materials being collected and the area over which a collection is taken. Furthermore, it requires a high degree of forethought in terms of how the spatial context of collected materials will be recorded and managed, so that the spatial context of each and every collected artefact is permanently linked to the artefact. Generally, this involves storing spatial information within the dataset itself; at its simplest level by adding this information to the database or spreadsheet for each and every artefact in the collection. A robust artefact cataloguing system is required for this, so that the record identification number in your database is the same as on the artefact. This might mean placing the artefact in a numbered sample container (bag, box, tube, etc.) or writing the number directly on the artefact itself (although be very cautious of this and what you do it with to prevent causing irreversible damage to the object).

There are many good reasons to collect surface material:

- you’re dealing with a large surface assemblage and may not have the funded time to record it adequately in the field;
- there are management issues and the site, or part of it, may be threatened by interference (e.g. from road construction);
- you may wish to perform specialised analyses on the materials; and
- you and/or a community group may wish to collect materials for use in interpretive displays (e.g. at museums).
Surface collections require a great deal more thought than in situ recording, though a key advantage of this technique is that generally it is much faster than in situ recording. Two general approaches can be used (see also ‘Sampling surface deposits’ below): collecting artefacts individually, or collecting assemblages of artefacts from within sample units.

**Considerations for surface recording and sampling**

Similar issues need to be considered when planning either in situ recording or surface collection:

- What sampling strategies will be used, or will you record or collect everything? Will you adopt the same approach, regardless of site size or type, or will you use different strategies?
- What techniques will be used to record spatial context? Will you record the precise location of every artefact, or will the association between particular artefacts and sample units be enough?
- What types of materials will be recorded (e.g. are you looking for diagnostic pieces of ceramic or glass, or only certain types of artefacts)?
- How will the recorded data be stored? Will you record on paper, with a tablet or a computer?
- How will you ensure that your data are standardised? What attributes will you record? Can you create standardised value lists?
- What forms and/or software will you use to collect this information?
- How and where will recorded data and/or physical collections be archived or curated?
**Sampling surface deposits**

While there are a range of justifications for collecting or recording everything you encounter on a site (e.g. the site faces imminent destruction, it may contain only a limited number or variety of artefacts, and so the logistics of collecting all of them are insignificant, or high-intensity collecting or recording may be essential to your research question), generally speaking, even in these scenarios, some selectivity is usually required. For instance, except in very rare circumstances where budgets for fieldwork are not a significant issue, there will necessarily be limitations on the amount of time you have to spend in the field and the area over which you can conduct your research. Furthermore, you may be constrained to working in a particular area—such as within a management or development corridor, a property boundary, or a defined study area. Furthermore, it is often the case that sites we wish to investigate are diverse, with a range of materials present, not all of which will be relevant to the project. Similarly, it is likely that some sites within a study area will contain very large assemblages of material, with hundreds, thousands or even hundreds of thousands of artefacts. All of these situations will require the development of a sampling strategy to select which artefacts will constitute the subset of the total population that you will work on. Deciding which sites to sample or how to sample within a particular site draws on the same sampling methods described earlier for selecting survey areas (see ‘Sampling’ in Chapter 4).

At its broadest level, it is necessary to decide whether a probabilistic or non-probabilistic method is most appropriate (see ‘Selecting a suitable sampling strategy’ on page ##) and what sized sample unit is best suited to your research question. Using either method the size and number of sample units will vary considerably and be influenced by the kinds of sites you’re working on. For example, when adopting ‘non-site’ or distributional approaches, where the surface record extends across large areas and your research focuses upon
specific concentrations of material revealed by taphonomic processes, it may be useful to use very large sampling units (e.g. 25 m by 25 m). On more discrete sites 0.5–2 m sample squares will be more common. Another approach is to use sampling units in the form of transects that cut across sites at a set width (e.g. 1–2 m).

Using probabilistic methods to choose a sample will involve using one of a range of sampling strategies designed to give an equal chance of selection. Such approaches would only really be of value where it was desirable to avoid bias in choosing which sites would be subject to surface recording or collection work. Probabilistic methods can be helpful in standardising your sampling and minimising bias in terms of how sampling units are placed. Random or systematic sampling strategies are common probabilistic methods used to distribute sample units, often with the aim of achieving a fixed percentage of coverage. Within sites this can be achieved in a variety of ways, for example by dividing them into grid squares, numbering the squares and then selecting according to the sampling strategy (e.g. with a random number table, or just systematically, i.e. by selecting every third square). Another method is to place parallel transects at systematic intervals across the site.

Once sites have been found, however, it is more common for archaeologists to use non-probabilistic methods for choosing between them. Non-probabilistic methods are likely to be of greatest value when you need to select which artefacts to collect or record, or what parts of a site are of most interest to you. When doing this, it is important to develop explicit criteria and to keep these criteria consistent when sampling across different sites. Examples of criteria that could be applied include:

- choosing complete bottles or, where broken, fragments that include a complete finish or a complete base;
- choosing the right valve of all bivalves only; and
• choosing stone artefacts larger than 10 mm in length.

Obviously, your criteria must relate directly to your research design. You may also wish to use non-probabilistic methods to choose where to place sample units. For example, it may be practical to place a 5 m² sample unit, oriented north, near the centre of a surface deposit, or to place a 2 m wide transect so that it cuts across the longest axis of the site. Alternatively, your choice may be guided by the visible patterning in a surface assemblage, such that you place your sample squares over the densest part of the deposit, or alternatively by the presence of visible features, such that you choose to place sample units both within and outside of the feature.

Both probabilistic and non-probabilistic approaches can be used simultaneously when sampling surface materials. A probabilistic method may help you to choose parts of a site for in situ recording or surface collection, but the selection of artefacts to be collected or recorded may be subject to non-probabilistic criteria as discussed above. Whatever the case, and as with most field methods, always try and think through your sampling methods in advance. Read the literature to see what approaches other people have used on similar sites and what the pros and cons of different approaches were. Whatever strategy you adopt, document very specifically what you did, why you did it and where you have deviated, encountered problems or ceased sampling (for example, if you did not complete a particular sampling unit). It can also be useful to maintain a systematic approach to sampling across different sites so that your data are comparable. Finally, keep in mind that fieldwork always throws up unexpected results and the characteristics of some sites or problems with method may require modifications to your sampling strategies while in the field. In such cases, write it all down!
Managing spatial context

The level of precision at which spatial data is collected will vary depending on the site in question and your own research agenda. At minimum, you should make sure that spatial information about the location of the site that the data relates to is included within a dataset. This may mean including a site name and coordinates within the dataset itself, and ensuring that reports, theses or publications explain the relationship between specific datasets and sites—so that others can always find out which site a particular artefact or data record comes from. Doing this, however, loses a great deal of information about the intra-site spatial relationships that exist. For this reason, such a general approach is not recommended here, particularly where artefacts are being collected. Perhaps the only situation where this is warranted is with highly disturbed surface deposits; for example, where a site has been bulldozed or otherwise damaged by recent human activities. Erosional processes can create similar situations, yet even here precisely documenting spatial context could be key to understanding the movement of artefacts through erosional processes as part of a research question.

Recent advances in surveying and geomatics (see ‘Geomatics in landscape archaeology’ on page ##) mean that it is relatively easy to record the precise spatial position of individual artefacts in the field. We suggest that this should be seen as best practice in Australian archaeology, since a unique coordinate is obtained for each individual artefact and little to no spatial data is lost. The degree of precision is likely to be variable and dependent upon the specific survey equipment and method being used, though aiming for ±10 cm spatial precision is feasible. This approach does have its disadvantages in that it requires specialised surveying equipment such as a total station or Real Time Kinematic (RTK) GPS in order to collect a precise coordinate for the individual feature at the time it is recorded or collected. This can also be a little more time
consuming than other approaches, but will mean that the precise coordinate of
an artefact becomes permanently stored as part of the data record for that item.
This allows both you and future researchers to have access to much more
detailed information about the spatial relationships that existed on that site
when the dataset was created.

While that is the optimal method, the minimum standard for recording the
spatial context of surface materials should be to record the coordinates of
sampling units; for example, by recording coordinates for corners of sampling
squares. This ensures that individual records about features or artefacts within
datasets can be placed within a specific sample unit and narrowed to a specific
geographic location on a site. Obviously, this needs to be done cautiously, taking
into account both the size and type of the site being recorded. For example,
noting that an artefact comes from a 4m$^2$ area within a site that is only 10 m$^2$ in
size does not really capture much more detail about that artefact’s original
spatial context other than saying the artefact came from that site. So, be sure to
choose sample units that are appropriate to the size of the site being used. For
example, on sites less than 50 m$^2$, recording spatial data to within 1 m$^2$ sample
units would be adequate. When recording very large stone artefact deposits,
extending over hundreds of metres, you might place 10–25 m$^2$ sample units as a
way of recording the spatial position of artefacts that have likely been moved
around a great deal by geomorphic and taphonomic processes. This approach
can be useful where dense accumulations of artefacts or other materials (e.g.
shells on midden sites) are being sampled, and where more precise coordinate
information is not likely to be very meaningful. It can also be a very rapid way of
collecting surface materials, as bulk collections can be made for each sample unit.
When doing this, it is essential that you create detailed plans showing the
position of sampling units within a site or landscape, and that sampling unit
information is included for each record in the resulting dataset.
A range of survey methods can be used for recording spatial context, though care needs to be taken to ensure that your survey data relates in some way to geodetic coordinates (see ‘Surveying in geodetic coordinates’ on page ##). Baseline/offset recording can be very useful, as it requires little in the way of equipment and baselines can be simultaneously used to arrange your sampling units on a site, as well as to record spatial data for artefacts within those units. Similarly, a dumpy level could be used to collect spatial data, though the precision of total stations or RTK/DGPS provide more advantages (see ‘Surveying in 3D’ in Chapter 6). Our recommendation is to record as much spatial information as possible, since it is easier not to use that data later than it is to go and collect that data again.

**Working below the surface**

Almost everyone recognises an archaeologist as someone who excavates. What is less well recognised is that part of being a professional archaeologist involves understanding that excavation or any other form of collecting artefacts is inherently destructive and can never be repeated. It is for this reason that most jurisdictions require you to obtain an excavation permit before excavation or collection can commence. We would like to emphasise that excavation should be a last resort—if you can get all the answers you want through non-destructive recording techniques, then don’t do it. As soon as you begin an excavation, it is your ethical responsibility to ensure that it is done professionally, up to and including the standards you adopt for analysis, reporting, archiving, artefact conservation and curation (see Chapter 1). In the end, it is 'better to go for less done well, rather than more done badly' (Drewett 1999: 97).

That said, however, excavation is able to provide information about past human behaviour that can never be recovered from surface materials alone.
Many research questions will depend on excavation to provide the necessary data, particularly where change over time is an important aspect of the research. Surface deposits are often formed over long time periods, which means that it is not necessarily possible to distinguish human activities that have occurred there at different times. This limits our ability to understand changes that might have occurred between different periods of occupation. Excavation, on the other hand, may contain material deposited over a similarly long time span but in a way that preserves the chronological relationships between periods, usually by trapping evidence in separate layers, or *stratum*. A site or feature that preserves the chronological relationships between its layers is described as being *stratified*, and finding such deposits is often a core goal of excavation-based research projects.

**The principles of excavation**

Sites can be created over long or short periods of time—they can even be the remains of a single event—but excavation assumes that the order in which the different parts of the site have been laid down will reflect the sequence of events that occurred at that site in the past. This is known as the **Principle of Superposition**, and it simply assumes that more recent deposits will be laid down on top of older ones. Another geological concept—**horizontality**—suggests that when sediments are deposited, physical forces will tend to reshape those deposits into horizontal layers or strata. While this is not always straightforward, it is the fundamental basis for using **stratification**, or the way in which the structure of the soil is divided into different layers or **deposits**, to interpret what happened at a site. You should note the distinction between stratification (the process of sedimentary layering and its observed result) and
stratigraphy (the archaeologist's interpretation of the stratified layers, in words or drawings).

There are often complicating factors to this, of course, such as when various natural processes deposit or remove material from a site (such as wind depositing silt or water eroding the site, or rodent burrows churning and mixing up the soil), or when later events remove or alter evidence of previous events. There are three other fundamental principles which describe these possibilities:

1. The **Principle of Association**, which presumes that items found together in the same deposit are of essentially the same age. This must be applied with caution, however, as some items may be looked after for a long time before they are finally thrown away (such as a treasured tool or family heirloom), making them much older than the other materials associated with them.

2. The **Principle of Intrusion**, which states that an intrusion must be more recent than the deposits through which it cuts (Barber 1994: 85). A rubbish-pit dug into the ground or an underground oven are both intrusions cutting into the older stratum.

3. The **Principle of Reversal**, which allows for those rare cases when deposits have been removed from the site and re-deposited in reverse order. This usually takes place as a result of major construction activity or digging, when large quantities of earth are removed and then re-deposited upside down.

All archaeological excavation is based around these three principles. Together they imply that, through the careful removal of the layers which make up a site, and a detailed description of their texture, colour and contents, an archaeologist can reconstruct the sequence of events (both human and natural) which took place at that site in the past.
Professional recording standards require that an archaeologist is able to control the excavation process as much as possible, particularly as not all archaeological evidence will be in the form of moveable objects. Much evidence for past human behaviour will be subtle and perhaps not even instantly recognisable, such as stained soil from decomposed timber posts indicating the original location of buildings, or slightly darker layers of soil indicating the presence of charcoal from cooking fires. This evidence will be lost if care is not exercised during excavation with regard to changes in soil colour, type or texture. Any change in the physical characteristics of the soil could be of great importance, so you should never underestimate what’s happening under your trowel (see ‘Using a trowel and brush’ on page ##).

The main purpose of maintaining this control is to enable archaeologists to pinpoint where each and every piece of evidence comes from within the site (see ‘Recording an excavation in 3D’ on page ##). This contextual, spatial information is called provenance. The positioning of artefacts horizontally can tell archaeologists how different parts of the site were used and what activities were performed there; the positioning of artefacts vertically can tell archaeologists what happened when and the order of events in the past; vertical changes in the frequency of faunal remains and stone tool types, for example, might provide information about changing dietary shifts and hunting methods through time. The need to be absolutely sure about the provenance of all artefacts and samples is what drives archaeologists to keep all the evidence from a particular context together throughout the excavation, sieving, sorting, bagging, cleaning and analysis processes (see Figure 8.1 on page ##). It is also why archaeologists tend to excavate carefully selected portions of a site in such a way that the boundaries of each trench are very specific. Usually they do this by adopting a standard grid system and stringing out their excavation trenches to exact dimensions (see ‘Laying out a site grid’ on page ##). Trenches are usually laid out in multiples of
1 m, and sometimes divided into smaller squares of 25 or 50 cm within each metre square; these are called **quadrats**.

In essence, all excavation requires careful planning (see ‘Research designs’ in Chapter 2). Think about what aspects are important to the success of your project and make sure you seek out and record those aspects during excavation. Every site is different, so you will need to weigh up the pros and cons carefully and tailor the excavation methods to suit your particular research questions, the time available and the individual nature of the site. Once you have carefully thought through your research aims and worked out how excavation can best serve them, all excavation follows a fairly standard process:

- lay out trenches;
- photograph entire site before commencing (see ‘Photographing excavations’ on page ##);
- excavate (this is in reality a complex series of steps in its own right—see Figure 8.1);
- photograph entire site upon completion;
- backfill;
- analyse excavated materials;
- report on the work; and
- conserve/curate recovered artefacts.

![Figure 8.1](here)

Figure 8.1: A flowchart to follow when recording an excavation unit, or context. This sequence should be repeated for all units

The single context system of excavation

Because stratification is so important, most excavation proceeds by carefully removing a single strata from a site. Stratigraphy is closely linked to the process of excavation itself in that, as you remove each layer, you form opinions about
how the different strata in a site were laid down and how they relate to each other:

The archaeologist’s golden rule is to excavate one layer at a time—and nothing in that layer should escape his or her detection. It isn’t possible to read significance into a layer or level until you know how it lies, how it was formed, what its composition is, and what its relationship is to the layers above and below it (Joukowsky 1980: 171–2).

For this reason, excavation should proceed horizontally first and vertically second. In other words, you should finish excavating one unit or layer completely before you begin the next. As a result, excavation requires both care and patience, since, to be able to understand the sequence of activities at a site, archaeologists must pay attention to subtle changes and slowly strip away each soil layer or feature separately and in succession. This kind of careful excavation process is called the **stratigraphic** or **single context** system of excavation.

On historical archaeological sites stratification might be relatively easy to recognise—typically such sites might contain buildings, demolition rubble, built features, soil layers and large quantities of discarded consumer artefacts. Each of these is known as a **context**—a term used to describe any discrete archaeological entity on a site, such as a feature (e.g. a wall, a well or a post hole), a depositional layer (stratigraphic unit) of either soil or cultural materials or an erosion event (Drewett 1999: 107). If you think of a site which has had many successive activities performed on it over hundreds of years, all of these activities may have left separate and distinct evidence, trapped in different layers of the soil or in different cultural features. If archaeologists were to mix up this information, they would be unable to separate each activity, date the sequence of activities or reconstruct exactly what happened there in the past. Under the context system, the goal of excavation is therefore not to dig as deeply as
possible as quickly as possible, but to be sure that all of the information from each context is recorded comprehensively and kept together. As a result, each context will be removed separately and will have its own recording form, or context sheet, where detailed notes are taken and will be recorded photographically, on plans and via spatial data. Modern excavations may also integrate various types of geomatic work into context and site recording, such as photogrammetry, LiDAR or terrestrial laser scanning to create 3D models of a site prior to, or during, an excavation, or total station recording of individual artefact positions. Geophysics may also have been applied prior to excavation to identify suitable subsurface deposits or features (see ‘Geomatics in landscape archaeology’ on page ## for more details of these techniques).

Not all sites are the same, of course, and some sites will have no visible stratification. At others, the more significant cultural layers might be covered by large quantities of later, less significant, debris, or the entire site may have resulted from a single event (such as a load of rubbish being dumped or a meal being eaten). In such cases excavating according to stratigraphic levels would be fruitless. Even if you choose not to excavate the site according to stratigraphic layers, you still need to be able to control the removal of deposit if you want to draw any meaningful conclusions about the vertical or horizontal location of artefacts. In such cases a site can be dug in arbitrary levels to provide sufficient vertical and horizontal control. These levels are sometimes referred to as spits or units, and can be of any thickness depending on the overall depth of the site and the degree of resolution you want to achieve in the data. Keep in mind that whatever arbitrary depth you choose as the standard, this will be the finest degree of resolution that you will be able to achieve in your analysis, so if you don’t get it right at the beginning your data will be flawed and your ability to interpret the site compromised.
On Indigenous sites this is a particular issue, as deposition tends to be slower, occurring over hundreds or even thousands of years, so stratification is quite subtle and changes are gradual. Sediments are often quite homogeneous and change in the nature of cultural remains can occur over vertical distances of only a few centimetres. The excavation of such sites still proceeds on the principle of excavating according to stratigraphic units, but a very fine-grained excavation resolution is crucial. In order to minimise the risk of losing what might later turn out to be critical information, it is normal on Indigenous sites to excavate in very thin vertical units measuring anywhere from only 1–5 cm in thickness. These vertical units are therefore arbitrary units of excavation (some archaeologists prefer to call these ‘excavation units’ [abbreviated to ‘XUs’] rather than spits, see, for example, McNiven et al. 2009: 32) that are dug within stratigraphic units (which some archaeologists label ‘SUs’). Whenever a new sediment or sediment change is encountered (even if the excavator only thinks it is) then the current spit is completed and a new one begun. Excavating in such small vertical units gives very good chronological and spatial control over subtle changes, even if you can’t see obvious changes in the stratigraphy or the stratigraphy consists of a single sedimentary unit.

The strategy you employ for excavation depends absolutely on your research questions, your resources and what you need to know. Some sites will be better excavated and recorded via the context system, while others may require a combination of arbitrary and stratigraphic excavation, such as when you find thick homogeneous layers within an otherwise stratified site (generally at the beginning or end of the excavation) which can be removed by arbitrary levels. As always, you should document such variations in your journal and on your recording forms.
Approaches to excavation

Once you have decided on the most appropriate method of excavation, the next important decision is which parts of the site you’re going to excavate. Again, this is a sampling decision and will follow the same principles as deciding how to selectively survey an area, select which sites to record in more detail or select samples for surface collection or recording (see ‘Selecting a suitable sampling strategy’ on page ##). As with any other sampling decision, you will need to make some meaningful decisions about which part or parts of the site are most likely to give you the information necessary to answer your research questions. There is an ethical element to this decision as well, of course, in that some archaeologists argue you should always leave part of a site intact so that future generations of archaeologists, who will bring with them newer and better methods and different questions, will be able to retrieve some in situ information. For excavations there are two aspects to this decision:

1. Deciding where to place your excavation trenches.
2. Deciding how much of the area to excavate.

In making these decisions, you are effectively trying to assess what might lie below the visible ground surface. There are more scientific ways of doing this than simply guessing, of course, both destructive and non-destructive. Non-destructive methods include various forms of geophysical survey, while destructive methods constitute various means of subsurface sampling (i.e. excavating small, discrete portions of the site to gain an understanding of stratigraphy and the location and density, or lack thereof, of archaeological materials).
Where?

**Intra-site sampling** is the choice of where to excavate within a site. In deciding where to place your excavations you will need to think carefully about what it is you want to know and how best you will be able to find this out:

- What kind of data do you want to recover?
- What sampling approach best fits this goal?
- What sample size will best answer your questions (i.e. how much information will you need)?

In reality, you will only be able to decide where to excavate after you have completed an intensive surface survey of the area in question and recorded as much observational data as you can. Careful surface survey may reveal discrete activity areas or clusters of certain elements or features, the patterning of artefacts across the ground surface may be able to tell you about differential erosional/depositional patterns across the site, or geophysical survey might provide detailed information on the location of possible subsurface features (see ‘Geophysics’ on page ##). Any indication of where there might be more archaeological evidence below the surface will be a useful guide as to where to place your trenches. You may also wish to excavate a seemingly bare area of ground to test whether what you observe on the surface is really a good indication of what exists below it. Examining the ground carefully before you excavate can also tell you what kind of tools you will need to do the job properly (Joukowsky 1980: 172). It is here that photogrammetry, terrestrial LiDAR scanning or geophysical techniques can also be very useful. For an historical archaeological site, researching its history may also give you some idea of what took place in the recent past at least, and therefore the kind of deposits you might encounter, which will also be a useful guide for methods and tools.
Subsurface sampling

Sometimes, small-scale subsurface sampling (in effect, a sample of a sample) will be necessary to determine the horizontal extent of a site or the nature of archaeological remains below the surface. While this seems a sensible solution to the problem of not being able to see below the surface, it is also one that needs to be conducted logically if it is going to generate useful information and not destroy the integrity or information value of a site. You will not only have to consider where you are going to place your sample excavations, but also how close together they should be, their size and depth. Perhaps the most important consideration is the method of excavation you choose, since this will directly affect the resolution of the data (i.e. how much detail you can extract from it and therefore how useful it will be for analytical purposes to understand what was happening at that site in the past). Bear in mind that any form of subsurface sampling will destroy a small portion of the site as it is dug, so it is always wise to limit the effects of this, particularly if you are going to conduct a larger-scale excavation later. Because of this, subsurface testing can only be conducted under the auspices of an excavation permit supported by a carefully thought out research design (see ‘Research designs’ on page ##) and according to an appropriate sampling strategy (see ‘Sampling’ on page ##). Soil cores, augers and test pits are all common forms of subsurface sampling. Obviously all larger forms of subsurface testing need to be backfilled upon completion, since open holes may injure people or animals.

Soil cores

These are commonly 3–5 cm in diameter and are excavated using a small tube that can be pushed into the ground to remove an intact column of soil (also known as a column sample). A soil core won’t tell you much about large, extensive sites or subtle subsurface features, but it will allow you to see the soil
layers across an area and gain an idea of what to expect stratigraphically or to investigate geophysical anomalies that may or may not be cultural. Soil cores will not be useful in areas with hard, dry or stony soils. They are frequently used to recover samples for palaeoecological studies, in order to understand past vegetation or shifts in fire regimes, as well as studies of the geochemical properties of soils.

**Augers**

Augers are screwed into the ground and will produce a slightly larger hole than a soil core, averaging 10–25 cm in diameter. They are a more destructive method, since they don’t allow you to retrieve an intact column sample, but they can be done by hand with equipment such as a post hole digger or a mechanical auger. Mechanical augers are efficient, but can reach speeds that tend to throw the soil some distance from the hole. Use them only if you can control the speed enough to allow you to examine the soil. Like soil cores, augers are useful to gain an idea of the stratigraphy or the presence or extent of artefacts across a site. The depth of auger samples taken with a manual instrument can be controlled, allowing for the analysis of samples retrieved from different depths, which is sometimes useful.

**Test pits**

Test pits will be larger than soil cores or auger holes and can range from small pits excavated by hand or using a shovel to larger areas excavated by machine. Note that in some states (such as NSW and Victoria) they can only be conducted according to very clear and detailed requirements for subsurface testing, including how test pits must be excavated and sieved, their size, the proportion of the surface area they can constitute and how they must be recorded. The choice among test pitting options must always be considered in the context of
the predicted scale, nature, density and value of potential archaeological remains or deposits and weighed up in terms of the pros and cons they will pose for retrieval and analysis.

**Hand excavated test pits**

The baseline standard for test pitting is a hand excavated, usually 1 m × 1 m square. These have the advantage of using all of the principles of stratigraphy and vertical and horizontal control to provide very good spatial resolution for the data, but are also very time and labour intensive. Alternative methods of test pitting may be less labour intensive, but will also provide less control over the excavation process and thus data resolution.

**Shovel test pits**

As their name implies, these are dug by hand using a shovel and are usually slightly larger than the width of a shovel blade (i.e. between 25 and 50 cm square). Some archaeologists believe that the best use of a shovel test pit is to detect the presence or absence of cultural materials and thus don't worry too much about the size or precise depth of the pit. Others wish to be more precise and dig a 50 cm × 50 cm test with square corners and vertical profiles. Using either technique, you must sieve all materials coming from the test pit and sketch the subsurface stratigraphic profile. How you approach it depends on the needs of the project and your own concerns with precision. Map and number all of the shovel test pits so that you can understand later how they relate to each other and what they tell you about subsurface conditions and artefact densities across the site. Detailed notes on each shovel test pit will also be necessary.

Comparison between different methods of subsurface sampling suggests that shovel test pits are highly effective for ‘seeing’ beneath the ground surface, although they are quite labour intensive (Hester et al. 1997: 57–9). Studies have also shown, however, that they are biased, particularly against small, low-density
sites, or where artefact concentrations are tightly clustered, simply because the likelihood of a test pit intersecting such a site or cluster is low (Nance and Ball 1986: 479).

**Mechanical test pits**

Mechanical excavation is not an excuse to shortcut on time or labour and mechanical test pits have the greatest potential for destroying data rather than revealing it. Nevertheless, they are an appropriate strategy to use over large areas with low visibility and where an adequate sample is necessary to understand the nature of the archaeology. Areas that have been ploughed, for example, and therefore are already disturbed on the surface, would be appropriate for mechanical test pitting. Mechanical excavation still needs to be controlled as much as possible and its use should be based on a solid and well-founded argument for preferring that technique over another, more highly controlled (yet slower and more labour intensive) one.

**How much?**

There are two ways to approach the excavation of any site: the **trench system** or the **open-area system**. The trench system is concerned with obtaining a cross-section through the site and tends to excavate relatively narrow portions to sufficient depth (because of this it is often referred to disparagingly as the ‘telephone box’ approach). Since it aims to dig deeply, it is well suited to answering chronological questions, such as the sequence of dates or the dates for the full range of occupation, and for indicating the richness of the deposits and revealing the stratification of the site, since the walls of the trench preserve the stratigraphic profile of the excavation unit until the very end of the excavation (although they may not necessarily preserve all of the excavated stratigraphic information—see ‘Interpreting stratigraphy—The Harris Matrix’ on page ##).
Because the trench system excavates narrow vertical slices through a site, however, it cannot expose spatial information across the site unless multiple trenches are opened. The open-area system was developed in response to this need for horizontal information and exposes large expanses of the site, often to only a relatively shallow depth. It is thus quite successful at revealing information about activity areas or site structure—although it may not be so successful for establishing a sequence of dates (if you dig deeply enough, however, it may be).

Each system has different pros and cons, and it is important to realise that each is designed to recover different types of information. They can, of course, be used in tandem to complement each other or be combined with other methods, such as mechanical excavation or surface stripping, to answer different kinds of questions. The choice of which to employ will depend on the type of site you’re excavating, the time and resources available and the particular set of research questions you’re asking.

**Laying out a site grid**

Once you have made your decision about where to excavate and how much of the site you want to excavate, the next step is to lay out your excavation trenches. This is essential in terms of being able to maintain control over the positioning of artefacts and features across the site. Archaeologists often use a grid which, for convenience, divides the site into metre grid units (often called ‘squares’). An excavation trench can be any multiple or fraction of these grid units, which are related to each other through a universal numbering system (see Figure 8.2). The two axes of the grid are labelled the ‘X’ and the ‘Y’ axis. Note that it is standard practice to begin numbering coordinates along these axes at a relatively high
number, such as ten, to allow for the possibility of extending a trench if necessary but to avoid going into negative numbers when doing so.

Figure 8.2: A hypothetical grid across an excavated site. Any of the squares in between the already excavated trenches can be opened and assigned X and Y coordinates from the established grid

You don’t need to string out every grid unit across the site, but to avoid having to measure them again, you should mark the ends of the X and Y axes with stable and relatively permanent pegs. If you want to excavate a trench that is larger than 1 square metre, but don’t wish to string out the boundary of every 1 m grid unit, it is simplest to mark the corners of each unit along the edges of the trench with masking tape attached to the trench string.

You do have to string out each excavation trench within your site, however. The string outline of the trench serves as a constant reference point for ensuring, among other things, that the sides of the trench are kept vertical. You must ensure that all of your excavation trenches are kept square (meaning horizontally rectilinear and vertically straight-walled), because it is this which allows you to control the excavation process. As a first step, establish where the edge of your trench will be, measure its length and then mark the two corner points with pegs hammered lightly but firmly into the ground. Because trenches are usually laid out in multiples of 1 m with 90° corners, the next step is to mark the opposite corners.

Once you’ve done that, establish a right angle from one peg to a third corner peg using triangulation (see ‘The baseline/offset technique’ on page # #). Install a fourth corner peg by the same method and then measure all four sides and the diagonals to be sure that the trench is square. Table 8.1 provides diagonal measurements for excavation trenches up to 10 m square, on the principle that the diagonal of a square will always measure 1.414 times the length of the sides. This is related to Pythagoras’ theorem, which states that in a right-angled
triangle, the square of the hypotenuse is equal to the sum of the squares of the other two sides \((A^2 + B^2 = C^2)\). This is easy to remember in the field. Take a right-angled triangle with two sides (A and B) that have known lengths; the unknown length (side C) will be the longest side or hypotenuse. When added together, the lengths of A squared plus B squared will equal the square of C.

In practice, even though you have carefully measured the first side of the trench, and then triangulated the opposite two corners from this, a trench will rarely be perfectly rectilinear on the first go. Inevitably you will have to keep adjusting the positions of your pegs until it is accurate. The only way to do this is to keep measuring the sides and the diagonals until you have them correct (see Figure 8.3). Ideally, you want a trench to be as accurate as possible; for example, with a 1 m by 1 m test pit, an error of more than 1 cm (e.g. if one side measured 1.02 m, instead of 1 m) would be sufficient cause to start again. Your degree of allowable error will depend on your trench size: for example, an error of 5 cm might be acceptable on a trench that is 5 m by 1 m. Whatever the case, decide on the degree of precision you're comfortable with and be consistent in ensuring your trenches adhere to that. Also be sure to document your degree of precision in your notes.

![Insert Table 8.1 Here]

![Insert Figure 8.3 Here]

**Figure 8.3: The sequence for laying out an excavation square**

Total stations have a built-in function for laying out grids. This can be very quick to do in the field once you know how to use the function. Generally, this involves importing the coordinates of a grid into the instrument and then letting the instrument guide your placement of individual points on the grid. The total station will take readings of a prism held near grid points, and indicate which direction the prism needs to move in order to precisely hit a grid coordinate. This has advantages, particularly where a grid needs to be established over a
large area because it can be very quick and, unlike string lines, is not hampered by interference from vegetation or other obstructions.

Once you have strung out your trench, make sure you don’t trip over the string or pegs during excavation. For this reason, you may wish to tie flagging tape or some other brightly coloured material to the pegs to make them easy to see (and avoid). Remember that the corners will be your permanent reference points for excavating and mapping, so it is very important not to disturb them.

**Labelling trenches**

All excavation trenches within the grid of your site must be numbered logically so that all finds and descriptions of deposits can be tied securely to their place of origin. There must be no confusion about this, so deciding on a labelling system is a first priority. Every artefact or sample which comes out of a trench, and every description of a layer, feature or context, must be able to be described so that you know precisely where it came from. In this way a numbering system is like a library catalogue: it is what ties the archaeological features and structures, the artefacts, their locations and the physical descriptions of the various soil strata together so that, in the end, the site may be analysed in a meaningful way (see ‘Labelling and bagging finds and samples’ on page ##). At the very least, a labelling system should contain a site prefix or code for the site (such as two or three letters which denote its name), a unique number or letter for each trench, and a consecutive and unique number for each context or layer. Individual artefacts or samples within each context can also be numbered if required. This string of letters and numbers will be the code that is written on every bag containing an artefact or sample (see ‘Labelling and bagging finds and samples’ on page ##), and on every recording form.
Recording an excavation in 3D

Because archaeologists want to know the exact location of artefacts and features, both horizontally and vertically, they record these things in 3D (see ‘Surveying in 3D’ on page ##). The most accurate way to measure the depth and position of artefacts or the extent and depth of excavation layers or contexts is to use a dumpy level or total station. If you don’t have access to this technology, you should reconsider whether you should excavate at all. While a string line and a tape measure can be used to record depth in a rudimentary fashion, the risk of error is very high and we do not recommend it.

On many sites recording the precise position of every individual artefact in 3D is not always practical and is not necessarily going to provide you with more accurate or ‘better’ archaeological information, unless there is good evidence that the artefacts are still in their area of primary use or discard (Drewett 1999: 143). Research (Balme and Beck 2002) suggests that simply plotting artefacts to within a 25 or 50 cm quadrat (i.e. ‘this artefact was recovered from Trench 1/context 10/quadrat a’) will provide sufficient spatial resolution to answer most questions about activity areas at a site. Any special or unique finds or particular contexts can still be plotted individually if necessary. Whatever you decide, try and be as consistent as possible across the excavation—and, of course, document your decision in your notes and on your recording forms.

Recording the excavation process

Just as with surface survey, there are several complementary aspects to an excavation which must be recorded consistently as the excavation progresses. These will be essential pieces of information in the final jigsaw puzzle which will be your archaeological analysis. The core aspects to record throughout any excavation are:
the soil or deposits (for each context or spit);
any features encountered; and
the process of excavation itself.

**Describing deposits**

The four main elements to record when describing soils are:

1. Colour.
2. Texture.
3. Consistency.
4. Coarse components or composition.

It is important you standardise such descriptive information as much as possible so that other people reading your report will know precisely what you mean. If you let everyone describe a variable such as colour in their own way, for example, you will end up with as many descriptions as there were workers. In reality, of course, none of these attributes can be assessed in the field with any kind of scientific accuracy, and the standards employed by soil scientists and archaeologists vary considerably. Your goal should simply be to try to record as much descriptive information in as standard a fashion as possible.

**Colour** should be recorded using a Munsell soil colour chart, which provides an internationally recognised standard against which to assess soil colour and makes the process far more objective than would otherwise be possible.

The basic divisions of soil **texture** are sand, silt and clay, defined in terms of the size of their mineral particles (sand = 0.06–2 mm; silt = 0.002–0.06 mm; clay = less than 0.002 mm). For on-site purposes, however, it is best to use a more general measure which can be estimated by hand-texturing, such as whether or not the soil will hold its shape when damp. The overall rule of thumb is that clay coheres, silt adheres and sand does neither. Thus clay will be sticky and plastic,
silt will have particles that are invisible to the naked eye, and sand will have a visible gritty feel when moistened (Roskams 2001: 178). A general test you can apply to all types of soil is to roll it into a ball and test its malleability (Figure 8.4). If the soil can be rolled into a sausage shape that still holds its shape when bent into a ring, then it is largely clay; if it breaks when bent into a ring, it is largely silt. Sand, of course, cannot be rolled into any shape.

[[INSERT FIGURE 8.4 HERE]]

Figure 8.4: Sediment composition flowchart (after Museum of London 1990)

Consistency measures the degree of compaction of the soil and whether or not it holds together. Variations in compaction across a deposit can be important, as different activities on the site will have affected the consistency of the soil in different ways. To assess consistency, take a slightly moist cube of soil and try to crush it between your thumb and forefinger:

- if it cannot be moulded into a cube at all, it is a loose soil;
- if it crushes easily (if there is no resistance), it is a weak soil;
- if low pressure is required to crush it, it is a friable soil;
- if greater pressure is required to crush it, it is a firm soil;
- if it cannot be crushed at all, it is a compact, or hard soil; or
- if it is bound together with a substance other than clay, it is a cemented soil. (Roskams 2001: 180)

The assessment of the coarse component is an estimate of the size of visible particles within the soil and of the proportion of different grain sizes in the deposit. When assessing the size of the visible particles, use the general guide in Table 8.2 (Museum of London 1990).

[[INSERT TABLE 8.2 HERE]]
When assessing the proportion of different grain sizes (composition), you can estimate the percentage of inclusions and their approximate grade size using the chart in Figure 8.5.

**Figure 8.5: Estimating the percentage of inclusions (after Museum of London 1990)**

If possible, you should also estimate the degree of sorting that is visible in the deposit. This is an assessment of the frequency with which particles of the same size occur and will give you some idea of how the deposit was laid down, or its origin. A deposit in which all of the particles are of very similar size, for example, indicates that it has been well sorted prior to deposition (by water or wind, for instance).

**Figure 8.6: Estimating the degree of sorting (after Museum of London 1990)**

**Describing cultural features**

The material evidence for past human behaviour can occur in forms other than 3D moveable objects (artefacts)—it can take the form of a posthole, a hearth from a fire, a pit or trench or the remains of a structure. These are commonly referred to as **features**: the non-portable physical and chemical remnants of human behaviour. They are still artefacts in the sense that they are humanly created, but are distinct from the portable objects that are contained within the deposits. They may be indicated by something as subtle as a change in soil colour, texture or pH—which is why all of these aspects need to be carefully recorded—or by something more obvious, such as the presence of structural materials or particular combinations of artefacts. Recognising cultural features means being alert to subtle changes in the trench, sometimes over very small areas.
Jane Balme’s tips for excavating bone

Observing small differences in the appearance of bones during excavation can pay enormous dividends in the quality of information gathered during excavation. The presence of clusters and alignments of bones can tell you about post-depositional processes. Articulated bones indicate a lack of disturbance and hence provide information about the spatial distribution of activities.

- Observations aren’t worth having unless you communicate them to other members of the team and write them down.
- A sample of animal bones is useless without labels containing information about their source. This includes their location within the site (square and excavation unit) as well as the mesh size of the sieve from which they were taken. The best way to make sure that you don’t forget some information is to be consistent in your labelling. Write down the information in the same order each time.
- Label the sample immediately and never leave any samples lying around unlabelled.
- Condensation in plastic bags will cause paper labels to disintegrate. You can reduce condensation by putting a few pin pricks in the bag, but you will need other labels too. Permanent marker on the outside of the plastic bag is good but, because this can scratch off, make sure that you pack the bags in boxes to reduce this problem.
- When bone is very fragile or waterlogged get expert advice on how to retrieve and store it.
- Patience is definitely a virtue when dealing with archaeological bones. You will need patience to pick each one individually from the samples and lots more when you do the identifications in the laboratory.

Recording the excavation process

An excavation is described by the information you record in your field notes, detailing its day-to-day running and any problems or successes (see ‘Important things to note in your field journal’ on page ##). Your details of the sequence of
events for the day and the decision-making process can be invaluable for sorting out problems in later analysis, or for clearing up any mistakes made on recording forms or artefact bags.

**Recording sections**

One of the other main ways in which archaeologists record stratigraphic information from a site is by drawing and photographing the vertical walls of their trenches. These walls are called *sections* or *profiles*, and the aim is to represent both the visible soil layers and the discernible archaeological features as informatively as possible. Stratification is what allows the archaeologist to place events at a site into chronological order. Because the Principle of Superposition rests on the assumption that the deposits at a site are laid down in sequence over time, it is also the basis for relative dating (see ‘The principles of excavation’ on page ##). This is the process of putting things into order from earliest to latest, but without assigning any specific dates to the things themselves. Absolute dating, on the other hand, uses a particular technique or process to assign a specific date to something (such as when radiocarbon dating is used to date a piece of bone). Both forms of dating are essential to archaeological research for obvious reasons. Without some knowledge of when things happened, it is impossible to interpret a site properly. For this reason, it is important that your photographs and section drawings represent the vertical sequence of layers or contexts visible in the wall of the trench as accurately as possible (see ‘Photographing excavations’ on page ## and ‘Drawing vertical surfaces (sections) by hand’ on page ##).

The principle of drawing a section is exactly the same as for drawing a site plan: using baselines with offset measurements to plot features (see ‘The baseline/offset technique’ on page ##, ‘Using the baseline/offset technique to record vertical surfaces’ on page ##). A section is simply the drawing of a
vertical, rather than a horizontal surface and can be applied to any vertical space, whether the side of an excavated trench, the wall of a standing structure, or a cross-section through a rockshelter (see ‘Using the baseline/offset technique to record vertical surfaces’ on page ##). Remember that the scale at which you draw your section will determine how much detail you can include in it (see Appendix 1).

The hardest part of drawing a section is deciding where one layer or context ends and the next begins and in many ways this is in the eye of the beholder (although these are also the interfaces of the Harris Matrix system, so are important in their own right). An excavator with more experience will have less trouble with section interpretation and drawing because they are more accustomed to recognising features, but it also helps if you excavated that trench or part of it yourself, since you will remember particular characteristics of the soil and different layers that will help you to interpret the section. Sometimes, lightly wetting the profile with water from a hand sprayer will bring out distinctions in soil colour, but another way around this problem is to use different symbols to identify a distinct boundary (i.e. one you are sure about) as opposed to an indistinct or uncertain one. While there are standard systems of symbols for drawing different materials and textures, it is difficult to achieve a uniform system because sites and their contents vary so widely (Adkins and Adkins 1989: 74). We have, however, made some suggestions for standardisation in Figure 8.7, which can, of course, be adapted. We also recommend that all projects should adopt or develop appropriate conventions to ensure that sections are illustrated consistently.

Figure 8.7: Conventions for drawing archaeological sections

You can draw a section either cumulatively—that is, as each context is excavated—or at the end once all excavation is complete. If you draw your section cumulatively, make sure that you include all the necessary coordinates to
allow the individual drawings to be fitted back together later. In many ways this is less desirable than drawing the section at the end, although if you wait until the completion of excavation you will probably have to refer back to your excavation notes to know which contexts you are seeing and drawing in the section. A certain amount of annotation will be necessary to make your section drawings intelligible to someone else, but try not to reproduce all of the information from the context or excavation recording sheets.

**Drawing vertical surfaces (sections) by hand**

When drawing vertical surfaces:

- Set up a horizontal baseline across a suitable part of the section—either at the top if it is a small section, or halfway down if it is a large section. To do this, first set out the baseline using a piece of string secured firmly to two nails. These can be inserted into the corners of the section if you are drawing a trench profile, or into cracks in the masonry if you are drawing a wall. Use a builders’ line level to make sure that the string is horizontal. Once you have established this, fix a tape measure to the string baseline with clothes pegs.

- Draw the datum line lightly on to your graph paper or drawing film as a horizontal line parallel near the top and mark the gradations of the tape measure on to it. Remember to place this appropriately on your page (i.e. at the top if your baseline is at the top, in the middle if your baseline is in the middle and so forth).

- As with all plans, move from the whole to the parts. Begin by drawing the gross elements, such as the limits of the section or wall, the level of the topsoil and the base of the trench, by taking offset measurements above and below the baseline.
• Once you have established the boundaries, begin on the details, such as the layer boundaries and individual features. If you are drawing an excavation trench you may have to go back and forth between your drawing and the trench notes, context sheets or other recording forms to make sure that you have captured all of the information.

• Remember that it is OK to draw in some smaller features, or fill in some details, by eye. As you gain experience this will become much easier to do.

• Clearly label your drawing with the site name, date, scale, your full name and the full names of anyone who has taken measurements for you.

**Tips for drawing a trench profile (section)**

• Make sure that you label each excavated context which appears in the section with its correct context number (if represented according to the Harris Matrix system this is indicated by the context number written inside a square (see 'Interpreting stratigraphy—The Harris Matrix' below).

• If the four sections of a trench are to be drawn on the one sheet, then draw them in the order of north, south, east and west.

• If you are excavating a large and complex site, you can secure an aluminium tag clearly showing the unit number to the trench section as the surface of each new unit is identified. This will help you later when drawing up the sections.

**Interpreting stratigraphy—The Harris Matrix**

Current archaeological analysis does not rely solely on drawn sections for interpretation. A Harris Matrix is commonly used to make sense of archaeological stratigraphy, although there are debated alternatives (see, for example, Brown and Harris 1993). Harris Matrices work best for the kind of deposits for which they were developed (i.e. complex historical archaeological
sites with structures). They are not necessarily very useful for pre-contact Indigenous sites, as these tend not to have the same kinds of depositional complexity.

A Harris Matrix makes it possible to represent a complete 3D stratigraphic sequence for a site in a 2D diagram. Its great virtue is that it enables all contexts excavated at a site to be shown simultaneously, not just those which appear in the trench walls (research has indicated that up to 40 per cent of recorded contexts will not show up in any section because their spread does not extend to the trench walls [Bibby 1993: 108]). According to Harris, there are only three stratigraphic events which are possible on a site (Brown and Harris 1993: 10):

- **Deposits** (a layer, which can be either natural or cultural, horizontal or vertical [i.e. a structure such as a wall]). A deposit is the result of any event that placed evidence at a site, such as layers of debris, a flood event, or the construction of a wall.

- **Interfaces** between one context and the next (i.e. the ‘skins’ or surfaces of a context). These can be either horizontal (i.e. the top surface of one unit and the under surface of the next) or vertical (i.e. the walls of a pit or a layer of whitewash on a wall), but are essentially the surfaces that people live on, relate to or use in some way. The floor of a house, for example, or the yard around it, are horizontal interfaces—deposits may exist below them and may well be deposited on top of them, but the human activity takes place on the surfaces. Harris makes the crucial point that an interface can be lived on or used for a considerable period of time even though it has no depth—thus many interfaces ‘represent more passage of time than do the innards of deposits’ (Brown and Harris 1993: 18).

- **Cuts**, such as pits, trenches, wells, graves, etc., which are dug through earlier layers and that can be defined as stratigraphic units in their own right. A ‘cut’ is essentially something which has happened on the site to
remove evidence, rather than deposit it. It is therefore a ‘negative’ feature, but it is important to record it in the same way as you would a ‘positive’ feature.

This means that, at the time of excavation, a decision must be made as to the nature of each context: is it a cut, an interface (which may or may not be the same thing), or a cultural or natural deposit?

There is no room here to include all of the interpretive information which can be encoded into a Harris Matrix, or to explore the various alternative schemas which have been developed in response to its perceived flaws. We have simply included the basic principles of the Harris Matrix as one means of attempting to define relationships between the different elements that constitute an archaeological site. A Harris Matrix is best produced as excavation progresses and each context must be added to the matrix at the time of its excavation. This is the only time that inconsistencies or unclear relationships between contexts can be sorted out through further excavation/investigation if necessary. Interpreting stratigraphy is rarely straightforward, and you should never assume that you will be able to remember stratigraphic relationships between units later. If you are working on a large site you may only be excavating a small part of the total sequence anyway, so your observations of how elements relate to each other will be vital to the overall understanding of the site.

The basis of the Matrix is very simple: a number, always written or drawn inside a rectangular box, is assigned to each context or unit. Horizontal and vertical relationships between contexts are represented by horizontal or vertical lines drawn between boxes to represent the sequence. There are only three possible chronological relationships between any two contexts (see Figure 8.8 on page ##).

**Figure 8.8: The stratigraphic relationships of a Harris matrix**
The elegance of the Harris Matrix is that it reduces all possible forms of stratigraphic connections to one of these three relationships and then uses these relationships to build a complete chronological sequence for the site. You can combine these three stratigraphic relationships in a variety of ways (see Figure 8.9).

![INSERT FIGURE 8.9 HERE]

**Figure 8.9: Representing stratigraphic relationships in a Harris matrix (after Brown and Harris 1993)**

When establishing matrix sequences:

- First, look for correlations *across* the sequence (i.e. horizontal correlations). This means looking for deposits which are of the same date, or for deposits which may once have been part of a single continuous unit, but which have since been cut by later intrusions (Relationship B). This last point is quite difficult to do and direct correlations between units must be inferred with care. It is for this reason that Harris Matrices can only be produced as excavation progresses, as decisions about where each context fits within the overall sequence will often be based on similarities or dissimilarities between physical characteristics (colour, texture, inclusions, etc.), surface level, or the nature or date of recovered artefacts. The physical characteristics of the units in question will probably be the best guide as to whether or not two units are linked. This is one of the key reasons that it is imperative to record all descriptive information about excavation units using consistent terminology (see ‘Describing deposits’ on page ##).

- Second, decide on the associations of successive units (i.e. vertical correlations). This means deciding on the sequence of deposition for the site—what is above or below each context (Relationship A)?
• Where a stratigraphic sequence exists, it makes sense to interpret it from the earliest elements upwards in the same order in which it has developed (Roskams 2001: 247).

Constant use by archaeologists has amended the basic Harris Matrix in many ways to depict a wide range of complementary information. By altering the form of the lines between boxes, the shape of the boxes or their relative positions, a matrix can be made to depict the strengths of linkages between strata, different types of debris resulting from different activities, relative or absolute periods of time, and even construction sequences for standing structures (see ‘Recording standing structures’ on page ##).

Figure 8.10: The basic principles of the Harris matrix can be adapted to record a wide variety of complementary information (after Brown and Harris 1993)

Using a trowel and brush

You use a trowel both to define the extent of a deposit and to remove it to expose the underlying layers. The nature of the deposit (its texture and consistency) will determine the most appropriate trowelling techniques. The main decision you will have to make is whether to use the point or the edge of the trowel to remove the soil. This will really depend on the depth of the layer, how compacted the soil is and how large or fragile are the artefacts contained within it. If the deposit is loose or sandy, for example, then it is probably easier to scrape the soil away with the edge of the trowel; if it is hard and compacted, then the only option may be to try and break it up carefully with the point of the trowel (but never by stabbing the trowel at it!). On the other hand, if you’re excavating a site containing relatively large and fragile artefacts (such as mollusc shells), then
removing the deposit in ‘chunks’ rather than scraping it away and risking slicing through the fragile organics may be your best option. [[INSERT FIGURE 8.11 HERE]]

Figure 8.11: Use the edge of the trowel to pull sediment towards you and onto the dustpan. Any fragile or delicate artefacts will require the use of more careful techniques, such as brushing or excavating with precise tools, to avoid damage.

Other essential archaeological items are a brush and a bucket. Some archaeologists use brushes to clean the soil from delicate or fragile finds and to tidy up the base of each soil layer after it has been excavated and before it is photographed (see ‘Photographing excavations’ on page ##). Small brushes and excavation tools (such as dental picks or plasterer’s tools) are best for excavating in small cavities. If you come across a discolouration in the soil or other unusual feature, it may be best to brush this down with a hand-held brush until you can determine what it might be, rather than to keep trowelling and run the risk of damaging it. Soft, hair-bristle brushes (like those used for typical household cleaning) are best for sweeping up loose dirt. Check first before you use a brush on an excavation, though, since they can sometimes blur subtle variations in the colour or texture of soil that may reveal features and this might upset the site director! Once you have filled your bucket, you will need to sieve the contents. As the sieves may be located some distance from the actual trenches, make sure that you do not make the bucket too heavy to carry (see ‘Sieving and sorting’ on page ##).

As the excavator, a careful approach to excavation will ensure that underlying or adjacent contexts are not cut into prematurely, thus destroying any opportunity to observe vital relationships between them. In essence, your job is to remove the uppermost layer only until something different appears. This is simple to say, but not always easy to do. Some differences between contexts will be very subtle (such as when one area of soil has a different texture or particle size
to other areas around it); others will be readily apparent (such as a layer of fill which is a different colour and composition to that underneath it). There is no easy answer here, and being able to distinguish between different contexts will largely be a matter of experience. Sometimes you can literally ‘feel’ the difference if one area is harder or easier to dig than those around it. *As a general rule, whenever you encounter any noticeable change in the soil (colour, texture, compaction, inclusions), stop and assess the situation carefully before you proceed.* If you find you’ve made a mistake (and cut too deeply for example, or removed the beginning of the layer below without realising it) the best response is to stop and record the situation fully (with drawings and notes). The most important thing to remember when excavating is always to work systematically. The best advice is to go slowly and methodically, and always ask for advice if you are unsure.

You should be aware by now of the necessity for archaeologists to control the excavation process. One of the many ways in which they do this is by trying to keep their trenches as square (or rectilinear) as possible. Obviously if the wall of a trench has been undercut (i.e. if it slopes away from the excavator, into the adjoining area), then any artefacts which are recovered from that undercut zone by rights come from the next square. One of the main aims of good excavation, therefore, is to keep the walls of your trench vertical (which is much easier to say than to do). If you’re excavating many small contexts, you don’t need to be too pedantic in keeping your walls absolutely vertical; they can be trimmed in a single operation before photographing the trench at the end of each context. Note that you may or may not have a flat floor to your trench—if you are excavating stratigraphically then you will be following the contours of various deposits or features, and so your floor will also follow these contours; if you are excavating in arbitrary levels, however, you will keep a flat floor in order to ensure that each context is removed to the appropriate depth. Remember to
keep the soil from the trimmings and any artefacts it contains separate from the other contexts. You have no way of knowing whether that soil and those artefacts came from the top of the trench, the middle or the base—all you know is that they came from the trench wall.

Figure 8.12: The best way to ensure that the sides of your trench are kept vertical is to stand or kneel directly above them and trim from the top down. It is easy to undercut the walls if you try and trim them with the wall in front of you since you can’t see whether you are cutting truly vertically or not

Excavation etiquette

- Check with the excavator before stepping into a trench or on to an exposed area of soil.
- Never undercut a trench wall, even if you can see an interesting artefact in the wall of the trench.
- Never pull an artefact, stone or other feature out of the wall of the trench.
- Never pull an object out of the ground. Excavate around it across the square until you have reached its base and then remove it in one piece.
- If a fragile object or unusual feature is uncovered, leave it in place (in situ) until the area is completely excavated and the object can be removed carefully in its proper stratigraphic context. This may require specialist techniques, so ask for advice if you are unsure.
- When working in a rockshelter or underfloor in a house, avoid wearing boots with deep tread or walking too much on the surface of these deposits. The deposits built up in these places are often very fine and silty, which means that artefacts are easily displaced (i.e. moved downwards in the deposit) by any pressure. Tennis shoes or other sturdy footwear with fine tread is best, although you may be asked to work barefoot and/or prevented from walking or standing on some areas of the site.
• Don't walk on newly excavated areas (particularly someone else's!) unless it is absolutely unavoidable (i.e. if you need to clean up that area prior to photographing or drawing it). Sometimes this will mean taking the long way around.
• When you're excavating, always move backwards across the trench to avoid kneeling on the freshly excavated surface.
• If weeds or roots are present, cut them with secateurs—don't pull them.
• Don't trip over the string or the pegs or disturb them in any way during excavation—this is easier said than done! It can be helpful to place sandbags around pegs or tie flagging tape to them to make them easier to see.
• Never step too close to the edge of a trench, as you may run the risk of collapsing the wall. If you're excavating in a deep trench, get someone to help you in and out, so that neither of you puts your full weight on the edge of the trench.
• Never sit on the edge of a trench (for the same reason).
• Be willing to take your turn at a variety of tasks. Excavation requires sieving, sorting, cleaning and backfilling as well as actual digging, and no one wants to be restricted to one task all the time.
• Different people have different physical tolerances and may work at different paces, so be patient if someone works more slowly than you do, or needs more guidance than you do.
• If you're a trench or site supervisor, be supportive in the way you provide advice to people who are learning to excavate. Remember that some people will need more specific instructions (or repeated instructions) than others.
• If you're supervising other workers, make sure that you brief them as fully as possible before the excavation begins. Make clear what your aims
are and what you want to know and explain why you are doing it in a particular way. This will help them to understand the importance of following particular procedures and guide them in terms of what to look for. Update these briefings regularly so that no one feels lost or confused (and see the point immediately above).

- Most importantly, fieldwork is a job, not a holiday, so if you’re part of a team make sure you’re always on time and promptly back at work after breaks.

Val Attenbrow’s tips for excavating shell middens

- Identify stratification and excavate accordingly. Shell middens vary widely in size, composition and complexity. They range from deposits which are homogeneous throughout to deposits which are finely stratified and may contain, for example, hearths, lenses of specific shell species and/or tool manufacturing events, as well as animal bones and stone artefacts. Excavation should proceed in a manner that ensures any stratification is identified so that excavation units can reflect stratigraphic boundaries.

- Where a midden appears to be homogeneous, excavators still need to take account of how the deposits may have accumulated—for instance, whether there is a slope in the particular areas being excavated. If the surface of the midden (or an exposed face) suggests materials accumulated on a sloping surface, then the orientation of excavation units should not be horizontal but on a slope that approximates the way the deposits accumulated. This will prevent excavation units from cross-cutting any ‘layers’, even if they are not visible during excavation.

- Choose the most appropriate sieve mesh size. If the midden is composed mostly of whole shells, then a 5 mm mesh may be sufficient, unless numerous small (less than 5 mm) species are also present. Where stone artefacts are present and fish bones are abundant, then nested 5 mm and 2 mm sieves are recommended, although the shell
analysis to identify species composition may be based on materials retained in only the 5 mm sieve. In deposits where fish bone is present but sparse, the addition of a sieve with 1 mm mesh may be necessary to recover the bones. Depending on the species, the addition of a 1 mm sieve where fish bones are abundant may enable more bone to be recovered (i.e. more fragments, greater weight), but it may not necessarily enable a greater number of species to be identified.

- Look for shell tools and manufacturing debris. It is often the case that only samples of the shell component of middens are analysed to determine the species composition; sometimes ‘excess’ shell is discarded in the field. In such situations, these deposits should be inspected prior to discard for any shells that may have been used as tools or for shell that is the debris from the manufacture of shell tools. Both bivalves and gastropods were used as scrapers and cutting implements—for example, in processing plant foods—and were also used as adzes to make wooden artefacts. In addition, along the eastern coast of Australia, shell fish-hooks were made from oval pieces cut from turbo shells. These ‘blanks’ may also be present, along with whole and/or broken hooks.

- Make a reference collection. Make a collection of whole shells of all visible species, large and small, from the shoreline adjacent to the excavated midden. This can be used as a reference collection to aid in the identification of midden species. Collect several specimens of each species, particularly gastropods, so that some can be broken up to examine the internal surfaces and shape of the column. If an analysis of meat weights and so on is to be carried out, collect live specimens. Bivalves and gastropods will stay alive for some weeks or can be put into preservative to keep them longer.

**Martha Joukowsky’s tips for excellent excavating**

- Don’t hurry. Excavation requires a calm and purposeful approach.
- Remember that all excavation proceeds horizontally first and vertically second.
• Be systematic. When a new layer or anything unusual is encountered, stop. Clean off the remaining soil so that none of the material from one layer will be mixed with the one below it.

• All grid units should be excavated in the same direction.

• Ideally, excavation should proceed from the uphill side of the trench to the downhill side, so that newly excavated areas won’t be trampled.

• For the same reasons, always clean higher surfaces before lower ones.

• Always keep the trench wall swept clean so that the area being excavated is not contaminated by falling dirt or debris.

• Always clean the top of the trench by moving the dirt back from its edges, so that the dirt doesn’t fall into the trench and contaminate other layers.

• Always keep the trench walls vertical by cutting sharp right-angled corners at the bottom and by regularly trimming the walls as you go along to ensure they are kept straight. Do this from above so that you don’t risk undercutting.

• Don’t wait until the earth dries out before you trim the walls, as there is greater risk of a cave-in when the earth is dry.

• Keep the wall trimmings separate to the material excavated from the body of the trench.

• Always be on the lookout for soil discolouration around features. This could be an important clue to interpreting those features.

• Make sure you record sterile layers in the same way as other layers.

• Make sure you record all descriptive information as objectively as possible.

• Don’t swing tools (such as picks, mattocks and shovels) higher than your shoulder. Don’t cut too deeply with them either, as you may damage buried artefacts.

• Only fill buckets two-thirds full. Soil, particularly if it has a high clay content, can be very heavy. (Joukowsky 1980: 172–5)
Sieving and sorting

Most artefacts from sites are not recovered during the process of excavation, but in the subsequent process of sieving the excavated soil. In the interests of stratigraphic control, it is important to sieve each excavated soil layer separately and to keep all artefacts and samples from each layer distinct through careful labelling and bagging. Never allow your bucket of excavated soil to become mixed with buckets from another grid unit or layer—and never allow the artefacts you recover from your bucket to become mixed with others unless they all come from the same context and will be bagged together anyway.

Most sieving is done by hand (i.e. by emptying your bucket into a hand-held sieve, shaking it to remove the loose soil, and then sorting through the material trapped in the sieve for artefacts). This is one of the most time-consuming jobs on site, and is usually where a backlog will build up if there are not enough sieves or sievers. For this reason, make sure that you have enough to keep the process moving. Think through how many people will be excavating at any time, and make sure that you have enough people in your team to have at least one siever per excavator. If the deposit being excavated takes a lot of work to sieve (e.g. clay soil, or where it is very poorly sorted) then you may need more sievers. On some large sites, it may be possible to use mechanical sieves to speed the process, although you will still need the same amount of time to sort through the sieved material for artefacts. Hand-held sieves come in a variety of mesh sizes (1, 2, 3, 4 or 10 mm are all standard), and can be ‘nested’ together (i.e. with one fitted over another) so that you can sieve through two sizes simultaneously. When using nested sieves, always remember that the larger mesh size fits over the smaller one.

Figure 8.13: Hand sieving

Figure 8.14: Sorting through sieved material
The decision of which mesh sizes to use will depend on the nature of your site and what questions you want answered. A small mesh size will obviously make a big difference to excavating a shell midden or rockshelter which may contain many small and delicate bones, but may be redundant on an historical site containing relatively large fragments of glass and ceramic. If, however, an historical site contains small beads or other artefacts then you need to choose a sieve size that will capture those materials. For sites with plant and bone material that needs to be recovered, research indicates that sieving down to 2 mm will provide a good indication of the fish and small mammal species present, but the full recovery of fish and small mammal bones will require a 0.5 mm or 1 mm mesh size (Zohar and Belmaker 2005). To recover this kind of small fraction from excavated soil, however, requires alternative techniques, such as flotation, a form of wet sieving that uses water to float lighter plant and bone materials to the surface before ‘straining’ them (putting them through a very fine mesh). It is an excellent means to recover small bones and macro floral remains, such as seeds, charcoal, wood or other plant parts if this is important to your project.

Wet sieving may be the most appropriate method to use on other sites as well, albeit for different reasons. On sites with high clay content soils, for example, it may be the only way to retrieve artefacts. Immersing hand sieves containing excavated material into large containers of water can sometimes be effective, although at some sites a pressurised stream of water may be necessary to break down the soil and reveal artefacts. The trade-off is that wet sieving will be a much more labour intensive process, so you will need to factor in the extra time required. All artefacts removed during wet sieving will have to be allowed to dry completely before they are bagged.

The other major decision in relation to sieving is where to sieve. This may sound trivial but, as all of the soil that goes through the sieves will ultimately have to be put back into the trenches, you should consider very carefully where
to place it. Sieve piles can become very large very rapidly, and have a habit of spreading widely at the base, particularly if people continually walk on them. When deciding where to place your spoil heaps:

- Use flat ground not too far from the trenches. (Think how far you can expect people to regularly carry heavy buckets of soil. Making sure that the spoil heaps are as near as possible to the trenches will also help you when you have to backfill.)
- Think about whether or not you will have to clear the ground surface of vegetation first to ensure that you don’t lose any soil.
- Think carefully about where you’re likely to excavate, particularly in terms of allowing yourself the option of extending trenches. In other words, don’t place your spoil heaps where you may later want to dig a trench.

Once you’ve removed all the artefacts from the sieve, they will have to be bagged and labelled to keep track of them. The precise system for tracking and labelling artefacts will depend on the preferences of the excavator or site supervisor, but as a general principle all artefacts will be grouped together by context/stratigraphic unit and placed in clearly labelled finds trays or bags. Any special finds which require immediate conservation should be bagged and labelled separately, and treated immediately (see ‘Managing excavated materials’ and ‘Labelling and bagging finds and samples’ on page ##). For detailed information on recommended conservation treatments for excavated materials, see Museum of London (1990) and Watkinson and Neal (1998).
Mike Morwood’s tips for protecting rock art when excavating

Because dust is highly abrasive, it can be extremely damaging to painted rock art panels, particularly in the confined space of a rockshelter. To reduce dust during the excavation process:

- Place a screen or curtain (calico is suitable) between the excavation area and the art surface and leave a gap of at least 30 cm between the screen and the rock art surface to allow the air to circulate.
- ‘Carpet’ the ground surface of the shelter or place wooden planks parallel to the edges of the excavation area to reduce dust stirred by traffic.
- Because sieving is the greatest generator of dust, place the sieves on plastic sheeting and contain the spoil heaps on this sheeting.
- Sieve downwind of the rockshelter, erect a screen between the sieving area and the general excavation area, and place calico ‘skirts’ around the base of the sieves.
- During backfilling, place the spoil into hessian or plastic bags and stack the bags in the trenches. Complete the backfilling by placing a layer of dirt over the bags. (Morwood 1994: 10–12)

Sorting

Sometimes artefacts will be sorted into different classes on-site (e.g. glass, ceramics, bone, metal, etc.) before being bagged but, once again, the complexity of this will depend on the size of the site, the number of workers and the preferences of the excavator. If you can, get as much as possible of the basic processing (cleaning, washing, gross sorting) done on site. Remember that for every day you spend in the field, whether surveying or excavating, you should ideally allow three days in the lab or office to process and another three to write up the results—longer if both are necessary (i.e. if you first have to analyse the artefacts and then write up the report).
When cleaning artefacts, it is always best to take a gentle approach. Ceramics, glass and stone artefacts can be cleaned with a soft toothbrush and water (Drewett 1999: 145). Other materials, such as metal, bone or shell, are often highly friable and shouldn’t be washed unless it is obvious they won’t be damaged. Most metals are unstable and will deteriorate rapidly when exposed to air or moisture. You should use only a dry brush to clean these kinds of fragile materials. Bear in mind, when excavating stone artefacts, that washing will remove any potential residues from the surface of the artefact (see ‘Recovering artefacts with residues and use-wear’ on page ##). If you are worried about damaging any fragile or unusual artefacts, then store them responsibly (see ‘Managing excavated materials’ on page ##) and seek professional advice before you clean them. When cleaning, make sure you keep the overall excavation recording system intact. In other words, clean each bag of artefacts separately and make sure that every artefact goes back into the labelled bag from which it came. Never separate the contents of any bag from its label or context identifier.

**Labelling and bagging finds and samples**

The labels which you attach to artefacts or samples need to be durable and legible for a very long time: archaeological artefacts are of little value if there is no record of their origin. Paper and card labels are not widely recommended, because they deteriorate easily; instead, the most durable labels are made from plastic (Tyvek™) and aluminium. When you write on these labels you should use permanent pigment-based markers so that the writing is as durable as the labels themselves. You can also use basic black ballpoint biros because, although their ink is less permanent, writing with the pen will make an indelible impression in the surface of the label which can still be read even if the ink has faded. This is
particularly useful for aluminium labels. When labelling a find or a sample be sure to include:

- the name of the site, or the site prefix;
- the excavation trench from which the object came;
- the context or layer from which the object came;
- the date; and
- a basic description of the contents (e.g. glass, metal, soil sample).

Keep in mind that when using aluminium labels, coarse or heavy materials such as shells, stones and so on can flatten the impression left by the pen and can make labels difficult if not impossible to read. If sampling such materials, take out some insurance in the form of additional labels and attach one to the outside of the bag, one in with the sample itself and—if you are double bagging (see below)—another in the space between the sample bag and the protective bag. Also, write the label on the exterior of the bag with a permanent marker. This may seem excessive, but an unlabelled sample can be a source of much frustration later; furthermore, the sample effectively has no context and can be difficult if not impossible to integrate into your analyses. Careful record keeping can help to minimise the impact of lost labels. We recommend that excavation directors create and maintain an inventory of all samples retained in the field so that a quick cross-check can be made in the event that there is a problem caused by mislabelling in the field, or as a result of a lost or damaged label. It also provides an opportunity for careful checking of field labelling practices as samples are being created. It is very easy to mislabel bags in the field!

Bags are another important consideration. If you are only taking light samples (e.g. a small amount of sediment or a few artefacts per bag), then light bags will suffice—and even plastic sandwich bags can be durable enough. If, however, you are taking bulk samples for later analysis then it is essential that
you purchase heavy duty bags. The most versatile and reliable sample bags are those that are made of strong plastic with a robust clip seal mechanism and are specifically designed as sample bags for sediments. These can be purchased from geological or earth science suppliers. Avoid using cheaper, lighter bags as these have a high failure rate and will often split at the sides or along the seal. Take a variety of bag sizes with you, including small bags for special finds and small samples, as well as medium and larger bags to cover the full variety of sampling work you are likely to do. In addition, bubble wrap, aluminium foil, tissue paper, small finds boxes or other similar packing materials can be very useful if you expect to recover fragile items such as complete glass or ceramic artefacts, fragile metal, bone and so on. When bagging small samples, a single bag should suffice: simply add labels, remove all air, and seal. Additional care is required where excavated sediments are being transported in bulk and in such cases double- or even triple-bagging is mandatory; that is, each bag should be placed in a bag of the same size so that if the bag holding the sample breaks, the other should be enough to contain any spillage. Where materials are being transported long distance, it is good practice to place bagged samples from the same context or feature into a larger bag or even boxes. These should also be labelled, with a list of samples contained in each bag noted on the sample inventory—down to the level of individual sample bags. Above all, this can help with finding small samples later and also allows you to quickly organise your samples into a more meaningful order when you return to the laboratory and begin your analysis.

**Photographing excavations**

An accurate photographic recording of archaeological excavations is essential and it is equally important to take photographs before, during and after
excavation. In more general terms, you need to think of the many purposes to which archaeological photographs can be put.

You should take each of the following:

- An establishing shot, taken with a wide-angle lens, that shows how the area to be excavated fits into its surroundings.
- A 'before' series of shots that records the excavation area before it is disturbed.
- Overall shots of people in action. This can give a vivid impression of the excavation process.
- Full-face portraits of people in action. Try to get candid shots of people performing routine activities, such as trowelling and sieving. The best technique here is to take lots of photographs.
- Shots of sponsors or visitors to the site, which may be used subsequently for publicity purposes.
- Close-ups of special finds, which should be photographed in situ. Bear in mind depth of field and make certain that all of the object is in focus.
- Close-ups of individual features as they are exposed.
- Individual photographs of the spatial association between artefacts.
- Individual photographs of each context or unit once it has been excavated, recording the particular surface characteristics of each unit. These should include both vertical and horizontal faces (i.e. separate shots of the walls and floor of the trench). They should be taken after the walls have been straightened and the surface tidied and brushed clean, and there should be no extraneous objects or material in or beside the trench to intrude on the photograph (see ‘Recording sections’ on page ## and ‘Tips for taking good archaeological photographs’ on page ##).
• An ‘after’ series of shots which records the excavation area once work is complete, but before the site is backfilled.

• When taking shots of successive levels in an excavation unit or trench, make sure that all of them are oriented in the same direction. In other words, if the first photograph of the excavation unit is taken facing north, then all subsequent shots documenting the excavation of that square must also be taken facing north, so that the complete series of photos can easily be compared. Obviously, if you are also taking individual shots of particular features within the unit, these can be taken from any angle. To avoid problems of distortion when photographing whole excavation units, you should try to keep the plane of the camera (i.e. its back) parallel to the ground surface. This may mean elevating the camera above the site so that the photograph can be taken looking down (see 'Do it yourself aerial imagery' on page ##).

**Photogrammetry and excavations**

Photographs taken from the ground can be used to create various kinds of photogrammetric models of a site during an excavation (see 'Photogrammetry' on page ##). For instance, it may be useful to create an orthophoto of the entire site’s surface prior to excavation or an interactive 3D model of how the site looked before you disturbed it via excavation. Additionally, you could take photos in order to create photogrammetric models of entire trenches, exposed sections or features that are revealed and then removed as the excavation proceeds. This takes relatively little time to do and should be seriously considered for all excavations—particularly as software for processing photographs becomes more accessible to non-specialists. If you are considering taking photos for photogrammetric post-processing later, talk to an archaeologist with experience in post-processing photogrammetric models.
before heading to the field as there are some important considerations that need to be made. As a general rule, follow these guidelines:

• The amount of light needs to be controlled as it does in any technical (archaeological) photograph (see Chapter 7).
• Photos need to be taken with approximately 60 to 80 per cent overlap (that is, photo A will overlap with 60 to 80 per cent of photo B).
• Take all photos at the same focal length and at the same distance from the subject.
• Include a north arrow with a scale that you photograph.

For a standard trench, we have found that photographs taken with a 50 mm prime lens at 50 cm intervals around the trench edge, with the camera position set back from the edge by approximately 50–100 cm will produce a good result. If the trench is deeper than 30–50 cm, it will be necessary to take images from both near to ground level and from a standing position so as to capture the trench walls and floor. All images should aim to capture the part of the trench that is at right angles to the trench edge closest to each camera position.

**Tips for photographing excavations**

• It is better to take photos in low light, in the morning or afternoon, so that there is consistent shade across the entire feature being photographed. Some of the most difficult photographs to take are where there is a stark contrast between an area that is shaded and an area that is very brightly lit (see ‘Tips for taking good archaeological photographs’ on page ##). This is not always an option when photographing contexts or features exposed during excavation, as these often need to be photographed quickly so that work can continue so you will have to do your best to maximise your chance for photography at these times.
• If you have problems with contrasting light causing parts of your photos to be over- or under-exposed (e.g. shadows in deep trenches, or bright sun on one corner of a section) try using a reflector or diffuser (or both) to make the light more even. Large shade sails or tarpaulins can also be used to cover sites if it is a persistent problem (and, if it’s hot, the shade will be appreciated!).

• If the stratigraphy is unclear, you can lightly spray the walls with water. This will darken the earth and can highlight differences in soil colour. In fact, at some sites differential drying is the best way to record important stratigraphic boundaries. If you do use spraying to enhance stratigraphic resolution, however, this should be recorded in your notes and on the photographic recording form.

• Take close-ups of any areas that are difficult to interpret, such as post holes, as you may want to revisit these features later or rethink your previous assessments.

**Collecting samples in the field**

Archaeologists often collect samples of materials found during excavation for analysis in the laboratory. This may include samples of charcoal, wood or bone for radiocarbon dating, soil for extracting pollen or seed samples or small flakes of ochre from rock art for dating or determining the source of the ochre. It is not enough, of course, to just collect anything that you like in any way that you like. The best samples are those which are found in situ, are properly described and recorded and which can be linked to archaeologically meaningful features (such as living floors, hearths, specific occupational periods, etc.) (Hester et al. 1997: 323). When collecting samples, you must follow certain procedures to ensure your samples don’t become useless for later analysis. In particular, be aware of:
• the proper methods for collecting different kinds of samples to avoid contamination; and
• the different quantities of each kind of material which will be sufficient for proper analysis.

Collecting to avoid contamination

The major kinds of samples collected by archaeologists are:

• sediments with a high proportion of silica, such as sands, or other suitable minerals, such as quartz, feldspar or zircon, for Optically Stimulated Luminescence (OSL) dating;
• charcoal, for radiocarbon dating;
• sediments for botanical analysis;
• bulk samples of faunal materials; and
• column samples taken from a section for specialised analysis.

Sediment and other samples

It is rarely the case that archaeologists simply collect artefacts when excavating since there is a great deal of information that can be gleaned in the lab via the analysis of samples of sediments. On many Indigenous excavations, archaeologists will routinely take sediment samples including:

• **Bulk samples of sieve residues.** Sometimes, if large proportions of sediment are being retrieved via a small sieve (e.g. 1–2 mm), and retaining all these sediments is seen to be of questionable value, then it can be useful to take a smaller sample of these without any further sorting in the field. Try and be consistent about this in terms of your sample size and detail your approach in your notes (i.e. kept bulk sample of 5 per cent of all 1 mm sieve residues).
• **Context or excavation unit samples.** These include taking a sample of what was excavated in a particular context or excavation unit prior to sieving or any other form of sampling or sorting taking place.

• **Section samples.** When an excavation is completed and the section has been drawn, some archaeologists will take small samples of each stratigraphic unit drawn. These can be useful to double-check pH, colour, sorting, particle size and so on in the laboratory.

• **Column samples.** These represent a small column, usually 5–25 cm² taken down through an exposed section of the trench at set intervals (e.g. 5 cm deep). Each sample will be excavated and bagged in its entirety. The point of these is to obtain consistently sized sediment samples through the entire section as a basis for various types of analysis in the laboratory (e.g. sediment geochemistry, palaeobotany, soil magnetism and particle size analysis).

On historical excavations, sieve residue samples and section samples are probably the most useful types of sediment sampling to consider, while on Indigenous pre-contact excavations all of these sediment samples might be useful depending on the context. For instance, with a midden excavation, sieve residue and context or excavation unit sampling is essential across all contexts or excavation units. Section samples are valuable for later reference (including beyond the timeframe of your project), while column samples are often used to obtain data for soil geochemistry and particle size analysis.

Take note that some sediment samples intended for specialised analysis will require specific methods for sample collection, storage and transport. It is best to check this for each analytical method that you intend to use, or with the lab where you will be sending your samples.
Luminescence dating

Luminescence dating is the principle method by which archaeologists can directly date the sediments within an archaeological site. Two key techniques are commonly used: Thermoluminescence (TL) and Optically Stimulated Luminescence (OSL). Both techniques work on the principle that grains of certain minerals—namely quartz and feldspar—are dosed with ionizing radiation as a result of the natural radioactivity of sediments within the natural environment, as well as chemical impurities within certain artefacts (e.g. pottery) (Roberts et al. 2015: 42). Quartz is most frequently used for luminescence dating, since this mineral has a crystalline structure with small defects that can trap electrons being generated by this low-level ionizing radiation. This radiation is emitted at a relatively constant rate and so these mineral grains also tend to accumulate luminescence at a constant rate (Liritzis et al. 2013: 2).

Early research in the 1960s showed that heating of pottery and other distinct cultural features (such as fireplaces or burnt sediments) and the production of ceramics (which necessarily involves heating) effectively ‘resets’ this store of electrons to zero. Once cooled, the newly-cleared electron traps were found to recommence electron accumulation at a constant rate. With further research it was found that exposure to light also reset this electron trap, which significantly expanded the range of contexts which could be dated via thermoluminescence dating, extending the method to sediments found in many natural and archaeological settings (Roberts et al. 2015: 42).

Thermoluminescence dating methods involve heating samples in the laboratory and measuring the degree of luminescence (or light) emitted. Because electrons have accumulated at a constant rate, it becomes possible to estimate to a high degree of precision the time that has elapsed since the electron traps had been last ‘reset’. As Roberts et al. (2015: 42) observe, this method was quickly
adopted by archaeologists seeking to date heated materials containing quartz mineral grains, such as ceramics and burnt pottery (Roberts et al. 2015: 42).

**Optically Stimulated Luminescence** came about as a result of advances through the 1980s that demonstrated that optical stimulation (that is, visible light at a specific wavelength) could also be used to release trapped electrons—hence, the technique’s name (Liritzis et al. 2013: 2). Thus, at a general level, the key difference between both techniques is the way in which luminescence is measured in the laboratory. Both TL and OSL are highly specialised techniques and it is generally the case that archaeologists will collaborate with a researcher who specialises in dating via these methods.

As with many specialised forms of dating and analysis, it is important to talk to specialists well before any planned field trip where you might use these techniques, and there are a number of specialised laboratories in Australia. A very wide range of materials can be directly dated including artefacts that have been fired (e.g. bricks, ceramics and burnt pottery) or burnt (e.g. stone artefacts), as well as sediments that have been exposed to light then buried. Key, of course, is whether the sample contains quartz or other materials able to act as ‘electron traps’. OSL signals in quartz are more stable than those from feldspars, for example, where signals sometimes unexpectedly exhibit instability known as ‘anomalous fading’ (Allen and O’Connell 2014: 88). The OSL technique has been widely used in the Australian context, particularly for dating sites created during pre-contact times.

**Radiocarbon dating**

Radiocarbon dating is used to obtain age estimates (or radiocarbon determinations) for archaeological samples that contain organic carbon. The technique of radiocarbon dating was first developed by researchers at the University of Chicago in the late 1940s and through the 1950s (Taylor and Bar-
Yosef 2014). The technique revolutionised the discipline because it enabled archaeologists to move beyond the constraints of relative chronologies based on artefact form and site stratigraphy, and to begin to develop independent chronologies for archaeological sites (Bronk Ramsey 2008; Taylor and Bar-Yosef 2014; Wood 2015). The technique is very popular within archaeology because organic materials containing carbon are commonly found in archaeological sites, most frequently in the form of charcoal, shell, bone, wood and other vegetative matter (e.g. peat). These and other carbonaceous materials can be dated because they contain radiocarbon ($^{14}\text{C}$), which is produced in the upper atmosphere as a result of complex nuclear reactions between cosmic rays and nitrogen atoms in the air (Bronk Ramsey 2008: 250).

Atmospheric radiocarbon oxidizes to form carbon dioxide which is rapidly mixed through the atmosphere and is absorbed by plants via photosynthesis, which is then incorporated into the tissue of animals when vegetative materials are consumed (Wood 2015: 62). This continues through the life of an organism, and once a plant or animal dies, it ceases absorbing carbon dioxide. This is often referred to as the ‘carbon cycle’ since carbon moves from the atmosphere and on into vegetation, soils and terrestrial organisms, as well as into oceans and bodies of freshwater and into the organisms that live in these environments. Fortunately for archaeologists, the concentrations of $^{14}\text{C}$ has a half life of somewhere around $\sim 5500–6000$ years (Wood 2015: 63), so in effect the amount of $^{14}\text{C}$ halves at a consistent rate until it is largely depleted. Hence, by measuring the amount of radiocarbon $^{14}\text{C}$ remaining in a sample, it becomes possible to determine when the organic material in that sample died. These determinations are generally given as years before present (BP), which is 1950 or the year when radiocarbon dating became established as a sound method. Hence, a radiocarbon date of 500 BP simply means 500 years before present (i.e. before 1950).
The amounts of radiocarbon produced in the atmosphere vary through time, so at different periods in the past there have been different atmospheric concentrations of radiocarbon. This is best evidenced by the significantly increased levels of atmospheric carbon that occur after the 1960s as a result of nuclear testing, which is often referred to as a ‘bomb spike’ because when plotted on a graph, the trendline ‘spikes’ at this time. As a result of these fluctuations, organisms that lived at different times in the past will have accumulated different concentrations of radiocarbon at the time of their death and when samples from these organisms are dated, they will return slightly anomalous dates. This tendency was noted during early testing of the radiocarbon method against samples of a known age, and it was suggested by some that a systematic error was affecting age determinations—though the imprecision of early techniques made it difficult to determine the magnitude of these errors (Taylor and Bar-Yosef 2014: 46). Advances in measurement techniques increased precision and helped to better define these discrepancies.

Dendrochronology, or tree ring dating, has been critical to this process because it has allowed for high-resolution calibration curves to be created against which radiocarbon determinations can be compared. Essentially, because many species of tree grow rings annually, dendrochronologists have been able to create relative chronologies extending back thousands of years by matching rings from different trees to create what are known as tree ring records. This is a very reliable means for estimating the age of tree samples as rings are accurate to the year, therefore providing a robust and independent chronological control (Speer 2010: 162). By obtaining radiocarbon determinations on tree ring samples within a dendrochronological record, it became possible to create calibration curves that plot radiocarbon ages against calendar ages, which highlight the difference between calendar ages (i.e. those based on dendrochronology) and radiocarbon ages (e.g. see Figure 4 in Wood 2015: 66).
Hence, all radiocarbon determinations are given in radiocarbon years, usually as years before present (e.g. 500 BP), which is not the same as calendar years. Where radiocarbon determinations are calibrated against a calibration curve, however, they are in calendar years which are typically referred to as calibrated years before present (e.g. 500 cal. BP).

Another key issue to consider when using radiocarbon dating is the **marine reservoir effect**. This applies to organisms that do not absorb carbon from the atmosphere, and instead obtain it from the ocean, where radiocarbon is mixed with water very slowly as a result of interaction between ocean surfaces and the atmosphere. Where the ocean is very deep, reservoirs of old carbon can accumulate and circulate for much longer than they do in the atmosphere (Bronk Ramsey 2008: 252). The effect of this is that marine organisms such as shellfish and fish will absorb older carbon that is still in circulation in oceanic systems, and when sampled and measured in a laboratory these materials can return quite anomalous age determinations—that is, the sample will seem older than it actually is as a result of the marine reservoir effect. This effect can be corrected by applying a systemic correction factor, derived from global studies of the marine reservoir effect. There are, however, regional variations that need to be further applied to samples that might be influenced by the oceanic circulation patterns in different regions and these need to be taken into account (e.g. see Ulm 2002; Petchey et al. 2013). Also, not all species have the same correction factors, particularly where a species is able to absorb both oceanic and terrestrial carbon (e.g. gastropods that spend much of their lives in the upper intertidal zone).

It is a relatively straightforward process to collect samples for radiocarbon dating and requires only standard excavation equipment. The key requirement, however, is to be sure that you are sampling materials that are likely to be associated with the activity you are trying to date. So, for instance, never use tree
roots as these will be modern and avoid using detrital charcoal (very small fragments of an unknown source) unless you have no other organic material suitable for dating, or you really know what you are doing. Ideally, you should take many more samples than you have funding to process since it is often the case that you or other researchers in the future can use them. The most reliable dates are derived from in situ samples that have been identified and collected while excavating, as the provenance is known and you can take photographs and obtain a coordinate while your sample is in its original context. Removing samples from stratigraphic sections once an excavation is completed can also be useful, as you can obtain samples from key areas such as stratigraphic boundaries or near key cultural features. This depends on the site though, and in some contexts it is difficult enough to find any organic material to date at all—so you can't really be fussy. Finally, sample a range of different materials where possible as comparison of discrepancies between determinations on different materials can be quite revealing. This includes, for example, selecting charcoal, wood or bone, different species of shellfish, or charcoal derived from different features within a specific context. Paired samples can also be useful to obtain, and involve finding samples of different materials that have a very tightly constrained stratigraphic relationship (i.e. touching within a deposit, or within a few centimetres of each other). This is especially the case for marine shellfish, because paired samples (e.g. shell and charcoal, or different species of shell) from secure stratigraphic contexts can help to refine local correction factors (e.g. see Petchey et al. 2013).

Any form of modern carbon can contaminate an archaeological sample. Therefore, you should not use paper or cloth bags to hold samples with your fingers or use cotton wool or tissues as packing materials for samples (Gillespie 1986: 5). The best storage containers are strong polythene bags, aluminium foil and small glass or plastic phials. While you are still in the field, pick out all
obvious foreign matter from your samples (stones, plant roots and leaves, loose soil or sand) and make sure that you have an adequate quantity for analysis. Any organic material can be dated with radiocarbon techniques (Table 8.3), provided you have the correct proportions.

Alice Gorman’s tips for collecting samples for radiocarbon dating

There are two types of radiocarbon (C14) dating: standard radiometric determinations and Accelerator Mass Spectrometry (AMS), which can be used for samples too small for standard dating. AMS costs more than standard dating, however, so contact the lab for the latest prices before you begin. You will need approximately 500 milligrams for a standard radiocarbon date, but only 5–10 milligrams for an AMS radiocarbon date. When collecting samples:

- Handle them as little as possible. In preference, pick them up using the point of the trowel or a pair of tweezers. You can use gloves, but be advised that some forms of disposable gloves contain a dusting of corn flour which, as an organic powder, may contaminate your samples.

- Wrap each sample in aluminium foil and clearly label it, so that it can easily be distinguished. You can place your sample directly into a plastic bag, but make sure you tell the lab what you have done.

- Remember to exclude all modern carbon from your sample, so never include a cardboard or paper label in the bag with your carbon sample. If you must use a cardboard or paper label, double-bag the sample (put the sample inside one bag, seal it, then place the sample and the label inside another sealed plastic bag).

- For advice on sample collection and packaging, contact the laboratory prior to fieldwork commencing.
Sample treatment

- Samples should be dry, as bacterial activity in wet samples can affect the final age determination. If you must dry out your sample, use a low-temperature oven which has never been used for radioisotope experiments. Cover the samples lightly with perforated foil and heat at a temperature of at least 40°C until dry.

- Record details of any treatment, such as drying, to submit with the sample.

Documentation

- It is important to have full documentation for all samples. Much of this information is routinely recorded for any archaeological project, but some laboratories have specific requirements, so check with them before collection. The kinds of information needed may include:
  - **Collection**: date, sample weight, grid references, latitude and longitude, depth of sample and stratigraphic position, stratigraphic relationship to other samples submitted. Was the sample sealed in a recognisable horizon, or sealed in a localised feature such as a grave or pit? How secure is the stratigraphic context? Was the sample wet or dry when collected? Can any more material be collected? Did the sample come from a surface or excavated deposit?
  - **Treatment and storage**: if the sample was wet, how was it dried, did you use any chemical treatments or preservatives, was the sample cleaned?
  - **Estimated age**: this helps the lab to select the appropriate instrument for measurement as well as enabling them to contact you at an early stage if the estimated age seems to be significantly different from the measured age.
  - **Environment**: geological, archaeological, palaeoenvironmental, associated cultural, palaeobotanical or other material; perhaps also site sketches and photographs.
  - **Taphonomy**, or how the sample got to where you found it: the factors that are relevant here are other, natural, activities which may have affected the carbon content of your sample, such as visible root penetration in the collection area, evidence of leaching or humus penetration in the soil profile, etc.
  - **Contamination**: any other carbonaceous material in the horizon, such as calcium carbonate (CaCO$_3$)-bearing rocks in the catchment, potential sources of non-contemporaneous carbon, etc.
Nature of the sample: for shells, for example, note whether they are marine or freshwater; note the family/genus/species if known for wood, charcoal, shell, seeds, etc.; note the type of bone, e.g. femur.

Submission

- Most labs have online submission forms. If you are sending samples overseas, there may be customs regulations you have to follow.
- Make sure you keep copies of all of your submission forms, in case anything is lost or needs to be checked.
- Turn-around times vary from four to six weeks to a few months, so check before you send your samples in.
- Some sample types require additional pre-treatments to remove contamination, such as dilute acid/alkali treatment for decomposed wood and charcoal, or for peat and lake sediments. Check the website and be aware that you may need to include the cost of pre-treatments in your budget.

For other organic samples (such as bone or shell)

- When submitting shells, clean off all soil, sand and debris and air-dry the samples prior to packaging.
- Cleaning should only be done with a brass, steel or nylon brush. Never use animal-bristle brushes or organic-fibre brushes.
- Make sure your shell sample consists of one species only, and preferably of large, single shells rather than fragments.
- When dating shell samples, make sure that you identify the shell species to the laboratory to avoid inaccurate dates. Shell species in the ocean will absorb less C14 from the atmosphere than lacustrine or riverine species and may return widely different carbon dates.
- Shell samples should also be tested for secondary recrystallisation using X-ray diffraction (XRD), so that rogue carbons are not being dated.
Try to avoid cleaning bone samples.

All samples must be properly recorded before collection—it is essential that basic information about possible associations, any evidence of disturbance, the method of collection, the handling and storage procedures you followed, the depth and position of the sample within the excavation unit, and the condition of the sample when collected are all noted at the time of collection. For example, if you handle a charcoal sample with your fingers, you will need to inform the laboratory of this, as the oil on your skin can contaminate the sample. You will need to give details of all the collecting and bagging procedures to the laboratory when you submit your samples, as you may not get accurate dates without this information.

**Recovering artefacts with residues and use-wear**

Residues and use-wear are the physical traces left on the edges of stone artefacts as a result of their use in various tasks. **Residues** can include trace amounts of starch, blood, hair or woody tissue still adhering to the artefact. Some residues will last much longer than others (resin, for example), particularly those that become compacted into tiny crevices in the stone. **Use-wear** is a description of the physical changes to the edges of an artefact as a result of its use: artefacts used to cut grasses, for example, develop highly polished edges; others used to saw bone develop particular forms of edge damage (for a full listing of a range of use-wear types, see Fullagar 1989: 45). **Micro-wear** refers to the use of high magnification microscopes to identify and interpret polishes on stone tools, while **traceology** refers to the study of either residues or surface alterations, normally in the context of tool use, and is sometimes synonymous with micro-wear (Fullagar 2014). Use-wear analysis can be applied to a wide range of
materials, including wood, bone, stone and metal, with specific methods developed for particular raw materials (Fullagar 2014).

A detailed recording or analysis of residues and use-wear is not really practical in the field and is best undertaken by a specialist. If you are retrieving stone artefacts for later analysis in a laboratory, however, bear in mind that the best artefacts to examine for residues will be those which have been protected from the elements and are retrieved through excavation (Fullagar 1989: 40). It is possible to recover residues from artefacts in surface scatters, although the most productive will still be those that have been protected in some way. When collecting stone artefacts for later analysis, follow these basic procedures to ensure that any residues are preserved (Fullagar 1989: 41):

- When you excavate the artefacts, try to leave as much of the adhering soil on them as possible.
- If you need to clean them, lightly brush them with a soft-haired paintbrush. If necessary, you can rinse artefacts in water.
- Don’t scrub artefacts. If soil is impacted and difficult to remove, gently rub the artefact with a wet cotton bud or a soft-haired paintbrush.
- Try to handle the artefacts as little as possible. It is not strictly necessary to wear gloves, as many disposable types contain powdered starch which can leave a residue on the artefacts.
- Bag each artefact separately.
- Don’t place an aluminium tag inside the bag (these will actually leave a residue on the artefact which might obscure other residues).
- Do submit a detailed history of excavation and handling to the analyst with the artefact.
Managing excavated materials

What happens once you have collected your artefacts or excavated your site, analysed your results and written your report? You're likely to be left with boxes of excavated material, some of which may be highly fragile or fragmentary, and a large archive of recorded data. As a professional, it is your responsibility to make sure this collection is taken care of in the long term, which may mean turning artefacts over to a recognised authority (a state or local museum or keeping place) or returning it for reburial on-site and archiving your dataset. Before you do anything with a collection, however, you will have to weigh up your ethical responsibilities (see ‘Archaeologists and their profession’ on page ##) and make sure that you're aware of your legal obligations under state legislation. You will also have to consult with the relevant authorities and other interested parties, such as the relevant community. While it would be ideal to turn all excavated collections over to an official repository for permanent care, in reality no museum is likely to want a collection of broken glass, fragments of domestic ceramics and miscellaneous rusted metal. You need to find out what the repository's collection policy is before you begin excavating, because if they agree to accept the collection, they will probably require you to follow particular methods when documenting and storing the archive.

Richard Robins’ tips on the proper care and management of excavated collections

If you intend to collect and store any archaeological material, the management of the collection begins at the inception of your research project. As archaeological excavations or surface collections are essentially destructive activities, it is incumbent on you to ensure that the material is preserved in the best possible way. From a research perspective, these collections serve the important function of providing a check on the work of the original collector. From a site-management perspective, well-made and
managed collections may reduce the necessity to undertake further collection or excavation on a site. There are three essential elements to proper collection management: organisation, conservation and storage.

**Collection planning (organisation)**

As a first step, consult with staff at the repository where your collection will eventually be housed. Most state museums now have strict depositional requirements and they will be able to tell you the necessary procedures and requirements for the deposition of material. If a museum has a computerised database, use it. It will be a useful tool to coordinate and track the collected material, including the paper archive, and if you use the museum’s official registration system from the outset, you will avoid unnecessary duplication and minimise handling of the artefacts. One of the golden rules of collection management is always to consult with museum staff and conservators before you begin fieldwork. The other is to make sure you obtain some preliminary estimates of the time and costs required to manage and store your collection so that the final figure doesn’t come as a nasty shock.

**Conservation**

Conservation is the most under-rated aspect of any archaeological excavation, so you should devise a plan to manage your archive prior to undertaking a collection or excavation. You will need to work out some preliminary costs for conservation, particularly in terms of estimating the time that will be needed to process the material. Prior to collecting any material, you should consult with someone with conservation expertise. They will give you an idea of what you can and can’t do. The following are some of the basic rules that should be followed:

- Immediately following excavation, maintain an environment around the artefact which is as similar to its burial conditions as possible.
- The less done to an object the better, so keep handling to a minimum.
• Ensure that techniques, particularly those using chemicals, are reversible. It is also helpful to know in advance the kind of laboratory tests you might use and any implications these may have for the way in which you collect or store your samples. The wrong treatment during excavation may make your artefacts or samples useless for analysis.
• Document *everything* done to the artefacts.
• Anticipate field conditions and plan accordingly—prepare a field kit with the correct storage materials.

**Storage**

Storage is not only an organisational issue, but also a conservation one. It is essential to use materials that will not decay or damage artefacts or aspects of them, such as blood residues or starch.

**Do not use:**

- matchboxes;
- plastic bags with twist ties;
- coloured plastic containers;
- plastics with PVC;
- acidic paper or cardboard;
- high-acid tissue;
- paper towels;
- newspaper;
- glass containers;
- rubber bands; or
- pressure-sensitive tapes.

**Do use:**

- clear Ziplock® plastic bags;
- clear plastic containers;
- acid-free cardboard boxes;
- acid-free tissue paper;
- polythene or polyether foam;
- Gortex®;
- unbleached muslin;
- bubble pack without PVC;
- silica gel; and
- natural fibre cloth bags.

*Stabilising Stuff (2012)*, published by the Heritage Council of NSW, will help you to understand the level of risk posed by a range of common conservation issues and plan a suitable strategy for stabilising and storing archaeological materials. It also includes an excellent guide to first-aid in the field for a wide range of artefact types.

**Useful resources**

A range of useful knots with nifty animations to show you how to tie them (important for all stages of archaeological fieldwork, but especially tying gear down in trailers and stringing up excavation squares. For excavation squares we recommend the clove hitch): [http://www.animatedknots.com/cloveend/](http://www.animatedknots.com/cloveend/).

For details of pre-treatment for different classes of excavated material see: [www.c14dating.com/pret.html](http://www.c14dating.com/pret.html).


A history of the Harris Matrix and various publications on its uses can be found at: [www.harrismatrix.com/history.htm](http://www.harrismatrix.com/history.htm).

The University of Central Lancashire (UK) has an excellent online archaeological methods course with details of all aspects of a field project, including the context system and context recording, surveying, planning and photography. The ‘How to Trowel’ section is particularly useful for first-time excavators: [http://www2.uclan.ac.uk/scitechmedia/archmethods/index.html](http://www2.uclan.ac.uk/scitechmedia/archmethods/index.html).


CHAPTER NINE

RECORDING ARTEFACTS

What you will learn from this chapter

- The importance of consistent terminology and practice when recording artefacts and their attributes
- The main classes of Indigenous artefacts and how to record them
- The main classes of historical artefacts and how to record them
- How to calculate minimum numbers as an analytical unit
- Techniques for photographing artefacts
- Conventions for drawing artefacts

The basics

The most important characteristic of any recording system is to ensure that it is consistent and tied to standard terminology and practice. This is as true for artefacts as it is for sites, deposits or landscapes. There are two parts to the artefact recording process: cataloguing, which is the process of creating raw data through describing your artefacts, measuring them and entering this information into a database; and analysis, which is the synthesis and ordering of this raw data for some interpretive purpose linked to your research design. Only the second part can really be called analysis (the first is really—and only—classification and quantification), although both are conditioned by your research questions and theoretical orientation. Unfortunately, many projects begin and end at the catalogue/classification stage and do not proceed to the analysis level, or do so only at a very general level.
A core problem with artefact recording is a general lack of consensus about basic standards of cataloguing and description for many types of artefact. While not everyone must record precisely the same attributes for all artefacts (in part your choice will be conditioned by time and cost, but most importantly by your research questions), core concepts do have to be consistent and well-defined in order for sites or assemblages to be compared. The main impediments to this for all classes of artefact are always going to be idiosyncratic choices (i.e. things that are classified differently by different people for no good reason, or things that are not clearly defined so that it’s unclear what they mean) and error (misidentification and mistakes). The Exploring the Archaeology of the Modern City (EAMC) project (http://www.latrobe.edu.au/humanities/research/research-projects/past-projects/archaeology-of-the-modern-city), for example, highlighted many problems associated with the classification and description of historical artefacts (e.g. Crook et al. 2003a, 2003b). In re-examining assemblages excavated from large urban, inner city sites in Melbourne and Sydney, the EAMC researchers found mistakes at all stages of the process that limited the usefulness of the information that could be extracted, and made drawing comparisons within or between sites very difficult. One of the key observations of the EAMC project was the necessity for cataloguers to include detailed notes on every individual item in order to prevent misunderstandings and facilitate the recognition of objects by other researchers.

This chapter covers basic identification and standard terminology for several common categories of artefact found on Australian sites. Throughout we have opted for defining a minimum set of core attributes that are most useful for broad analytical purposes, while also recognising that you will need to match your research questions to the most relevant measurements. In all cases, more variables could be recorded, depending on what you want to know.
Diagnostic features and minimum numbers

Artefact recording—regardless of the type of artefact in question—follows a fairly standard process and asks a similar range of questions: What is it? What is it made from? How and when was it made? How was it used? How many of these artefacts existed in the site originally? To answer these, you must look for and record those particular aspects that can most clearly provide relevant technological, construction or chronological details. These aspects are the key identifying criteria for each artefact class and are called diagnostic features.

Apart from being the key to understanding how something was made, perhaps when, and what it was used for, diagnostic features also allow you to calculate a minimum number of artefacts for an assemblage. A minimum number (of specimens, artefacts, vessels, individuals—the precise term will vary between artefact classes) is not just a count of how many fragments are present (this is called, not surprisingly, a fragment count), but a calculation of how many once-whole objects those fragments might represent. One glass bottle can be fragmented into a hundred pieces, so while the fragment count will be high (100), the minimum number will be low (1). A minimum number accounts for each possible individual object in the most parsimonious way and is a very useful analytical measure, since it compensates for the differential breakage of objects. It will always be a count of the fewest number of objects that are represented in an assemblage, however, rather than an exact count of how many were present originally, or how many were actually used by the people who created the site. These are both things that you will probably never know, since they depend on how artefacts were discarded at the site, what happened at the site after it formed, how you subsequently sampled it and how many diagnostic features were preserved in your sample. For these reasons a minimum number count is best used to compare categories of objects to one another (e.g. ‘there is a greater frequency of gin bottles compared to beer bottles’) rather than to establish
absolute frequencies. Both Peter Hiscock (2002) and the EAMC project (Crook et al. 2003a, 2003b) have pointed out that the calculation of minimum numbers is not always standard practice in Australian archaeology.

In addition, many artefacts (fragments) will have no diagnostic features and therefore will not contribute to your minimum artefact count. A small piece of dark brown glass from the body of a bottle, for example, gives you little specific information about the specific contents of the bottle or its date of manufacture, so you will not spend too much time recording this artefact. Non-diagnostic artefacts should still be recorded, however, as the information they provide is complementary and can tell you a range of other things, for example the extent to which your site has been disturbed, or trampled, and thus your artefacts fragmented (i.e. the taphonomy of the site).

Where relevant we have provided guidelines throughout this chapter for calculating minimum numbers of artefacts within each artefact class, since this forms 'the basis of meaningful artefact analysis and interpretation' (Crook et al. 2003b: 41). In all cases, for the benefit of other researchers, the process you adopted to calculate minimum numbers, your defining attributes and the methods by which you reached your calculation should be clearly recorded in your report (for more information about what should be included in technical reports, see Appendix 7). When calculating all minimum numbers, you should be rigorously conservative.

**Stone artefacts**

Indigenous people made and used a variety of stone artefacts. Some were flaked from larger pieces of stone; in other cases, stone was ground to produce a particular type of artefact, such as a grindstone or an axe. All archaeologists working in Australia should have at least a basic familiarity with identifying
stone artefacts such as flaked pieces, cores, edge ground tools, grindstones and mullers, as well as recording fundamental descriptive attributes. Analysing stone artefacts is a highly specialised field and approaches and methods for documentation are strongly influenced by theoretical orientation. For more detailed treatment of some of the methodological and research design issues surrounding the analysis of stone artefacts, see Hiscock (1989), Holdaway and Stern (2004) or Andrefsky (1998).

**Recording flaked stone artefacts**

Flaked stone artefacts are made by hitting one stone (called a **core**) with another (called a **hammerstone**). This process is called **knapping** (Figure 9.1). Artefacts made by knapping have a number of things in common and it is these things which an archaeologist looks for when identifying a piece of stone as a flaked artefact (Figure 9.2; see also ‘How to identify stone artefacts’ on page ##)

![Figure 9.1: Knapping, the process of making a flaked stone artefact](image)

There are many systems for recording stone artefacts in the field. Some attributes are more reliable than others, and the recording system you choose may depend on the questions you wish to answer. In recognition of this, we have not tried to establish a set of rules to follow. Nor have we tried to provide guidelines for detailed analysis, as there are several debates surrounding which characteristics are considered the most useful to record and why. All we intend here is simply an outline of some of the basic parameters which can provide you with quick and useful information in the field.

The first step is obviously to be able to recognise a flaked stone artefact when you see one. Archaeologists classify flaked artefacts according to four basic technological divisions:

1. **Flakes**: the piece of stone which is struck off the core.
2. **Cores**: the piece of stone from which flakes have been removed.
3. **Retouched flakes**: sometimes people will use a flake as a core and knap it to remove other, smaller flakes from along the edge. These twice-knapped artefacts are called retouched flakes. The appearance of retouch may also be created by using the flake.

4. **Flaked pieces**: artefacts which cannot be clearly identified as a flake, core or retouched flake. This is a category for artefacts which are clearly artefacts but which have lost their defining features, or become detached because the core has shattered in the process of knapping.

**How to identify stone artefacts**

**How to identify a flake**

The basic morphology is as follows (see Figure 9.2):

- The ‘back’ of the artefact (the side that was part of the outside of the core) is called the dorsal surface.
- The ‘front’ of the artefact (the side that was once part of the interior of the core) is called the ventral surface.
- The ‘top’ of the artefact (the part that the knapper hit to remove it from the core) is called the platform or proximal end.
- The ‘bottom’ of the artefact (the end opposite the platform) is called the termination, or distal end.

When trying to decide whether a piece of stone is a flake look for these important features:

- When a flake is removed from a core, there is often a distinctive circular mark where the hammerstone has hit the core. This is called a **ring crack**. Because the ring crack occurs in the precise spot where the hammerstone has hit the core, it is also sometimes called the **point of force application** (or PFA).
• The ventral surface may have a bulb of percussion, or a rounded bulge where the force from the hammerstone has radiated through the stone and split it from the core.

• The ventral surface may also have other features on it, like concentric ripples or waves which spread out from the ring crack.

[[INSERT FIGURE 9.2 HERE]]

**Figure 9.2: How to identify a flake**

To produce a flake successfully, the knapper must hit the core in the right spot with just the right amount of force (Figure 9.3).

[[INSERT FIGURE 9.3 HERE]]

**Figure 9.3: Physical constraints of knapping**

**How to identify a core**

The key to identifying a core is to look for the opposite, but complementary, characteristics to those you look for in a flake. One of the key characteristics of a flake is the rounded bulb of percussion on the ventral surface. One of the key characteristics of a core, therefore, is the negative imprint of this bulb—a rounded hollow where the flake was split off from the core. This is called a negative flake scar (see Figure 9.4).

[[INSERT FIGURE 9.4 HERE]]

**Figure 9.4: A negative flake scar**

It is important to remember that even flakes may have negative flake scars—anything that has been removed from the core after the beginning of the knapping process is likely to carry away with it the negative imprint of earlier flakes. The crucial distinction in telling a flake from a core, however, is that *a flake must always have the positive attributes of the knapping process* (a bulb of percussion), whereas *a core will only have the negative attributes* (flake scars). The only exception to this will be when a flake has been used as a core, in which case you may see both kinds of attributes.

[[INSERT FIGURE 9.5 HERE - TWO PAGES]]

**Figure 9.5: How to measure and record the key attributes of a stone artefact**
How to identify a flaked piece

This is actually quite difficult if you have never seen a flaked piece before, and your success at identifying such items will depend to a large extent on your experience. Because this category was created explicitly for all those definite artefacts which have no defining attributes, if you are unsure about what is or is not a ‘definite’ artefact, then this category will be highly problematic for you. Artefacts which are highly weathered or very broken, or which have been shattered in a fire might fall into this category, but so might artefacts which were shattered from the knapping process (Hiscock 1989: 26). It is important to remember that this category is not a catch-all ‘too hard’ basket for all those things that you think might be artefacts—if you are unsure seek a second opinion. The easiest way to identify a flaked piece is to look for ventral or dorsal features. If you can define even one of these, such as a ventral curvature, ring cracks, negative dorsal scars, undulations, etc., then the artefact is a broken flake. If you cannot, but are sure the piece derives from knapping (i.e. it is made from the same raw material that you know was knapped), then it is a flaked piece.

Recording other classes of stone artefact

- **Manuports.** This is a category for pieces of stone which are obviously not found locally in the area and therefore could only have been carried in by people. It doesn’t necessarily have to be knapped (although it may be)—just exotic to the local area. You will only be able to tell whether a piece of rock is exotic by familiarising yourself with the local geology. Manuports may have been used for a wide variety of purposes, including as unutilised raw material for flaking, as a general purpose tool for pounding or cracking (e.g. cracking nuts, breaking bones for marrow or opening shellfish), or as part of a hearth.

- **Grinding stones.** Unlike flakes, which are customarily made from fine-grained, sharp-edged, raw materials, grinding stones are made from coarse-grained and abrasive materials, such as sandstone. They were used by
Indigenous people to grind seeds, roots, tubers or ochre and consist of two parts: a flattened ‘dish’ in which the material rested and a rounded stone which was held in the hand and used as a pestle or muller. Look for relatively flat, dish-shaped (concave) stones, and smaller rounded stones of the same material (but note that you might not find them together). One surface of each stone (and possibly more than one surface of the muller) is likely to be smoother and possibly polished as a result of repeated grinding.

- **Edge-ground axes.** These were commonly made of volcanic raw materials, such as basalt, because they are extremely hard. To make an axe, a ‘blank’ (an axe-shaped piece of stone) is knapped, and one edge of this knapped further to create a chopping angle. This edge of the axe was then ground smooth until it was sharp (see ‘Grinding grooves’ below) and the axe head attached to a wooden haft with twine and gum. An entire axe will be easy to identify because it will have these ground edges and because it will be made from hard volcanic material. If, after use, the edge of an axe became dull, Indigenous people would often knap some further flakes from the axe’s cutting edge and regrind it. These waste flakes are called ‘edge-sharpening flakes’ and will be relatively easy to spot because of their distinctive raw material and because they may have polish on some margins.

- **Potlids.** These are small circular pieces of stone which have literally ‘popped off’ the surface of the artefact as a result of exposure to extreme heat. Sometimes people deliberately heated certain kinds of raw material (such as silcrete) to make it easier to knap; sometimes artefacts were simply thrown into cooking fires after use. Bushfires, of course, can also cause potlids on open sites. If you find a potlid on an artefact, you will need to decide whether it has been caused by natural or cultural processes. Look for whether the incidence of potlids is spread evenly across the site and across different types
of raw material (this may indicate the passing of a bushfire) or whether they are highly localised, or only occur on one type of raw material.

- **Grinding grooves.** These are a by-product of the manufacture of ground stone axes or adzes. The highly polished surfaces and sharp edges of such artefacts arise from grinding them against a permanent rock surface. Such surfaces are usually horizontal and are located near water, which is an essential lubricant for the grinding process. The grooves that result from this process have their own patina, are narrow, relatively short (think of the length of an arm-swing) and deeper in the middle than at either end (see Figure 5.2). To record these, first count the number of visible grooves and note their orientations. You should then measure the length, width and depth of each groove and estimate the quality and extent of patina present (Is the entire groove highly patinated? If not, where is the patina concentrated? Is there little or no patina?).

To produce a particular kind of artefact, a knapper will sometimes remove many flakes from a core until he or she has precisely the right ones. When a person sits down in a particular spot to knap an artefact, that place is called a **knapping floor.** At sites that were knapping floors, archaeologists can sometimes literally put the artefacts back together. In some cases, this allows them to see the original shape of the core and to work out how the person went about reducing it to make a particular collection of stone artefacts. Many of the artefacts an archaeologist finds in the field are the waste products from this process (often called **debitage**) rather than the desired end product, because this was usually taken away for use elsewhere. In recording such a group of stone artefacts, archaeologists try to distinguish between those flakes that were removed at the beginning of the process and those that were removed from the core towards the end of the process. One way of doing this is to measure the
amount of **cortex**, or the original, weathered, outside surface of the core which is visible on each flake. Cortex can be pebble cortex, from a water-rolled pebble, or outcrop from an exposure of stone. Either way, it will appear on the dorsal surface only. If you can see cortex on the dorsal surface of the artefact, this means it has come from the outside of the core and was removed at the beginning of the process. If, however, the artefact has no cortex, it has obviously come from the interior of the core and was removed in the middle, or towards the end, of the process. Archaeologists use the relative amount of cortex on an artefact to distinguish between three types of flake, according to when they were struck off the core:

1. **Primary**—where the entire dorsal surface is covered with cortex. This means the flake was one of the first to be struck off the core.
2. **Secondary**—with some cortex and some flake scars. This means the flake was not one of the first, but was still struck off early in the manufacturing process.
3. **Tertiary**—an artefact with no cortex. These flakes must come from the last stages in the manufacturing process.

Be careful not to confuse cortex with weathering (which results from prolonged exposure to the elements). The thing to remember is that weathering can occur on all surfaces of the artefact (including dorsal and ventral), whereas cortex will only be found on the dorsal surface.

**Denis Byrne’s tips for recording stone artefact raw materials**

- Use commonly accepted archaeological terminology for describing raw material types, but don’t get too technical (unless you’re a geologist).
- Describe your types in a glossary so that your meanings are clear.
• If you want to use more general terms such as ‘fine-grained’ or ‘coarse-grained’, make sure you define what these terms mean in the glossary.

• If you are unsure of types, either consult a specialist or flag your uncertainty (use ‘?’ or ‘unknown’, or a very general descriptive term such as ‘volcanic’ or ‘fine-grained siliceous’ if you are sure about this).

• Give the total number and, if possible, weight of each material type, plus their percentages. (Byrne 1997)

Much of the analysis of flaked stone artefacts is simply an attempt to make sense of the sequence of events that have happened to an artefact throughout its life. Beginning at the stage of obtaining the raw material from a source, this sequence will include the processes of manufacture (knapping) and use, and will end with all of the subsequent modifications that have taken place since the artefact was discarded (Wright 1983: 123). Working through this process will not only help you to understand how the particular artefact was manufactured and used, but will also give you a good idea of the archaeological context of the site and how taphonomic processes may have affected a site’s contents over time (Figure 9.6) [[INSERT FIGURE 9.6 HERE]]

Figure 9.6: An example of how to work through the analysis of an artefact. You need to look at many different aspects of the artefact’s life history in order to analyse it properly (after Wright 1983: 123)

Calculating minimum numbers: minimum number of flakes

To calculate a minimum number of flakes (Figure 9.7) add together the number of complete flakes, the higher number out of the transversely broken proximal or distal fragments (i.e. the ‘complete’ ends of broken flakes, either proximal or distal, whichever category is larger) and a count of the longitudinal fragments (Hiscock 2002: 254). To count longitudinal fragments, add the greater number of left or right longitudinally broken flakes (those that have both a fracture initiation and a termination and therefore can be considered ‘complete’
longitudinal halves of flakes) and the largest of the four relevant categories of transversely broken, incomplete ends of flakes (right/proximal, left/proximal, right/distal, left/distal) (Hiscock 2002: 254). Medial fragments (those with neither an initiation nor a termination) are not used to count minimum numbers.

[[INSERT FIGURE 9.7 HERE]]

**Figure 9.7: Calculating a minimum number of flakes**

**Molluscs**

Mollusc shells are a common feature on archaeological sites around the Australian coastline, as well as near many bodies of freshwater. There are three classes of molluscs that archaeologists commonly encounter: Chitons (Polyplacophora), bivalves (Bivalvia) and gastropods (Gastropoda). Others, such as cephalopods (including squid and cuttlefish), are encountered rarely (Giovas 2009: 1558). Mollusc shells provide an easy means of identifying archaeological sites because they are often easily spotted and tend to be quite durable—particularly where they have been deposited in reasonable numbers. Quantifying mollusc shells is a useful undertaking, even during initial archaeological survey and site recording work, since it provides direct information about dietary focus, foraging practices and, potentially, changes in local ecosystems through time. Mollusc shells can be used to conduct a range of more sophisticated analyses, including studies of site taphonomy, spatial and chronological shifts in diet, estimating foraging intensity and resource specialisation, occupation chronologies, seasonality, social organisation, symbolism, ritual practices and even past rainfall and temperature (Álvarez et al. 2011; Bailey 2004; Balbo et al. 2011; Bourke et al. 2007; Claassen 1998; Demarchi et al. 2011; Erlandson 1988, 2010; Faulkner 2009; Luby and Gruber 1999; McNiven 2013; Meehan 1982; Morrison 2013; Thomas 2015a, 2015b; Waselkov 1987). Such specialised research is frequently the domain of archaeomalacologists—or archaeologists
with a specialisation in molluscs. Here we focus on more general descriptive methods for quantifying molluscs found on archaeological sites during field surveys, or where shells are found in the context of archaeological excavations.

At a general level, quantification of molluscs is a relatively simple task, although it requires some pre-fieldwork preparation in order to ensure you collect meaningful comparative data. Some of the preparation you can do includes the following:

1. Identify the range of species commonly found in archaeological sites within the region. Read the literature, and create an inventory of common species.

2. Find the correct species name. Taxonomists have a habit of regularly revising species names, which can be confusing. Find the accepted scientific name by consulting the World Register of Marine Species (WoRMS) (http://www.marinespecies.org/) and use this term (even where it goes against accepted terminology in archaeology, which is often out of date!).

3. Create a reference manual that lists each commonly found species, including its accepted scientific name, common name and, importantly, several good quality colour photographs of that species. This is essential if you have multiple teams of surveyors with varying levels of knowledge about local shellfish species.

4. If you are excavating, do as Val Attenbrow recommends and create a reference collection of mollusc shells found on shorelines adjacent to the location where you are working (see ‘Val Attenbrow’s tips for excavating shell middens’ on page ##).

5. Develop or adapt a recording form for molluscs, with a guide to the different elements found on both gastropods and bivalves (see Appendix
3). This makes quantification quicker, simpler and should ensure more consistent data.

Mollusc shells are typically quantified via MNI, a concept used in faunal analysis to mean the ‘minimum number of individual animals necessary to account for all the kinds of skeletal elements found’ within a complete skeleton of a particular taxon (Lyman 1994: 100). With shells, this means a non-repetitive element (NRE) that represents a single, complete living mollusc and that can only be counted a limited number of times (and ideally, once) for a complete mollusc (see Figure 9.8). This might be the valve hinge (where two parts of a bivalve are joined), which occurs twice on bivalves, or an apex (the end of the spire on gastropods), which occurs only once and so is a unique NRE. [[INSERT FIGURE 9.8 HERE]]

Figure 9.8:

NRE-based classification first involves species identification, which is quite simple for complete shells and is often possible even where only fragments of the original shell remain, including for very small fragments that are only 5–10 mm in length. This, however, does require you to have some familiarity with the different elements that occur on common species and in turn requires you to think about how you will quantify your assemblage. This is because there is a high degree of inter-species variability in terms of the ways in which mollusc shells fragment and are preserved in archaeological sites. For this reason, you should decide on at least one NRE for each species you are working with. Choose an element that is hardy and that only occurs once or twice on a whole shell.

Once diagnostic criteria are decided, quantification simply involves obtaining a count of all fragments that have one complete NRE for that species, which in turn allows you to calculate MNI. This is easily calculated for complete molluscs via a simple count, though care must still be taken to ensure that nearly whole shells are not missing the NRE (e.g. a small part of the shell has broken off) and
could therefore be counted later. Gastropods are usually very straightforward to count, though bivalves are a little more complicated. For symmetrical bivalves, such as mussels, pipis and cockles, there are often two NREs to consider (i.e. one on each valve) so your MNI is half the total count of NREs. On asymmetrical species, such as the various types of common oyster (Saccostrea spp., Ostrea spp.), there may be unique NREs on both valves. In these cases, it can be useful to use a different NRE that occurs on both valves, then use the highest number of NREs to calculate the MNI. The problem with this is that some species (e.g. Saccostrea culcullata) have very few NREs and so you may only be able to rely on a count of the adductor scar—the place where the muscle of the animal attached itself to the shell (see Figure 9.8). If you are unsure, collaborate with someone with experience in the analysis of molluscs in archaeological contexts.

For light shell scatters or very low-density shellfish recovery in excavations, classification and quantification can be done quite quickly. While recording a site, simply take a tally of the numbers of fragments or whole shells that have an NRE for each species you encounter, remembering not to move the element from its original position. Pin flags or other temporary markers can assist with this. If you are working with a species that has shells that are relatively fragile (e.g. freshwater mussels), then you may find that NREs are rarely preserved and that a count would likely misrepresent the MNI for that species. In such cases, a Number of Individual Specimens (NISP) count will suffice, which is basically a count of the total number of fragments present—though there are important limitations and considerations with this technique (see Claassen 1998). For larger shell matrix sites, such as shell mounds or surface deposits extending over large areas, surface counts of NREs are not recommended, since this is likely to take a very long time. Here, a sampling approach is more practical and can be quickly achieved by calculating the overall surface area of the site and then using an appropriate sampling strategy (see ‘Sampling’ on page ##). Keep in mind that
on large, complex sites, MNIs based on surface counts are rarely an accurate indication of overall site MNI, though they are useful as a preliminary estimate where excavation is not going to take place. When processing excavated materials, mollusc shells should first be separated from other materials, then washed and air dried in order to assist with classification and quantification. Once completed, sort your assemblage according to species and ‘unidentified fragments’ (whose species is indeterminate), then tally the NRE for each species as discussed above. When working in the lab, it is useful to obtain weights as well as NRE counts.

Glass

Bottles and bottle glass

As the most common containers of the nineteenth and early twentieth centuries, bottles are a ubiquitous find on historical archaeological sites. Like ceramics, glass is both durable and breakable and therefore constitutes one of the most common artefact categories on historical period sites. Glass relates to many aspects of human behaviour, including food, drink, health, medicine, sanitation, building standards, lighting and more. Indigenous people after contact also sometimes used bottle glass to make flaked artefacts, so recording bottle glass can also form a component of Indigenous site recording (see ‘Recording Indigenous historical sites’ on page ##).

The basic components of a bottle are the body, shoulder, neck, rim, finish, base, push-up and heel (see Figure 9.9).
There is enormous variation in the shape and style of bottles which can tell you when the bottle was manufactured and the purpose for which it was used.

The diagnostic features to look for and record for bottle glass are:

- shape;
- base;
- mould marks;
- mouth;
- seal/closure;
- trademark;
- decoration; and
- colour.

**Recording shape**

The shape of some bottles will be relatively easy to describe; for others it can be very complex. To convey accurately the shape of the vessel, you may have to describe it in three planes:

1. As viewed with the body **horizontal** (i.e. a description of the cross-section of the bottle if it was cut in half across the body through its mid-section) (see Figure 9.10).
2. As viewed with the body **vertical** (i.e. a description of the cross-section of the bottle if it was cut in half down its length) (see Figure 9.11).
3. Its 3D body shape. ‘Cylindrical’ may be a much simpler way of describing the general shape of a bottle, as opposed to ‘straight/vertical, circular/horizontal’.

[[INSERT FIGURE 9.10 HERE]]

**Figure 9.10: Describing the shape of a bottle in the horizontal plane**

[[INSERT FIGURE 9.11 HERE]]

**Figure 9.11: Describing the shape of a bottle in the vertical plane**
Recording mould marks

Changes in glass manufacturing technology have resulted in several distinctive criteria which can be used to date bottles (see Appendix 5: Guides to dating common historical artefacts). Machine-made bottles have very well-defined mould seams, so make sure you take note of the number of mould seams which are visible and their placement on the body of the bottle.

Recording closures

This is essentially a recording of the shape and form of the neck and mouth of the bottle. Methods for sealing in the contents of a bottle have changed over time, particularly since the rapid technological changes of the Industrial Revolution. Make sure you take note of the way the lip and rim of the bottle are formed, and any other evidence for how the bottle was originally sealed.

Recording trademarks, decoration and colour

Even the most inconspicuous letters and numbers can sometimes be a guide to the company which made the bottle, the contents of the bottle, its date or its place of manufacture. Embossed letters and numbers on a bottle base may refer to a mould number, the manufacturer and sometimes also the place of manufacture. When recording such decorative information, make sure you record both its form and placement on the bottle.

Colour is another important aspect of bottle manufacture. When describing the colour of a bottle, however, be careful to distinguish between colour and transparency. A common confusion is between clear and colourless glass. ‘Clear’ is a description of transparency—i.e. you can see through the glass to the contents—and not a description of the colour, which may be either slightly aqua tinted or completely colourless, depending on when, and from what constituents, it was made. Iron impurities in sand (silica) will always lend a variety of tints to glass (ranging from the more common aqua/green shades to pale blue or brown
depending on the iron) and the greater the iron content the darker the glass that will be produced from it. ‘Black’ (really very dark green) bottle glass, for example, is made from silica with a high iron content and was the most common colour for alcohol bottles in the nineteenth century. In contrast, colourless glass must either be made from extremely pure silica—which was very expensive—or have a bleaching agent added to it to remove the colour impurities. Before local manufacture commenced most imports to Australia came from Britain, where rigid laws and excise controls placed high taxes on colourless ‘flint’ glass and caused the cheaper, darker and greener bottles to be imported into Australia in large quantities throughout the nineteenth century (Boow 1991: 113).

While there is only a very weak relationship between glass colour, date or function, some bleaching agents can be useful for dating purposes. The distinctive colour of amethyst bottle glass, for instance, results from the use of manganese to produce clear glass; when exposed to sunlight, this is apt to discolour to purple. Adding manganese to glass has a long history (see Lockhart 2006), but as a dating tool for historical archaeologists it is generally accepted to fall most commonly between the mid-1870s and the 1930s (Bolton 2005: 51; Lockhart 2006: 54). For more information on dating bottles and bottle glass, see Appendix 5: Guides to dating common historical artefacts.

**Calculating minimum numbers: minimum number of vessels**

A minimum number of vessels is calculated for archaeological bottle glass by counting all of the diagnostic or other elements that can represent a single bottle. The most obvious of these is bases or rims (but not both together), since each bottle can have only one. To do this, first separate out the different base fragments in your assemblage and see if any conjoin and are therefore part of the same vessel. For round bases you can use the same method as for a rim diameter count for ceramics within each bottle base size class. For example, you can group all olive green bottle base fragments with the same base diameter together,
measure their arc length (see ‘Calculating a minimum number of vessels (MNV) from rim diameters’ on page ##) and divide by 100 to gain an idea of how many complete bases of this size class your assemblage represents. You can use a combination of bases with different diameters and shapes, but also other diagnostic elements, to represent different individual vessels—for example if you have five round, olive green bases and several fragments of amber bottle glass (but no amber bases), you clearly have a minimum number of six vessels, since the amber glass must have come from a different vessel.

**Cut and pressed glass**

Not all glass on an archaeological site is bottle glass. Decorative glass bowls, salvers, cups, vases, egg cups, juicers and ornaments were also common, made from cut and pressed (or moulded) glass. Cut glass is made by hand and has always been much more expensive than pressed glass. Most pressed glass on Australian sites dates to between c. 1860 and 1870 when there was an expansion in British production (Boow 1991: 88). Australian production of pressed glass on a large scale did not begin until the 1920s and 1930s. This period also saw the introduction of coloured pressed glass.

It is relatively easy to distinguish between pressed and cut glass because of their different manufacturing methods (see Table 9.1). Be sure not to confuse mould-blown glass (popular for only a very short time between 1820 and 1850) with pressed glass. While superficially they appear similar, mould-blown glassware may still have traces of a pontil mark on the base where the pontil or handling rod was attached and will be thinner and lighter.

[[INSERT TABLE 9.1 HERE]]
Calculating minimum numbers: minimum number of vessels

Calculating a minimum number for cut or pressed glass vessels will operate on the same basis as for ceramics—i.e. calculating the fewest number of vessels based on decoration, form, bases and, possibly, rim size.

Window glass

Window glass is another form of glass that occurs at many historical sites. Because of the limitations of glass blowing technology, it was impossible to make large, flat sheets of glass until after 1896 (Freeland 1988: 80). Window panes made before this date were all made by hand and tended to be relatively small. The earliest were made using a technique called ‘crown glass’ in which flat panes were literally spun from a molten bubble of blown glass, and only measured around 25 cm square. From the 1830s onwards window panes were made by flattening a glass cylinder and could measure anything from 60 × 45 cm up to 1.5 m × 90 cm (Freeland 1988: 6, 79). The introduction of machine technology to Australia in 1932 finally resulted in glass panes that were of uniform thickness and size. When you find window glass at an archaeological site, you must always record its thickness and whether or not it is hand- or machine-made. [[INSERT TABLE 9.2 HERE]]

Calculating minimum number

The only way to do this is to separate window glass into its different thicknesses (and possibly colour, since you may have colourless or aqua tinted panes), since it is likely that this comes from different panes. Given that small panes of glass may have been replaced when broken, however, you can't guarantee that different panes come from different windows, so the utility of this method on Australian sites is limited.
Ceramics

Ceramics are a particularly problematic artefact category and the EAMC project found that they were often misidentified according to form, ware type or decoration or just insufficiently described (e.g. Crook et al. 2003a, 2003b). Most of the ceramics found on historical period sites in Australia will be either of English or local Australian manufacture, although Chinese domestic ceramics are also relatively common in some states. Ceramics can be handmade (such as coil pots), thrown (on a potter’s wheel) or moulded (also referred to as ‘pressed’). Avoid using the meaningless word ‘china’ to describe ceramics; this was simply a generic term used by seventeenth century European merchants to describe porcelain vessels exported from China and has remained in popular use.

Historical archaeologists draw many distinctions between different types of ceramic vessels based on a range of features. The difference between flatware (plates, platters, saucers, etc.) and hollowware (bowls, cups, tureens, etc.), for example, refers to the shape of the vessel, as well as its purpose (Figure 9.12). Differentiations according to use might distinguish between vessels used to cook, mix or store foodstuffs (‘kitchenware’), vessels used in serving and consuming meals (‘tableware’) or beverages (‘teaware’), and vessels used for toileting and grooming (‘toiletware’). These kinds of categories are more descriptive than classificatory—in other words they tell you something about the gross general categories to which a vessel might belong (‘bowl’ versus ‘plate’, or ‘mixing bowl’ versus ‘soup bowl’), but little about the specifics of that particular piece. Alternatively, drawing distinctions between vessels based on how they were made draws attention to specific trajectories of technology, innovation and competition between manufacturers that produced the various technological ware types of porcelain, earthenware and stoneware. When recording ceramics, it is better to distinguish between them on the basis of technological ware type
first, since each had a different range of uses and qualities, and then classify them according to other variables, such as shape, decoration or colour.

[[INSERT FIGURE 9.12 HERE]]

**Figure 9.12: The parts of a ceramic vessel**

Key features to record are:

- The colour of the **paste** (i.e. the colour of the clay used to make the vessel). The paste is the clay fabric that forms the body of the vessel (it is often referred to as ‘**fabric**’ or ‘**body**’) and is one of the characteristics which will allow you to distinguish between stoneware and earthenware, for example. Look at the edge of a broken ceramic fragment (you may have to clean it first) to see the paste colour and make sure you are not simply recording the discolouration caused by soil or age. If necessary, scratch a small portion of the exposed fabric to see what the underlying colour is.

- The hardness of the paste. Harder bodies will be more durable and more highly vitrified (see ‘Recording technological ware type’ below). Scratch a small portion of the edge of the exposed fabric in an unobtrusive area to see whether it is softer (in which case scratching it will produce a powder) or harder (in which case the tool you are using, such as a dental pick, will have difficulty scratching it and is apt to leave a coloured mark on the fabric).

- The decorative technique(s) employed.

- The colour(s) of the decoration.

- The placement of decoration.

- Visible iconographic details (e.g. motifs or pattern elements).

- Visible trademarks or backmarks.

- Rim diameter, especially for table and teawares.

- The vessel type (if you can tell).
Recording technological ware type

A piece of ceramic may be porcelain, stoneware or earthenware, depending on how highly it was fired, the purity of the clay body used to make it, what else was added to the clay and what use it was intended for. The problem with the concept of technological ware as a unit of analysis, however, is that it tends to suggest that each ware is discrete and self-contained (Majewski and O’Brien 1987: 104). In reality all wares occurred on a spectrum of experimentation and competition within the pottery industry that began in the late eighteenth century and only intensified over the nineteenth century as prices rose and fell and consumer tastes changed.

Classifying according to technological ware type can therefore be very complex. As a general guide, on a spectrum of firing temperatures and clay purity, coarse earthenwares will be at the lower end and porcelains at the higher end (see Figure 9.13). Wares fired at higher temperatures will be harder, more durable and more glass-like (vitrified), while wares fired at lower temperatures will be more friable, softer and not at all glass-like (unvitrified).

Figure 9.13: Vitrification scale

Porcelain is made from a mix of fine clay and stone fired to a very high temperature so that it becomes vitrified and impervious to liquids. One of its core characteristics is translucency, which means that if you hold it up to the light you will be able to see light through it. Porcelain was invented and perfected in China and was initially a very expensive export-only commodity. Although its price decreased through time as European manufacturers competed to produce it, it was still more expensive than other wares. English factories mainly produced soft paste porcelains, while continental, Japanese and Chinese potters tended to favour hard paste porcelains (Majewski and O’Brien 1987: 126). Hard paste porcelain is distinguishable by virtue of an abrupt boundary
between the body of the vessel and the glaze, meaning that you can see a ‘layer cake’ effect with the glaze sitting like icing on top of the body; on soft paste porcelain, the glaze and the body blend together. Bone china is an English form of soft paste porcelain.

Porcelain was used for all forms of tableware, as well as a variety of non-tableware items, such as dolls, marbles, figurines and buttons. The term porcellaneous is sometimes used to describe bodies that seem like porcelain (i.e. they have the characteristics of being thin, light bodied and non-porous) but that are not translucent and are therefore difficult to classify more accurately. Fine stoneware and some other bodies can be suitably vitrified and porcellaneous, but are not translucent.

Stoneware is halfway between porcelain and earthenware. It is made from coarse to refined clay and fired to a point where it is impervious to liquids (non-porous) but is only semi-vitrified. It is not translucent. Stoneware commonly has a grey, tan or brown fabric, although higher quality stonewares were produced as tablewares in the seventeenth and eighteenth centuries. Even though non-porous, it is almost always glazed—either with a self-glaze produced by salt-glazing (literally throwing salt into the furnace to change the colour on the outside of the vessel) or with an applied glaze, such as a single colour slip. Stoneware was very common throughout the nineteenth century and was used to make a number of specialised but ordinary household storage vessels, such as crocks, jam and pickle jars, ink bottles, and ginger beer and ale bottles.

Unlike porcelain and stoneware, earthenware is not fired to the point where vitrification occurs, and is therefore porous unless it has been glazed. Earthenware came in both coarse and refined forms. Coarse earthenware was of lower quality and was used to make a range of industrial products, such as flower pots, tiles and sewerage pipes, as well as tobacco smoking pipes. It commonly has a red or buff fabric (although note that most tobacco smoking
pipes are white) and may or may not be glazed. Unglazed terracotta is a typical red-bodied, coarse earthenware. Only in the seventeenth and eighteenth centuries was coarse earthenware used to make tablewares, although note that many teapots were made from a red-bodied earthenware throughout the nineteenth and twentieth centuries. Refined earthenware was made from better quality clay and, as a cheap alternative to porcelain, was used to make a range of different white-bodied table- and teawares from the late eighteenth century onwards. It commonly has a white fabric, although late eighteenth and very early nineteenth century forms, such as creamware, may have an off-white body. Refined and decorated white-bodied earthenwares were extremely popular throughout the nineteenth and early twentieth centuries and are the most common domestic ceramics found on historical archaeological sites.

While porcelain, stoneware and earthenware are the three broadest divisions of technological ware type, competition in the domestic ceramic industry to find cheaper, more durable alternatives to porcelain produced many variants. Experiments with extremely expensive hard paste porcelain resulted in the development of bone china, which was manufactured by adding bone ash to the refined clay body. This produced a white, soft paste porcelain-like ceramic of good translucency at very reasonable cost. Another such experiment was ironstone, which added finely powdered stone and iron slag to the clay to produce ‘ironstone china’, first patented in 1813. Like bone china, this new material was favoured for its cheapness and durability and was variously referred to as ‘ironstone china’, ‘stone china’ or ‘opaque porcelain’. Except for the highest quality services, bone china and ironstone replaced porcelain in popularity during the nineteenth century. White granite was a further offshoot that was developed c. 1845 as another hard, vitreous white-bodied ceramic. Miller (1993: 19) notes that post-1860, as the price dropped, white granite became more cheaply produced and tended not to be vitrified. It was most
commonly decorated with embossed moulded patterns on the marley (c. 1850–1890), although it could also be decorated in other ways or left plain. Brooks (2005: 59–60) contends that white granite dates mostly to the period 1845–1890 and mostly to after 1860 on Australian sites, when the Civil War disrupted ceramic supplies from England to America, causing large quantities of white granite to be sent to Australia instead. Ironstone and white granite gave rise to the plain, white, heavy and semi-vitrified earthenware known as ‘hotel ware’ that was popular for hotel dinner settings throughout the twentieth century. This was thick, durable and inexpensive. Marked hotel wares generally date to after 1870 and most will date after the twentieth century (Barker and Majewski 2006: 216).

Figure 9.14 presents a beginners’ ‘lumper’s’ guide to determining technological ware types for nineteenth and twentieth century ceramics. The process can be more complex than this, and some analysts may prefer more refined categories than these. Within the broad grouping of refined earthenware, for example, some archaeologists draw distinctions between creamware, pearlware and whiteware, as three successive ‘phases’ in the competitive manufacturing process. The label ‘pearlware’, however, initially only meant the addition of a blue-tinted glaze to make the surface appear whiter, while the paste was the same as that used for the earlier creamware. With later changes, however, the body became harder and whiter, and the glaze virtually colourless (Miller 1980: 18). Just as later pearlware may look quite different to earlier creamware, early whiteware can closely resemble later pearlware, because they were all part of the same technological trajectory. Essentially, all refined, white-bodied earthenwares became quite homogeneous in composition by the mid-nineteenth century, making it extremely difficult to tell them apart reliably (Majewski and O’Brien 1987: 113). This is why, unless you are an expert, we recommend using broader rather than narrower categories—in other words,
‘lumping’ rather than ‘splitting’. To achieve a more accurate classification for some sherds (i.e. to distinguish between a grey-bodied ironstone and a grey-bodied stoneware if you can’t tell these apart by sight) you will need to use other variables, such as form, use or decoration, or seek specialist advice.

[INSERT FIGURE 9.14 HERE]

**Figure 9.14: A lumper’s guide to technological ware type**

**Recording decorative technique**

By the end of the eighteenth century boundaries between technological ware types were breaking down and most ceramics (with the exception of porcelain) were marketed and priced according to their type of decoration (Miller 1980). Trying to understand in any measure the economic scaling of ceramics (see Miller 1980, 1991)—i.e. whether people were purchasing and using high-end or low-end ceramics—therefore requires you to pay close attention to decoration. When you record decorative technique you need to take note of the type of decoration and how it has been applied to the vessel. If you find a sherd with a complex decoration (i.e. that uses more than one technique), record the primary, or main, form of decoration first, followed by the secondary and then other forms. There are many ways of decorating a vessel with colour, including transfer printing, hand painting, lustre, edge banding, lithographic decals, hand-stamping, hair-lining, gilding and applying coloured glazes or slips.

**Calculating minimum numbers**

**Minimum number of vessels**

While superficially similar to a minimum number count for bottles, a minimum number for ceramics is slightly more complicated because there are a number of complementary ways to perform such a count. Voss and Allen (2010) have separated these into quantitative and qualitative methods. Quantitative method counts rim sherds for round objects (plates, saucers, bowls, cups) in different
size classes (see ‘Calculating a minimum number of vessels (MNV) from rim diameters’ below), plus other unique diagnostic features, such as bases or handles (provided they could not have come from any of the round vessels already counted from a rim sherd), or unique vessels (e.g. a statuette). Qualitative method makes a more subjective assessment based on other qualities, such as decorative treatment (two different coloured transfer prints probably come from different vessels, provided the transfer print wasn’t multichrome to begin with, and two very different decorative treatments—e.g. a flow blue transfer print versus sprigging—are also likely to indicate different vessels) or trademarks. Quantitative method provides a count of the minimum number of vessels in different size and form classes (the number of teacups, 10 inch plates, or saucers, for example) and so relies on rim sherds, but does not take into account body sherds. Qualitative method, on the other hand, may include body sherds.

Both methods use technological ware type as the primary variable for separating the assemblage into quantifiable groups, since a stoneware ginger beer bottle fragment and a refined earthenware plate fragment must derive from different vessels. Both may also vary between analysts, however, depending on their accuracy, how well the analysts agree on attributions of technological ware type, or how broad the ware type categories are to begin with (the broader categories, such as ‘refined earthenware’, will take into account more individual variation among analysts).

Quantitative rim diameter counts will be most useful to you for larger assemblages, when you have many fragments of vessels within different size classes, while qualitative assessments of form, technological ware type and decoration will be most useful for smaller ones. To some extent rim diameter counts and decorative type estimates will always be complementary and should be used together, since they are counting slightly different things. Any time that
two sherds could conceivably belong to the same vessel, however, (e.g. two different portions of the same rim, or two parts of the same body) then they should be grouped together, even if they vary slightly and you are unsure. In all minimum number counts, always opt for conservatism.

**Calculating a minimum number of vessels (MNV) from rim diameters**

This calculation is based on the percentage of the original rim that each sherd represents and the diameter of that rim as indicated by the curvature of the sherd against a rim diameter chart (see Appendix 4). Hold the sherd upright with one corner of its rim aligned with the 0 per cent baseline on the rim chart. When you do this, make sure that you are holding the sherd in the best approximation of its original curvature (i.e. make sure that all parts of the rim are touching the surface, since this is how the sherd would have been aligned when upright and part of the whole vessel). Slide the sherd slowly along the baseline until you find the concentric ring which best fits its curvature. This is your estimate of the original diameter of the vessel. The radiating line closest to the end of the sherd will give you an estimate of the proportion of the vessel’s rim that the sherd represents (rim percentage, also known as **arc length**). Bear in mind that the smaller the sherd the less accurate will be your estimate of rim diameter, since smaller sherds tend to fit more curvature lines.

Arc length and rim diameter should be measured for each rim sherd in your assemblage. You can also measure these attributes for bases, but the information obtained is less useful. Within each technological ware type, separate your rim sherds into their different size groupings (i.e. group all 10 inch plates together, all 3 inch cups, etc.). Add up the arc lengths for each size group and divide by 100 (representing one complete vessel in that size class).

Remember that a rim diameter does not take into account decorative treatment (e.g. you may have rim fragments from transfer printed and moulded 10 inch plates which are obviously from different vessels, but both will be
grouped together in a rim diameter assessment), so will not be a complete minimum number for your assemblage (see ‘Calculating minimum numbers’ above).

**Calculating a sherd count**

A sherd count is simply a fragment count, which will obviously be affected by a number of factors. Put most simply, the number of sherds from any given vessel (its degree of ‘brokenness’) will depend on things such as its size, its technological ware type and its use. It is obviously going to be a coarser measure of variation in an assemblage, since it can at best only tell you the proportions of technological ware types (such as the relative abundance of stoneware versus porcelain vessels in an assemblage). Whether you choose a fragment count or an MNV/rim diameter count will depend on what you’re comparing and what your research questions are. If you want to evaluate the relative abundance of different vessel types at a site, such as dinner plates versus tea cups in order to understand place settings, dining rituals or the presence or absence of matched sets, you would need an MNV/rim diameter count. Research suggests that a sherd count and an MNV/rim diameter count are positively correlated (i.e. when one increases, so does the other) (Hull 2007), so for relative abundance counts one will be just as useful (although measuring different things) as the other.

**Nails**

The diagnostic features of a nail are the head and various characteristics on the shaft (shank) which correspond to how the nail was made (see Figure 9.15). Wells’ (1998) list of best diagnostic features includes whether the nail is made from iron or steel, whether the head and shaft are uniform, the shape of the shaft (also known as the shank), its cross-section and the presence or absence of any taper, the presence, and nature, of any ‘pinch’ under the head (a deformation left
by the clamp that gripped the upper part of the nail when the head was being shaped), the shape of the point, the presence or absence of a burr (a slightly raised edge along the shank produced by the slicing motion of the cutting machine) and which edges this burr is present on, and how the nail has been headed. Common heads on nails include hammer-rounded rose-headed nails, made with four or five hammer blows around the circumference of the head, a flat, side-hammered T-shaped or clasp head, that often cups slightly downward and is used for clasp or flooring nails set below floor level, and flat, ‘L’-shaped-heads used for brads in interior trim, flooring, furniture and cabinetry. For more information on types of nails and their dates, see Appendix 5: Guides to dating common historical artefacts. [[INSERT FIGURE 9.15 HERE]]

**Figure 9.15:**

**Buttons**

While initially a luxury item for the wealthy, buttons became more widely used in the eighteenth and nineteenth centuries. For much of the nineteenth century, however, most of the clothing worn by women was tied, laced, or fastened with hooks and eyes, with buttons only coming to dominate the market from the 1860s and 70s (Cunnington 1990: 3). This meant that, up until the 1860s, men were the primary target for the button market and men’s costumes were often liberally supplied with both decorative and functional buttons (Lindbergh 1999: 56). The range of clothing items with buttons could include (for women) underwear, sleepwear, dresses, coats, gloves and shoes, and (for men) vests, waistcoats, jackets, overcoats, shirts, collars, trousers, underwear, sleepwear and shoes.

Like other kinds of artefacts, buttons are typically classified according to their form, manufacturing technique, material, size, and other distinguishing
characteristics, such as decoration. Since all buttons have to be attached by thread, the main division is between those for which the thread remains visible (i.e. where it passes through the face of the button; these are usually flat and are called sew-through buttons) and those for which it is hidden behind the button (i.e. where it passes through a shank at the rear; these are called shanked buttons). Sew-through buttons are the most common and oldest forms. They can have between two and six holes (two and four are the most common; six highly unusual) and, because they sit flat when sewn onto a garment, they received less wear and tear from the laundry process than raised buttons (Lindbergh 1999: 51). The shank for a shanked button could be fastened directly to the rear of the button, attached as part of a metal plate which itself formed the back of the button, or formed from the body of the button itself (this is known as ‘self-shanked’).

Both sew-through and shanked types could be left bare and plain, have their surfaces decorated by various means or be covered with thread or cloth for decoration. Thread-covered buttons were sew-through varieties made by sewing threads over a round, ring-shaped wire mould or a flat disc with a single hole in the centre, and stitching them together to form a decorative pattern. The moulds or blanks, made from round discs of wood or bone with a single hole in the centre, or from thin metal rings, are the only parts recovered archaeologically from these types of buttons. As their name suggests, cloth-covered buttons were covered in fabric, often to match the article of clothing they adorned. Shanked varieties were made from at least two pieces: a round ‘front’ that would be covered by a small piece of cloth and a second, smaller piece that fitted snugly in to form the back, although more complicated patents sometimes required several layers of cardboard and other material as infill. Covered buttons were first introduced in 1825 (Lake 1902: np) and manufactured well into the twentieth century. Two different types of shanked,
covered buttons are frequently recovered from Australian historical archaeological sites (Lindbergh 1999: 52–3). The first is a two-piece dome-shaped metal button with a hole in the base plate for the shank. The fact that no shanks have been recovered for these buttons suggests that they were made from the covering itself forced through the back of the button. The second form is a two-piece, two-hole copper alloy sew-through, which was originally covered with cotton or linen to match articles of clothing. These were first patented in 1841 (Houart 1977: 37) and mass manufactured after 1851 (Rickards 2000: 197), but see Appendix 5: Guides to dating common historical artefacts for more information. The cloth covering rarely survives archaeologically.

There is a general and logical relationship between the size of a button and its use (Lindbergh 1999: 51), although specialisation linked to size steadily decreased throughout the nineteenth century, so that by the 1920s all sizes of buttons were used on all types of clothing (Claassen 1994: 79). Before the 1920s:

- smaller buttons (8–15 mm) tended to be used on underclothing, shirts or waistcoats;
- medium-sized buttons (16–21 mm) were used to fasten coats, jackets, pyjamas and trousers; and
- larger buttons (>21 mm) tended to be used to fasten coats (George 1999: 16).

While there is a rough relationship between the form of a button and its use (Lawrence Cheney 1995: 197), all such relationships should be used with caution:

- Flat, sew-through buttons were typically used on lighter garments of cotton and wool, including underwear. These could be made from porcelain, bone, or metal and sometimes these might be covered in fabric. Most metal sew-through buttons were used on men’s trousers or other
male work clothing (Ritchie 1986: 515, 521), although covered and mother of pearl buttons were also used on men’s dress uniforms (Lindbergh 1999: 51).

- Cloth-covered: After the mid-1870s in Britain male clothing usually contained cloth-covered or plain buttons in sombre hues, a trend that continued until after WWI.
- Plain (white) porcelain buttons were used on underwear and nightwear.
- More decorative pressed glass and milk glass buttons were used on cuffs, collars and shirts.
- Metal buttons were more common on heavy work clothing, e.g. jackets, coats or overalls. Jackets and other forms of outerwear could also use linen/fabric-covered buttons, or buttons of bone, plastic or other material.
- Shell (mother of pearl) and glass buttons and collar studs were typically used on shirt cuffs and collars.
- Shell buttons were used on shirts and nightwear.

As George (1999: 2) points out, however, we can really only speak in generalities in terms of any connection between a particular button and a specific item of clothing, because buttons were (and are) highly recycled items—an activity which leaves no trace on the artefact itself.

When recording buttons, note their size (this is usually represented in lignes, as well as millimetres), form (shanked, or sew-through), the form of the shank and its method of attachment, the material(s) of the button, its form, its method of manufacture and any decorative details or trademarks.
Nicolas Grguric’s tips for recording firearms-related artefacts

The most common firearms-related artefacts found on historical sites are projectiles, percussion caps and cartridge cases. Firearms-related artefacts have the potential to provide a wealth of information to historical archaeologists, but in order to do so they need to be recorded correctly.

A **projectile** is an object that is fired out of a firearm and is almost always made of lead or lead alloy (for example, a musket ball is a projectile). A **percussion cap** is a tiny cup-shaped object, made of copper or brass, which provided the ignition in a percussion firearm, similar to modern toy cap-gun caps. A **cartridge case** is an object that contains and unites the gunpowder with the projectile and is usually made of brass or sometimes copper. When the firearm is discharged, the projectile separates from the cartridge case. When the projectile and case are still together (i.e. unfired) the object is called a cartridge (as distinct from a cartridge case).

Measurements of firearms-related artefacts should be taken in decimal points of an inch (e.g. .450”), ideally to three decimal places, in addition to metric measurements. This is because the names and calibres of firearms and ammunition used in colonial Australia were described using imperial measurements, which are still used today. For the same reason, projectiles should also have their weight recorded in ‘grains’ (1 gram = 15.4324 grains).

When recording a projectile make note of whether it appears fired or unfired (known as ‘dropped’). This can be determined by noting any deformation of the projectile and/or the presence of raised or impressed lines running longitudinally along its length (i.e. from point to base) caused by the rifling grooves inside the barrel of the firearm. Other useful attributes to record are the presence or absence of mould seams (also known as sprue marks), whether it’s conical or spherical, and, in the case of conical projectiles, whether the base is flat or hollow.

Percussion caps should be recorded by noting their interior and exterior diameter and height. Also note any embossed markings on their crown (the flat top of the cap).
Cartridge cases come in either straight-walled or bottle-necked forms and this should be noted when recording them. Take measurements of the diameter of the case at the base, body and neck, as well as the interior diameter at the neck.

When excavating firearms-related artefacts, a methodical metal-detector survey is the most efficient and effective means to locate them. If possible, fired projectiles should be excavated carefully to expose them in situ, as their orientation can suggest the direction of shooting. Orientation is not significant for percussion caps, cartridge cases or dropped projectiles. Unfired (i.e. live) blackpowder small arms cartridges are highly unlikely to explode during careful excavation and normal handling.

**Photographing artefacts**

Because artefact photography is designed to reveal technical details, it is very important that you photograph all parts of the artefact clearly. Lighting is crucial in close-up artefact photography. If you are photographing something small like a coin or a stone artefact, mount it so that it is a centimetre or two above the background. This will allow you to focus on the object, while throwing the background out of focus. Plasticine or Blu-tack® is not ideal, as it may mark the material, but it will work.

Make sure that the background contrasts with the colour of the artefact so that the entire margin of the artefact is clear. A plain-coloured background is best: either black or a relatively neutral colour. Try to avoid casting shadows since they can obscure details on the margins of the artefact, and try to ensure good, even light. Take the time to get it right, because you may never find that object again.
Tips for artefact photography

• The most important factor in taking a good artefact photograph is to ensure that you use the space to frame the artefact. There is nothing worse than looking at a vast expanse of background with a tiny artefact in the centre. While you can crop photos later, if you are not focusing sufficiently closely on the artefact, your photograph will lack the necessary detail. If you are going to be taking lots of photographs of small artefacts (for example, stone artefacts), this may mean investing in an appropriate lens to obtain the necessary close-ups.

• Use a tripod for sharper images for in low light and to compensate against hand movements that can blur the image.

• Glass artefacts are some of the most difficult artefacts to photograph well. When photographing glass, try holding the artefact up to the light in order to reveal any detail.

• If you’re photographing several artefacts in the one shot (e.g. an assemblage of bone buttons, or stone artefacts), arrange the artefacts in rows and group together artefacts of similar size.

• Choose the appropriate background for your photographs. This doesn’t always have to be artificial (e.g. a background of pale sand can work as well as a piece of cloth or paper), but make sure that the colour of the background doesn’t make it difficult to see the artefacts clearly.

• Always try to keep the plane of the camera as close as possible to the horizontal or vertical to avoid distortion. When photographing artefacts, for example, you’ll need to get directly above them to keep the camera horizontal.

• If you are taking a context shot, use a wide-angle lens to include more of the environment in landscape shots without having to sacrifice detail.

• The most important factor when using a person for a scale (e.g. in site/context photographs) is to make sure they do not look artificially posed. A photograph of them casually examining the site, or a detail of the site, will look more natural than a
photograph of them standing to attention. The latter can be especially marring if the photograph is of Aboriginal people.

- When photographing underwater, remember that the deeper you dive, the less light there will be to take good photographs. You will also lose different wavelengths of light at different depths, which will give a colour cast to your photographs.
- Also remember that objects underwater will actually be one-third further away than they appear.

**Drawing artefacts**

Measured drawings of individual artefacts are time consuming and usually only done for publication. The drawing of any artefact is not simply a mechanical process, however, but requires some interpretation and selection (Drewett 1999: 177). First, carefully examine the object and decide which aspects are most important to convey. The size and shape of the object will always be important, but what about its material? Evidence for how it was made? Different surface finishes, or areas of damage? What will need emphasising in the final drawing? It is also important to consider how you will convey the 3D nature of the object on a 2D surface: which side or aspect is the most important to draw? This will determine what will be regarded as the ‘front’ or the ‘back’ of the object, and therefore what is also drawn as the side, top or basal view. All good artefact drawings will not only be technically correct and convey the relevant technical information, but also be pleasing to the eye.

The basic process is similar for all kinds of artefacts. Unlike plans, it is far easier to draw an object at a scale of 1:1 (i.e. actual size) than to reduce or enlarge it. If an object is particularly large or small, however, the drawing may need to be reduced or enlarged as appropriate, simply for ease of working. There are four main stages in drawing most artefacts:
1. Drawing the outline.
2. Drawing the details.
3. Drawing a side view.
4. Drawing a cross-section.

Some more complex artefacts may require more views than this (such as a top, base or back for instance)—use your own judgement as to which will convey the most useful information, or look at published drawings of similar artefacts as a guide.

If you are drawing more than one artefact, give some thought to the placement of artefacts together on a page:

- Set your drawings in horizontal rows to the extent allowed by their shape and size.
- Don’t be tempted to rotate the artefacts to fit them in, however. Always keep them in their correct conventional positions.
- Put the smallest, lightest-looking artefacts at the top of the layout, and the darkest, heaviest ones at the bottom (Addington 1986: 68).
- Try to keep all the specimens of one artefact type together in a series. Do not randomly mix your drawings in complete disregard of their classifications (Addington 1986: 69).
- If you are numbering each artefact, put the numbers in the same relative position beside each artefact and make sure that the numbers or letters are arranged in a logical order (i.e. running from left to right and top to bottom).
- Make the numbering or lettering as unobtrusive as possible.
- Consider placing a border around the drawings to visually draw them together.
Drawing the outline

To draw whole objects, place the object flat on a piece of graph paper (it can be held in place with Blu-tack® or small wooden blocks if necessary). If you are drawing a small artefact, you may be able to trace directly around it using a sharp, long-pointed lead pencil. If you can’t trace directly around it, use the pencil to project points around the edge of the artefact which can be joined to give the outline (see Figure 9.16). If you are drawing a large artefact, use a set square to project points in the same fashion around the edge of the object on to the paper. If the object is regular in shape, you can probably get away with relatively few points, but if it is irregular you will need to draw as many as are necessary (generally, wherever there is a major change in angle/shape) to indicate its precise outline (see Figure 9.16). Remember to keep the pencil or set square vertical while you are doing this, otherwise you will distort the shape of the object.

Figure 9.16: Measuring the outline and details of an artefact for illustration (after Griffiths et al. 1990; Mumford 1983: 161)

Now place the artefact to one side of the outline and compare them critically by eye. You will no doubt see several anomalies in the outline which have dropped out or become ‘softened’ through the tracing process (indentations will be smaller than they ought to be, and bumps bigger). Correct the outline to define the details of the edge more sharply. If necessary, check your measurements with callipers to ensure that it is accurate. Remember that you are drawing a plan view of the artefact, therefore make sure that all of your measurements are kept in a horizontal plane. If you are drawing a stone artefact, make the lines of the outline angular rather than rounded, because this will emphasise details rather than obscure them (Mumford 1983: 161).
Drawing the details

Once you have a measured outline, you can begin on the detail. You can plot in details of the surface of an artefact by hand (Figure 9.16), or by measuring the artefact with callipers. If you are doing it by hand, place the artefact over its drawn outline and hold your pencil over the point you wish to plot. Keeping the pencil steady, slide the artefact away, then simply lower the pencil point on to the paper immediately below. You can repeat this process until you have enough points on the paper to draw the feature in fully.

This will give you a complete ‘skeleton’ of the artefact: its edge and all its features in outline. Sometimes this is all that you will need to show the artefact clearly and indicate its main features (Figure 9.17). If you think your artefact requires more interpretation, you can do this by adding shading to make it 3D. Shading can be added as stippling (small dots which increase in frequency in darker, more shaded areas), or cross-hatching (diagonal lines which increase in frequency in darker, more shaded areas). If you are at all hesitant about adding shading, then don’t attempt it—it takes as much effort to do it badly as to do it well and it is not always vital to an understanding of the object (Mumford 1983: 166) (for more tips on shading, see ‘Golden rules for drawing artefacts by hand’ on page ##).

Figure 9.17: Shading is not always essential to an understanding of an artefact, but can be used to add 3D form

Drawing a side view and cross-section

A side view is drawn by rotating the object through 90° from the surface or ‘front’ view. Always place a side view parallel and to one side of the front view—it doesn’t really matter which, although the convention is to place it to the right.

Many object drawings also require a cross-section to show the thickness or shape of the artefact. This is not a substitute for a side view. For ceramic vessels,
a cross-section will be a half-profile divided down the long axis of the pot; for stone artefacts, it will be a cross-section through the middle, or most informative section of the artefact. When measuring the thickness of an artefact for a cross-section, make sure to measure it at as many points as are necessary to convey the object’s precise form (because its thickness may not always be constant).

Whenever you draw a cross-section, make sure you indicate the line of the section (i.e. the place on the object which the section passes through) with a short line on either side of the object in the appropriate spot. Make sure the cross-section is always placed parallel to the axis of these lines and to one side of the front (surface) view. In Britain and Australia, the convention is to place this on the left-hand side, in the United States it is to place it on the right. Either way, the cross-section should either be coloured in solid black (if it is a cross-section of a pottery vessel), or cross-hatched (if it is a stone artefact).

**Reduction**

Very few finished drawings of artefacts will be reproduced at life size. Drawings are reduced for many reasons, most of them economic (some artefacts are simply too large to fit on a page and many will often need to be included on the same page). This means that the scale and level of detail you choose for drawing an artefact is very important. Bear in mind that reduction will affect every aspect of your drawing: every line will be reduced in thickness, the white space will be reduced in area, any shading, stippling or cross-hatching you have used will be closer together. This will be particularly important if your drawing is going to be reduced to one-third or one-quarter of its size for publication: if you think of how your drawing will look even when only reduced to half its size, how much of the decoration or fine detail will still be visible? When it comes to making decisions as an illustrator, one of the most important things to think about is the final scale of the published drawing: large artefacts are usually drawn at a scale
of 1:1, but then reduced to 1:3, or 1:4 in the final publication; while small artefacts are usually drawn at a scale of 2:1 so that they can be reduced to life size in the final publication.

The positive side of the reduction process is that it can actually make your drawing look better because it reduces any flaws. If you want to get an idea of how reduction will affect your drawing, try reducing it on the photocopier to see how it will look. Digital illustration via graphics programs has largely replaced the hand-drawing of artefacts and site plans. While this is good in that fills, lines, lettering and symbols can be standardised and executed more cleanly and clearly, and most people can produce their own figures quickly and cheaply, it can also impart a false sense of confidence in the final product. In particular, the fact that you can enlarge your diagram to suit the size of your monitor (or your eyesight) tends to obscure the effect of reduction for publication on your figure. Just because you can read that 8-point font when enlarged to 200 per cent doesn't mean that it will be visible on the published figure when it is reduced to one column width. Likewise, because you can use 26 different shades to denote various aspects of your site doesn't mean that the final figure will be more easily understood by a reader. We suggest that, regardless of whether you are drawing digitally or by hand, you still follow the golden rules below.

When preparing an illustration for publication:

- Draw lines which will be thick enough to reduce without disappearing. The thinnest line which can be printed confidently is 0.1 mm, any less than this and the line will break up (Griffiths et al. 1990: 8). Your lines will therefore have to be proportionally thicker than this: for those that will be reduced to one-quarter of their size, the safest thin line would need to be 0.4 mm thick, for example; for drawings which will be reduced to half their size, the safest thin line would need to be 0.2 mm thick, and so on.
• This scaling effect applies to font sizes as well—a font size that is readable when the image is large is unlikely to be when it is scaled to single column width. Make your text larger rather than smaller, assuming that everything will be greatly reduced upon publication.

• If you are using different shades for infill, make sure that reducing the drawing will not simply make them all look the same. In general, go for readily distinguishable and separable shadings (e.g. for black and white, use white, 50 per cent black or 100 per cent black; for colours, avoid shades of the same colour that are too close in hue) and not minute variations in between.

• Think about the size of your scale and how this will look when reduced. For scales, it is best to stick to simple and easily legible black-and-white bar scales with lettering that is large enough to remain legible after the reduction process.

• Bear in mind that the white space is just as important as the black lines when it comes to the reduction process. This will apply particularly to the spacing between text labels and the objects you are labelling. Make sure that you don’t place the text too close to the object, because the reduction process will reduce this spacing even more.

Golden rules for drawing artefacts by hand

• Keep your pencil sharp.

• Try not to use a hard-lead pencil (H series), as this will leave an indelible mark on the paper or drawing film that will remain even if you rub the pencil itself out. HB or B series pencils are softer and can be rubbed out completely.

• Never give only a written description of a scale (e.g. ‘Drawn at 1:1’), as the size at which an illustration will be published is unlikely to be the same as
the original (Mumford 1983: 168). Always include a simple bar or linear scale.

- Always include your name as the illustrator, and the names of any others who have taken measurements for you, as well as the date and the name of the site or other title.
- If you are drawing a plan of a site, always include a north arrow.
- Use conventional symbols wherever possible.
- Never use felt-tip pens, fountain pens or ballpoints to make final illustrations.

**For artefacts**

- Always draw an artefact as if the light is coming from the top left-hand corner. This means that shading will be to the right and on the lower right-hand sections of the artefact. If you are unable to arrange lighting from the left-hand corner, use your imagination to guide your shading.
- The main component is the front or surface view (remembering that ‘front’ will be arbitrary in some cases).
- Always use a consistent orientation, and make sure the vertical axis of the object is always kept parallel to the vertical axis of the page.
- Other standard components for most artefact drawings are a side view and a cross-section. Some very complex artefacts may require a view of the top and bottom of the artefact as well.
- Draw views of the top or the bottom of the artefact above or below the object respectively.
- Side or back views should be drawn to the right of the front view.

**For stippling**

- When stippling, hold your pen upright to produce a discrete dot rather than a small comet. If the drawing is used in a publication, it will be
reduced and stippling can easily become a black blob. Start with an overall light covering and work from lighter (less dense) to darker (denser) areas.

- Remember that the dots should be randomly placed and not ordered in rows or lines and this is harder to do than you might think. They should be evenly spaced and their density should increase gradually (Mumford 1983: 167).
- If the surface of the artefact is smooth and uniform, keep the dotting fine and uniform, with only gradual changes in tone.
- If the surface is rough and coarse, stipple with more vigour in some areas according to the character of the surface features (Addington 1986: 18–19).
- When stippling, remember that variation in the amount of white space between dots can give an impression of an undulating surface.
- Add the dots for the more heavily shaded areas last. Try to fade these areas gently into each other, unless you are trying to indicate a change of plane. Bear in mind that the densest parts should be on the right-hand side, if the light is coming from the upper left-hand corner.

For cross-hatching

- Cross-hatching should be at the same spacing as the line shading and generally should be at right-angles to the lighter tones.
- On curved surfaces, hatching should follow the curves, either round the edges or radiating down curved surfaces.
- If you need a particularly dark shadow, add a third level of diagonal hatching across the cross-hatching (Griffiths et al. 1990: 31). Avoid the temptation to add a fourth level of hatching, as it will simply appear solid black.
• It is always easier to add extra lines, cross-hatching, dots or stippling than to take them away from too crowded a drawing. If you are unsure, it is better to do less rather than more.

**Drawing stone artefacts**

Stone artefacts are arguably one of the key categories of artefacts that still need to be drawn by hand in order to reveal the full extent and scope of their features. For this reason, they are also some of the most difficult objects to draw, simply because they come in a wide variety of raw materials and sometimes show extremely detailed evidence of working. One of the main conventions to follow is to use different drawing techniques to represent the different kinds of raw materials: stippling for coarse-grained material such as sandstone, commonly used in grinding implements, and hatching for smooth, fine-grained materials such as obsidian, chert or flint (see Table 9.3).

To draw a stone artefact, follow the usual basic sequence: outline, details, side view, cross-section. There are some specific conventions to follow, however:

• When drawing the outline, remember that pencil lead will leave a residue on the artefact. If you are intending to analyse residues, use only a set square to project the outline and don’t trace around the artefact with the pencil.

• Draw the outline of the artefact first, followed by internal features such as scars and ridges.

• Draw the positive features of the ventral surface, such as ring cracks, eraillure scars and undulations.

• The position of the flake scars can be measured with dividers or callipers. Remember that you are drawing a plan of the artefact, so all measurements need to be taken from a horizontal plane (see Figure 9.16).
• Do not leave flake scars or retouched edges incomplete. If you cannot decide where each starts and ends, either dot it in, or do not show it at all.

• If the outlines of the flake scars and other details have been precisely drawn, then the direction of flaking will be self-evident (Mumford 1983: 165). You can draw curved lines within each flake scar to indicate the direction from which flakes were struck for both positive and negative scars, if you wish, but this is not generally recommended unless you are sure you can do it well. If you are not confident that you can, then leave it out.

• Indicate the point of force application with a small arrow outside the drawing.

• Cross-sections are used to show the form and thickness of an artefact. When drawn, they should be parallel to the axis on which they were taken. Draw two identifying marks outside the artefact plan to show the line of this axis.

• If drawing cross-sections of several flakes, make sure all cross-hatching lies in the same direction.

• If you are in any doubt about how much detail to include, understate rather than overstate. An artefact is much easier to interpret if it is simply and clearly drawn.

[[INSERT TABLE 9.3 HERE]]

**Drawing ceramics**

Just as there are conventions for drawing stone artefacts, there are also conventions for drawing ceramic vessels. The point of most ceramic drawings is to give an impression of the overall shape and size of the vessel, even if only fragments are available for drawing. If you are drawing a whole pot, the convention is to draw it as though it was standing upright but had been cut in
two, with one half of the drawing showing the external surface of the vessel, and the other half depicting the section and interior. The two halves of the vessel are demarcated by a solid vertical line. In a similar way to the process followed when drawing stone artefacts, to capture the shape of a ceramic vessel lie it down upon the drawing paper and use a set square to project points around the vessel down on to the paper and simply join these dots. When drawing the section, don’t assume that the thickness will be even. Use callipers to measure the thickness of the wall of the vessel at various points.

If you are drawing ceramic fragments, the focus is usually on rim or base sherds, rather than body fragments, unless the body fragments have particularly interesting or diagnostic decoration. If you are drawing fragments of a larger artefact, they should generally be drawn in their correct relationship to the whole object. In other words, if you are drawing a pot, then rim fragments should be drawn in their correct location at the rim, base sherds at the base, and so on. If you do find yourself drawing body sherds, then you will have to make your best guess as to where they fit in relation to the original curvature of the complete vessel and any other distinguishing features, such as thickness or decoration.

**Useful resources**

WORMS (the World Register of Marine Species): Find the correct species name for shellfish with this online database.
http://www.sha.org/publications/technical.htm. This is a series of technical briefs dealing with various issues in analysing and using a range of historical archaeological artefacts.

Digital type collections for historic period ceramics (US):
http://www.flmnh.ufl.edu/histarch/gallery_types/. This fully searchable site contains images of individual sherds from hundreds of different ceramic types, along with a brief guide to identification.

Evolution of English Tableware: http://nautarch.tamu.edu/class/313/ceramics/period-6.htm. The 1820s–1900s period is most useful for Australia, but this site covers several key ware and decorative ceramic types.
Colonial ceramics in Maryland (US), Seventeenth to twentieth centuries:
http://www.jefpat.org/diagnostic/ColonialCeramics/index-colonial.html. Examples of a wide range of ware and decorative types from sites in Maryland.


SMU Archaeology Lab Ceramics Database:

Resources on the north Staffordshire pottery industry:
http://www.thepotteries.org/pottery.htm. This site contains a guide to British ceramic companies and their trademarks, key ceramic types and a searchable mark database.


The most comprehensive site on historic bottle glass, organised according to diagnostic and other useful features.

The Jim Rock Historic Can Collection: information, typologies and dating techniques for cans, including examination of seams, closures, openings and materials composition, made available online by the Southern Oregon University Hannan Library Digital Collections:
CHAPTER TEN

CULTURAL HERITAGE VALUES AND SIGNIFICANCE

What you will learn from this chapter

• What cultural heritage significance is
• The role of the Burra Charter in the significance assessment process
• How to assess the cultural heritage significance of a site
• The importance of making this process evidence-based and as objective as possible
• The relationship between the statement of significance, conservation policies and the development of management strategies for a site
• Strategies for assessing the impact of development
• How to formulate appropriate management recommendations

The basics

A large proportion of archaeological fieldwork is carried out within the confines of cultural heritage management projects—the ‘business’ of professional archaeological practice. Cultural heritage management (CHM) is the branch of archaeology that deals with making decisions about why sites are important (or conversely, why they’re not), how important they are and to whom, and, based on this assessment, whether they should be preserved and, if so, how. This is no light matter—all archaeologists would accept that not every site is worth preserving. Not only are there insufficient resources for state authorities (or
anyone else) to physically look after every site, but not all sites are equally important and preserving every example of a particular site type is not necessarily going to provide better information than only preserving the best and most informative examples (otherwise known as a representative sample). To be able to make professional judgements about which are the best and most informative examples, however, requires a broad knowledge base: an understanding of sites and artefacts, both as individual representations of human behaviour and as components of a wider landscape; an understanding of representativeness (how those sites compare locally, regionally and nationally); knowledge of the appropriate legislation and relevant state regimes; an understanding of the concept of cultural heritage significance and how it is assessed; and the purposes and limitations of archaeology as part of this (archaeology is at best one part of the whole story). As a process, CHM has a number of clearly defined goals (after Pearson and Sullivan 1995: 11):

- To elucidate fairly the range of cultural values (also known as the cultural heritage significance) represented by a heritage place.
- Based on this assessment of significance, to put in place strategies for short- and long-term preservation through legal and physical preservation and conservation mechanisms.
- To implement management practices that minimise the necessity for destruction, while maximising opportunities for mitigating (i.e. moderating the severity of) the unavoidable effects of destruction or deterioration.
- And finally, if appropriate, to present the values of the place to the public through access and interpretation.

CHM thus draws on all of the skills of an archaeological field project: detailed background and desktop research; negotiation and liaison skills; a good standard
of site and artefact recording that is comparable with the results of others; detailed field observations about current site condition and past and present management issues; the ability to write complex, detailed and clear reports; and produce other outcomes when required, such as interpretive plans or materials, all within the confines of various logistical limitations. For this reason, the minimum qualifications which are considered adequate for undertaking such work are a Bachelor’s degree with Honours in archaeology or a closely related field, or some other form of postgraduate qualification in archaeology that mirrors this, such as a Graduate Diploma or Masters by coursework. A Bachelor’s degree alone is not considered sufficient. A certain amount of full-time experience may also be required, as may be a demonstrated ability to conduct a project of a certain size or scope. Such requirements are a by-product of the ethical responsibilities of the archaeologist (see ‘Archaeologists and their profession’ on page ##), in that you must be sufficiently well qualified to be able to carry out a job to acceptable professional standards. Poor quality or ill-informed assessments damage archaeological resources and the professional reputation of the archaeological community, sometimes irretrievably. It can also cause significant concern, or even emotional and psychological harm for communities or individuals with strong attachments to particular places.

**Development versus non-development CHM**

Most of the day-to-day business of CHM takes place within the context of modern development and deals with assessing the effects of potentially harmful (and often imminent) human activity on heritage sites, and taking steps to either protect those sites or to allow their destruction. This is the standard context for much professional archaeological practice and is how the majority of archaeologists find employment. In such a context, the basic tasks of CHM are to
assess which heritage sites are significant enough to preserve and which are not and to produce a written report on the process, otherwise known as a **cultural heritage management plan (CHMP)** (see also Appendix 7 for guidelines on general technical reporting). A CHMP (also known as a conservation management plan, a management plan or a conservation plan) presents an argument for the significance of a place and the actions that need to be taken to conserve that significance (or conversely, if the place is not significant, why it is not and therefore what can happen to it). It is a crucial management tool to provide advice to guide current and future activities and in some parts of Australia will function as a legally binding agreement between a land user and another group (for example, in Queensland, between a land user and a traditional Indigenous owner group). In the context of Indigenous heritage management and recent changes to Indigenous heritage legislation in Victoria and Queensland, CHMPs are the main tool used to regulate Indigenous CHM activity.

Not all CHM takes place in the context of development, however, since many organisations will undertake studies that are oriented towards documentation and management of cultural heritage where there is no specific or immediate threat of development. For example, many Indigenous Land and Sea Management programs around the country routinely undertake projects to identify cultural heritage places in order to assess their significance and whether there are management issues that need to be addressed. Commonly, issues such as erosion, vehicle traffic, vandalism, feral animals and fire are the subject of such efforts. This reflects a growing focus on holistic management that is emerging in this sector, where ‘caring for country’ as it is often called includes the stewardship of the full suite of cultural values within an area, including what many commonly (and somewhat inaccurately) refer to as ‘cultural’ and ‘natural’ heritage. In other contexts, baseline studies of heritage values are a useful means
of understanding the management issues associated with particular regions or places. As with development-driven studies, such work ideally results in the production of CHMPs as a framework for strategically focusing future management and research activities—and critically, obtaining funding to do so. Such contexts can represent very productive and positive spaces for archaeologists to work.

This chapter takes you through some of the end stages of various projects, focusing on development-driven work and recognising that the final stages of a development-driven project can require a different set of outcomes to that of a research based project. In either case, you need to understand what you are being asked to do, and know how to communicate your decisions clearly. The final stages of a project often have the most far-reaching consequences. The decisions that are made about the short or long term future of a site, the consequences of change or the way that heritage is represented and understood by the world at large reflect clearly the professional standards in a discipline and the way its practitioners see their obligations in terms of various stakeholders.

Cultural heritage significance and people

Cultural heritage significance is the fundamental building block of CHM and is the label given to those aspects of a place which make it of value to society (see ‘Assessing the nature of significance: The Burra Charter’s categories of cultural significance’ on page ##). To have cultural significance, a place must have some capacity to contribute to our understanding or appreciation of the human story (Pearson and Sullivan 1995: 7).

There are two essential models for conceptualising cultural significance: the intrinsic value (fixed) model, and the contingent/constructed (assigned) model (see Mason 2002; Tainter and Lucas 1983. Byrne et al. 2001: 7, 57–59 draw a
similar distinction between inherent meaning and attributed meaning). The intrinsic value model implies that heritage places and objects contain fixed and ‘natural’ characteristics of significance, and that, with enough research, it is possible to determine what these might be: ‘in other words, [value] is intrinsic to or inherent in a place rather than being something given to a place’ (Byrne et al. 2001: 57, italics in original). This notion places the emphasis of significance on the object (the thing being valued) rather than the people (the valuers) and sees the object as having meaning in itself, not as part of any past or present social context (Byrne et al. 2001: 59). The contingent model, on the other hand, argues that values are socially as well as spatially constructed and are only assigned as a result of the interactions between people, places and things.

[[INSERT FIGURE 10.1 HERE]]

**Figure 10.1: Intrinsic and contingent value models**

Australian practice follows the social, or contingent, model of cultural significance. Significance is thus a measure of how and why people value a place, something which can often be highly emotive and intuitive, rather than rational and logical. For this reason, what is considered to be ‘significant’ and why can change through time, as history unfolds and communities and their value systems change. Obviously, assessing cultural heritage significance is in part a subjective process, in that values can never be fixed as the ‘truth’ for all time. This does not make cultural significance any less real or important, however, nor does it remove the requirement for significance assessments to be well researched, rigorously argued and clearly evidence-based.

If we accept, then, that cultural significance is not an inherent quality of a place, but a social outcome resulting from people’s interactions with a place, then the community itself must be the most important source of significance. The central questions in assessing cultural heritage significance for any site or place should always be: who values this heritage and why, and how much do they
value it? (Johnston 1992). In this model, the archaeological profession is simply one sector of the community and, as such, must make a space for other, non-archaeological groups to value places in quite different ways. To do this we must understand the professional value system we take with us into the field as supposedly ‘objective’ observers and understand that this is just one part of the overall story of a place and its significance (Byrne et al. 2001: 69).

A central component to the process of assessing cultural significance is therefore talking to the community which interacts with, and values, the site (see ‘Community values and oral histories’ on page #). ‘Community’ can be defined in any number of ways, of course, and one of your tasks will be to decide who the community is and how its members value the place. To do this, you will have to take into account how different groups value the same place, and the scale at which these groups can be defined (are they local? regional? national?). The community which values a site such as the Sydney Opera House, for example, could be defined at a national level as all of the people of Australia, while the community which values the original cemetery at Mintaro, South Australia, might be limited to the people of Mintaro or those who have relatives buried there. At some point you will inevitably have to take into account the existence of varied and potentially conflicting values for the same place as part of the process.

**Tangible and intangible cultural heritage**

Cultural heritage is a very broad term that encompasses both the physical (tangible) aspects of sites and objects, and the many levels of intangible meaning that individual people and communities weave with, and around, them. Tangible cultural heritage includes those places or objects that have some actual physical manifestation: they can be seen, touched, measured, recorded, etc.; intangible cultural heritage includes practices that leave no enduring physical trace and
might include things such as language, dance, stories and other cultural traditions. While there is also natural heritage to consider, this is rarely the archaeologist’s purview, although aspects of natural and cultural heritage can closely overlap, particularly with Indigenous knowledge.

**Landscapes and intangible values**

Incorporating the intangible into heritage means taking seriously the idea that the community is the source of value, and recognises the complex, emotional and deeply symbolic relationship between people, identity, memory and place. As a result, while we use the term ‘site’ throughout other parts of this book, in this chapter we use ‘place’ to indicate that CHM often focuses on a broader construction of location. ‘Place’ in this sense has two meanings. Literally, it can be defined as a singular location (a house, a picnic spot, a hill or a rockshelter) or as a conglomeration of places (a town, a holiday zone, a rural area, a river valley)—i.e. as physical places. Metaphorically, however, it also has a meaning that is associated with the active construction of identity and belonging through relationships between people, sites and landscapes.

In trying to quantify how people value places it is obvious that a large part of this will extend beyond purely physical fabric (the sites and artefacts), to incorporate the intangible traces of people’s attachments that usually operate on a much broader scale:

[L]andscapes, with all their heritage places and remains, and also our minds with all their memories, are a form of archive of the past of our culture and of ourselves as individuals. We mobilise elements from this archive in the process of forming our identity. (Byrne et al. 2001: 69)
When individual places are interconnected (either as components in a larger landscape, or through specific histories of use, association or meaning), they are referred to as a **cultural landscape**, or the totality of human physical and social activity and meaning, both tangible and intangible, in an area. Because of this, the practice of CHM discourages assessing sites in isolation. At the same time, you need to take care in defining the extent of a place and its associated tangible and intangible elements, so understanding how to determine the balance between these two is a crucial skill.

**Defining cultural landscapes**

Though the idea of a cultural landscape intuitively seems simple, it is difficult to define. For most archaeological work in Australia the appropriate definition is that proposed in the NSW government publication *Cultural Landscapes. A Practical Guide for Park Management* (DECCW 2010c: 4), which defines a cultural landscape as:

> ... those areas which clearly represent or reflect the patterns of settlement or use of the landscape over a long time, as well as the evolution of cultural values, norms and attitudes toward the land.
> (DECCW 2010c: 4)

Cultural landscapes can be envisaged on a number of scales and in a number of ways. All human groups create the ‘dynamic mix of symbols, beliefs, languages and practices’ that, in Anderson and Gale's terms (1992: 3), constitute culture- and culturally-specific environmental relationships. Moreover, differences in environmental valuations may arise from personal differences affected by cultural beliefs, practices and values embedded in social context (O'Brien and Guerrier 1995). In addition, interactions between people and landscape are not only ‘complex and multi-layered’ but also ‘distinctive to each space and time’
(Brown 2007: 37). Consequently, the analysis of ‘patterns of settlement or use of the landscape’ or ‘the evolution of cultural values, norms and attitudes toward the land’ that are core to DECCW’s (2010c: 4) definition of cultural landscapes can be determined at scales that range from the area that is subject to development to the Australian continent as a whole. Different scales are appropriate for different purposes and according to different values. One approach in development-driven work is to identify the cultural landscape at two levels: (1) the core cultural landscape, which will be the focus of immediate impact; and (2) the wider cultural landscape, for which development may have ramifications. Step 2 in the *Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation* (DEC 2005: 4), headed ‘Landscape’, states that:

A description of the landscape (the physical setting of the land to be assessed) and its resources is essential for understanding the nature of the Cultural Landscape, as the opportunities and character of the land has a major influence over the nature of the interactions of the people with that land. This should describe and map landscape and landform units being used for the study (at the different levels of landscape, landscape unit, landform, topographic unit).

The idea of cultural landscapes is based on the notion of connectivity, so this needs to be assessed in terms of whether a place or area has value due to its location and functioning in relation to its surroundings. An area may be significant because of its connections to a neighbouring area, or as part of a network of areas. For example, an area may act as a corridor or stepping stone for movement/migration between, or to, areas of important resources.
Cultural mapping

One obvious way to understand and assess the web of connections between communities, sites and landscapes, intangible values, tangible remains and cultural practices is to map them spatially. This is known as cultural mapping and involves identifying and recording the cultural resources and activities of a community or region in order to understand that community's connections with the historical landscape. In essence, it is the process of understanding the relationship of all forms of culture to the social and physical spaces in which they are manifested. Under the rubric of a cultural map it is possible to map almost anything: values, individual and group histories, folktales, memories, movements, etc.

One particular form of cultural mapping, known as participatory mapping, derives from development and land-related planning worldwide, particularly in developing countries, and emphasises principles of community authorship and ownership over the maps they create. The process of a community being able to represent their own knowledge in such a way can contribute to community cohesion, raise awareness of management and decision-making issues, help to involve community members more closely in the process and ultimately empower them to articulate their own goals and needs. In archaeology, participatory cultural mapping is often used with Indigenous groups to map the values associated with heritage, but is by no means limited to this and can, in fact, be used in a variety of ways to understand and plan both with, and for, communities of all kinds.

Cultural landscapes and cultural mapping are both place-based approaches that emerge from Australia's contingent (i.e. socially constructed) model of cultural heritage significance, in particular the recognition that cultural heritage always exists within a wider framework enmeshing the places themselves and the web of connections and meanings that are woven between them (see Byrne
et al. 2001; Byrne and Nugent 2004). Denis Byrne and Maria Nugent conceptualise cultural maps as a form of ‘geo-biography’—the geographical mapping of intangible heritage (travel pathways, daily rounds, memories), documented through a variety of means, particularly oral histories. The geo-biographical approach has two aims:

1. To recognise that Aboriginal heritage, rather than being connected to the event, the activity, or the individual site, is intrinsically connected to the total landscape that gives meaning and form to these events.

2. To create a more culturally-responsible framework from which to understand sites. By moving away from an idea of sites as discrete and bounded entities, it is possible to trace the interconnections between places and the many intangible aspects of heritage that are still imprinted on the landscape through people's experiences, emotions and memories: 'It is the landscapes themselves that ought to be considered heritage, rather than discrete and dispersed “sites” within them'. (Byrne and Nugent 2004: 73)

They argue that a geo-biographical approach illustrates how memory, heritage and people are all interconnected and argue that such understandings can only enrich spatial and discrete archaeological data. Such an approach works just as well for European as Indigenous sites, of course, since all human beings create such webs of meaning around the places they value.

**The Burra Charter and cultural significance assessment**

Understanding that people and their memories are what construct heritage is one thing; understanding how to quantify this in relation to an actual site and therefore compare and assess one site in relation to others is something quite
different. To do this requires some means of separating different types of significance, understanding their overlap and measuring their relative importance. In Australia the **Burra Charter** (Australia ICOMOS 2013a) is widely accepted as the standard means of achieving this. Even though it evolved from European charters designed to protect monuments, the Burra Charter was specifically developed for the Australian context and therefore can equally be applied to Indigenous or European sites. One of the 2013 Practice Notes (Australia ICOMOS 2013b) provides specific guidance on how the Burra Charter can be used within the context of Indigenous CHM.

According to the Burra Charter model, cultural significance is customarily assessed in terms of five main categories: aesthetic significance; historical significance; scientific/research (in many cases archaeological) significance; social significance and spiritual significance. These are not mutually exclusive: a site which has historic significance can also possess aesthetic significance as part of its locale or scientific/archaeological significance if it can also contribute to archaeological studies. It is also possible for the one site to possess significance for both Indigenous and European people. Even though some values will be more dominant than others, a professional assessment of heritage values will include all the values that are depicted in Figure 10.2, with consideration of the interrelationships between them.

**Figure 10.2: Assessment of values**

Different states have specific definitions of cultural heritage significance enshrined in their Acts, so you also need to be aware of how these echo and diverge from the Burra Charter categories. The *Victorian Aboriginal Heritage Act 2006*, for example, defines cultural heritage significance as including archaeological, anthropological, contemporary, historical, scientific, social or spiritual significance, and significance in accordance with Aboriginal tradition.
The overlap with the Burra Charter categories is clear, as are the specific requirements of working under the Victorian legislation.

If we can’t retain everything, then the assessment process becomes one of objectively establishing the *nature* of a place’s significance (i.e. what categories of cultural significance it may embody), the *degree* of that significance (as a ranking of items, places or elements against one another) and the scale or level of that significance (local, regional, state, national or global). It is only once you’ve done this that it is possible to develop strategies to manage the place (remembering that ‘managing’ is not necessarily synonymous with ‘retaining’).

**Assessing the nature of significance: The Burra Charter’s categories of cultural significance**

**Aesthetic significance**

This is one of the hardest categories to evaluate, as almost everyone has their own idea of what is visually pleasing. In addition, there is a general recognition that aesthetic significance is a Eurocentric concept which may remain quite alien to Indigenous cultures, or at least that particular understandings of aesthetics may be overly culturally determined. Aesthetic qualities may include the concept of beauty and formal aesthetic ideals. Expressions of aesthetics are culturally influenced (Australia ICOMOS 2013c: 3) and aesthetic significance often is closely linked with social significance (Office of Environment and Heritage 2011: 9). The assessment of aesthetic significance also often seeks to integrate both natural and cultural heritage values (e.g. Context 2003). Aesthetic considerations are particularly pertinent to assessing some kinds of heritage, such as rock art, not only in terms of appreciating the art itself but also in terms of rock art research (Heyd and Clegg 2006).
The qualities which might be considered part of aesthetic significance have been most clearly set out by James Semple Kerr as the formal or aesthetic qualities of a place which make it visually pleasing (Kerr 2013: 15–16), although how to determine this has long been a vexed question. Kerr argues that aesthetic significance can be assessed in terms of the individual elements present at a place, in terms of the unity of scale, materials, texture and colour evident between elements, in terms of the degree of contrasting elements which may or may not be disruptive, or in terms of the entire landscape setting in which each of these elements combine to produce an overall impression (Kerr 2013: 15). Of importance in assessing aesthetic significance is the degree to which a place has a relationship between its parts and its setting which reinforces the quality of both (Kerr 2013: 17).

Aesthetic significance, then, according to Kerr, is concerned with:

- The form, scale, materials, texture, etc. of the object/place.
- The visual setting of the feature/place and the visual relationship between a place and its surroundings. The visual catchment is an analysis of the physical and symbolic relationship between the components of a place and its/their landscape setting. How much of the immediate setting is evocative of the nature of its significance?

There is often no clear distinction between a place and its setting, but if a place is significant because of its visual attributes, then its setting is also going to be of some importance. One obvious problem with aesthetic significance, at least for archaeologists, is that many archaeological sites will be subsurface and therefore unable to be assessed on aesthetic criteria. You will need to decide on a site-by-site basis whether aesthetic significance is a relevant category to assess, rather than taking this as a given. In an attempt to break away from narrow or conventional—and certainly Eurocentric—definitions of ‘pretty’ or ‘beautiful’, an
Australian Heritage Commission working group into identifying and assessing aesthetic value defined it more broadly than Kerr, as:

The response derived from the experience of the environment and cultural attributes within it. This response can be to visual or non-visual elements and can embrace emotional responses, sense of place, sound, smell and any other factors having a strong impact on human thoughts, feelings and attitudes. (Paraskevopoulos 1994: 81)

This hints at some of the problems inherent in trying to capture aesthetic significance: it is a product of a powerful emotional experience rather than a checklist of attributes. If aesthetic significance is at least in part about the emotional responses that we have to a place, then in some cases, other senses apart from sight have the potential to contribute to a place’s aesthetic significance. Vision accounts for 80 per cent of our sensory input, but sound, smell and tactility are also important, since we can smell, hear and feel different aspects of places. One definition of aesthetic significance is:

Aspects of sensory perception (sight, touch, sound, taste, smell) for which criteria can be stated. These criteria may include consideration of form, scale, colour, texture and material of the fabric or landscape, the smells and sounds associated with the place and its use. (Australia State of the Environment Committee 2001, Natural and Cultural Heritage, Theme Report: Glossary)

Obviously, many archaeological sites will be subsurface and therefore will not be able to be assessed on aesthetic criteria. You will need to decide on a site-by-site basis whether aesthetic significance is a relevant category to assess, rather than taking this as a given.
The Burra Charter Practice Note on Understanding and Assessing Cultural Significance (Australia ICOMOS 2013c) outlines useful questions to ask when assessing the aesthetic significance of a site:

- Does the place have special compositional or uncommonly attractive qualities involving combinations of colour, textures, spaces, massing, detail, movement, unity, sounds or scents?
- Is the place distinctive within the setting or a prominent visual landmark?
- Does the place have qualities which are inspirational or which evoke strong feelings or special meanings?
- Is the place symbolic for its aesthetic qualities: for example, does it inspire artistic or cultural response, is it represented in art, photography, literature, folk art, folklore, mythology or other imagery or cultural arts?
- Does the place display particular aesthetic characteristics of an identified style or fashion?
- Does the place show a high degree of creative or technical achievement?

Because aesthetics is so closely tied to personal experience, many definitions of aesthetic significance tend to merge with aspects of social significance, and there can be considerable slippage between the two.

**Historical significance**

Historical significance was the first and oldest conservation value, and has been linked to the historic preservation agendas and missions of the National Trusts in the UK and Australia since the late nineteenth and early twentieth centuries (Emerick 2001: 279). Historical significance relates exclusively to the period of European occupation of Australia, although it does not refer exclusively to European places or things (for example, Indigenous–European contact sites may possess significance under this category). Such significance is commonly
identified in terms of a set of themes which relate to such influences as an
historic figure, event, phase or activity. More specifically, a place may have
historical significance because it typifies past practices, or because it may be the
site of an important event (Pearson 1984: 32). Such connections are part of what
James Semple Kerr (2013: 14) terms ‘associational significance’:

Irrespective of whether evidence survives or not, places can have
associational significance for a variety of reasons. These may include
incidents relating to exploration, settlement foundation, Aboriginal-
European ... contact, massacre, disaster, religious experience, literary
fame, technological innovation, notable discovery and popular affection.

Almost all sites will have an association with something or someone,
however, so Kerr (2013: 14, 17) also notes a threshold for assessing such a link:

In general ... the accidental or transitory association of the ‘Great’ with a
place, for which there is little surviving evidence or aspect of symbolic
importance, does not confer significance ... Assessment of the level of
significance in associational links requires a knowledge of:
0  The level of importance of the associated event or person to the locality or to the
    nation.
0  The level of intimacy and duration of the association.
0  The extent to which evidence of the association survives, either in physical
evidence at the place, or as evidence of the impact of the place on persons,
literature and events.
0  The intactness or evocative quality of the place and its setting relative to the
    period of the association.

The Australian Heritage Commission (2001), later the Australian Heritage
Council, developed a range of historical themes applicable to Australia as a
whole. These are deliberately generic and intended to apply to all places at all
levels of significance—local, regional, state or national—so cannot just be
applied ad hoc. Instead, you should use them to stimulate your thinking and help you to make comparative assessments. Many states have adapted these national themes to produce sets of complementary state historical themes which are particular to their own contexts and may be more relevant to particular sites and case studies.

The Burra Charter Practice Note on Understanding and Assessing Cultural Significance (Australia ICOMOS 2013c) outlines useful questions to ask when assessing the historical significance of a site:

- Is the place associated with an important event or theme in history?
- Is the place important in showing patterns in the development of history locally, in a region, or on a state-wide, or national or global basis?
- Does the place show a high degree of creative or technical achievement for a particular period?
- Is the place associated with a particular person or cultural group important in the history of the local area, state, nationally or globally?

**Scientific (archaeological) or research significance**

Because archaeologists were often the ones studying the ancient monuments and other traces of a supposedly dead past that have formed the core of conservation agendas for the last two centuries, archaeological value became a core, early tenet of the conservation movement, reinforced by the New Archaeology of the 1960s which sought to quantify, compare and measure sites across widely varying contexts. With the rapid professionalisation of the discipline in the 1970s and 1980s archaeologists often became the ones staffing heritage conservation departments and so their interests greatly influenced the direction of the idea of significance, particularly in its technical (or scientific and research-based) sense. Because specialists are commonly the ones who are called in to deal with heritage management assessments, however, scientific research can be
interpreted overly narrowly as ‘archaeological’. For example, buildings and engineering features contain evidence of stylistic or technological innovation that can be investigated, while nineteenth century gardens may contain plants or plant remains with historical or horticultural research potential.

In essence, scientific significance captures the research potential of a site and the relevance of any data that the site might contain for the pursuit of meaningful research questions. Bear in mind that the research questions may well be applicable beyond the context of the single site being studied (Pearson 1984; Schiffer and Gummerman 1977). Significance under this category includes the research potential of the site itself and its representativeness within a wider suite of known sites. The scientific significance of Indigenous heritage sites is normally determined by the project archaeologist in cooperation with the Indigenous community. Ideally, scientific significance is evaluated in terms of a detailed research design focused on some aspect of past Indigenous lifeways. If a site can be demonstrated to contain information important for addressing issues in the research design, a defensible evaluation of scientific significance can be made.

Scientific significance is also concerned with the potential of a site to address anticipated future trends in academic research interests and should take into consideration the issue that future research capabilities and interests cannot be predicted with any accuracy. Since it is impossible to anticipate all research questions, it is also difficult to identify and conserve suites of sites that may be capable of addressing all future research problems. To avoid the problem of using specific research designs to evaluate sites, the concept of ‘representativeness’ was advocated in Australia as an additional consideration for evaluating scientific significance (Pearson 1984: 2). According to this concept, an adequate dataset for all present and future research designs can be
conserved by identifying and preserving a representative sample of the complete range of site types in an area.

There is no nationally set threshold for archaeological significance, partly because the issue of what constitutes an archaeological ‘research resource’ is, and probably always will be, highly debated. One guide which may help you to decide whether a site is of archaeological significance rests on its ability to answer three questions (Bickford and Sullivan 1984: 23–4):

1. Can it provide information not available from other sources?
2. Can it provide information not available on other sites?
3. Can it answer pertinent research questions?

The NSW Heritage Branch (2009) provide more specific advice for assessing archaeological research potential for historical archaeological sites (although the principles can be applied to any site). This is ‘the ability of archaeological evidence, through analysis and interpretation, to provide information about a site that could not be derived from any other source and which contributes to the archaeological significance of that site and its “relics”’ (NSW Heritage Branch 2009: 11). In deciding whether something has high or low research potential, the integrity of a site and its preservation conditions for archaeological material and deposits will be highly relevant. They suggest asking the following questions:

- Is the site likely to contain the mixed remains of several occupations and eras, or is it expected that the site has the remains of a single occupation or a short time period?
- Is the site rare or representative in terms of the extent, nature, integrity and preservation of the deposits (if known)?
- Are there a large number of similar sites?
- Is this type of site already well-documented in the historical record?
• Has this site type already been previously investigated with results available?
• Is the excavation of this site likely to enhance or duplicate the dataset?

**Social significance**

The significance of any site in terms of its social value lies mainly in its association with a particular recognisable community, or parts of a present community. Social significance is often defined in terms of the degree of contemporary community esteem which is attached to a place and aims to establish whether, for example, damage to a site or its contents would cause the community a sense of loss, or whether the site contributes to a sense of community identity. Marquis-Kyle and Walker (2004: 80) define social significance as ‘the qualities for which a place is associated with a community or cultural group and the social, political or other cultural meanings that the place signifies to the group’.

• Is the place important as a landmark or local symbol?
• Is the place important as part of community identity, or the identity of a particular cultural group?
• Is the place important to a cultural group because of associations and meanings developed from long use and association, or from the strength of attachment?

When considering sites of social significance, it is important to try and distinguish heritage values from other values, such as amenity or utility. The local supermarket has great amenity value but it may not be a place with social heritage value. Places with current, but probably short-lived, amenity value to a community would usually not be assessed as having heritage value. As an illustration, an assessment in 1998 of the social significance of State Forests
across NSW from the border with Queensland to the lower Hunter River Valley asked community members to nominate the places they felt attached to. The majority of these were the traditionally scenic natural landmarks (mountains, hills, rivers, escarpments, etc.), water features (waterfalls, lakes, pools) and lookouts and scenic drives that people typically took visitors to. Several sites, however, related to other forms of regular and often long-term community use, such as camping, picnicking, horse riding and fishing spots. A smaller percentage related to places that had served as foci for other community initiatives, such as protest sites associated with the logging of old growth forests, koala habitats and flora reserves.

All of these locations either had a long history of use, were places that locals took visitors to as part of presenting the character and nature of their local area to outsiders, or had served as important social and political focus points that had brought members of the local and wider community together over key issues. James Kerr (2013: 48) uses the term ‘sense of place’ to describe these attributes and separates them into five categories:

1. Places that remain evocative of an event or association. Creations, disasters and massacres are high on the list of examples—particularly if physical or topographical evidence continues to reflect the contemporary situation and the place has not been overlaid with distractions.

2. Places where function and/or attitude and belief are dominant elements in giving expression to the form and character of the place. Specialised structures such as prisons, forts, churches and industrial plants are examples.

3. Places that are dominated or affected by a powerful feature or features, either natural or man-made, that imposes its character on the surroundings.
4. Places that sensory impressions and current tastes identify as pleasing and appropriate. Both townscapes and landscapes are strongly in this category. These impressions may arise from homogeneity and congruity or from the nature of relationships within and without the site. The reverse may also be true: locations that are displeasing or horrible may have an even more powerful sense of place.

5. Places that have been fashioned and used by the occupants over a period of time in accordance with local traditions and materials.

Social value is not always clearly understood, even by those who can be considered to be its possessors, until faced with a sense of loss or an imminent threat to a place, indicating how contingent it can be on wider activities. Social significance can only be identified by seeking the shared opinion of community members about the characteristics they value, or by observing the way in which the community relates to the place. Realistically, all places are likely to have some degree of social value to some part of the community, provided you ask enough questions and talk to enough people, so the assessment process needs to be able to distinguish objectively between those places and the places that can be argued to meet a threshold for social heritage value. These will be places that are held in strong and special regard by the community as a whole or by a particular group within it. For example:

- Does the current community or group see the place as being more important than other places?
- Is it important in maintaining the community’s or group’s sense of identity in some way, and, if so, how?
- Has it become important to the community or group because of its use over a long period of time?
• Is it associated with an event or person venerated by the community or group?
• Does it have special meaning in the community’s religious, cultural, educational or social life?
• Is it held in high esteem because of its visual qualities or its landmark qualities? (i.e. is it a place people identify with as part of who they are, such as places they show to visitors, or places that everyone recognises as a landmark?)
• Is there a strong sense of attachment to the place? In other words, would damage to the site or its contents cause the community a sense of loss?

One of Byrne et al.’s (2001: 7) main problems with the treatment of social significance by the Burra Charter is that it places all categories of significance on a par with each other. They argue that this artificially makes social significance appear to be equal with all of the others and presumes that aesthetic, historical and scientific qualities are somehow not also social values themselves. It also reinforces a separation of professional ‘objective’ values from ‘subjective’ community values. Instead, Byrne et al. argue that the social is not a subset, but rather the overall framework which contains the others. For them, all cultural heritage is only meaningful because it is located within society—i.e. heritage cannot exist outside of the social.

When assessing the degree of social significance a place may have, ask yourself these questions (for more detailed discussion, see Australia ICOMOS 2013c; Johnston 1992 and ‘Assessing the degree of significance’ on page ##):
• Is it widely known among the community?
• Is it highly valued by members of the community?
• Has it been known and valued for a long period of time?
• Is the place important as a local marker, landmark or symbol?
Answering yes to one or more of these questions means the place has social significance. Assessing how large the community which values it is will give you some guide as to how significant it may be and why (see ‘Assessing the scale or level of significance’ on page ##). This means that you will also have to make a decision about who constitutes the community. It is not necessarily going to be simply all the people who live in a particular area, because sectors of this geographic community may be unaware of a place, or may value it completely differently to others. If a place is a popular recreational destination, for example, it may be of value to a much wider community than simply the people who ordinarily live there. Holidaymakers may come from all over the country to visit it, making the community which values it much broader (see ‘Assessing the scale or level of significance’ on page ##).

**Spiritual significance**

The fact that strong symbolic values are a central part of social significance led the Burra Charter to define a fifth category of significance in 1999: spiritual value. This embraces intangible aspects and meanings of a place that relate to traditional knowledge, spiritual belief systems, art or other related cultural practices (Marquis-Kyle and Walker 2004: 80):

[Spiritual value] may derive from the intensity of aesthetic or social values and the physical qualities of the place that inspire an overwhelming spontaneous response in people, evoking or broadening their understanding and respect of life.

As outlined in the Burra Charter Practice Note on Understanding and Assessing Cultural Significance (Australia ICOMOS 2013c) useful questions to ask when assessing the spiritual significance of a place include:
Does the place contribute to the spiritual identity or belief system of a cultural group?

Is the place a repository of knowledge, traditional art or lore related to spiritual practice of a cultural group?

Is the place important in maintaining the spiritual health and wellbeing of a culture or group?

Do the physical attributes of the place play a role in recalling or awakening an understanding of an individual’s or a group’s relationship with the spiritual realm?

Do the spiritual values of the place find expression in cultural practices or human-made structures, or inspire creative works?

Peter Read (2003) has extended notions of spiritual value to European sites through his work on ‘inspirited places’, but also points out that spiritual values are extremely difficult to quantify according to accepted precepts of Western scientific objectivity (Read 2003: 246).

**Community values and oral histories**

The very fact that ... remembrances exist only in memory means that they are a nonrenewable resource ... When a generation dies, it is like burning down an archive full of unique and nonretrievable information. (Orser and Fagan 1995: 150)

Archaeologists primarily use oral histories as a way to understand the contemporary meaning of sites and places—the intangible values that people hold—although site- or artefact-specific information might also be included as part of the questions or answers. They thus can contain important data upon which you can base your assessment of the social or spiritual significance of a
site and may also help you to determine appropriate management strategies for places or objects, particularly if management in any way involves people from the local community.

Oral histories can be as valuable as written documents, particularly in relation to those aspects of daily life that don’t translate directly into archaeological artefacts, such as personal beliefs, feelings, reactions or kinship networks. The most important thing to bear in mind is that an oral history is a collaborative process between you, the interviewer, and the person being interviewed. It is not a process of ‘extracting’ information from an ‘informant’, but building a shared understanding of what a site or artefact meant to the people who used it in the past. You should also be aware that all university-based research involving oral histories will need clearance through a university ethics committee before you can begin. Similarly, all research projects funded by the Australian Institute of Aboriginal and Torres Strait Islander Studies (AIATSIS) require ethics approval before the project begins. The AIATSIS Guidelines for ethical research in Australian Indigenous studies are outstanding and encompass both ethical research and human rights (see ‘Archaeologists and ethics’ in Chapter 1).

**Recording oral histories**

Oral histories may be formal oral histories (i.e. structured or semi-structured interviews with identified questions or areas for discussion) or informal discussions with individuals or groups. Group meetings, or focus groups, in which community members can participate to identify places that are of value to them and talk about why those places are of value, are a particularly good way to begin this process. These can then be followed up with targeted oral histories with older residents or more knowledgeable or relevant people.
When recording an oral history, either for research or consultancy purposes, don’t just target important or historic events. These are singular, one-off occurrences which, while interesting, provide little information about ordinary people and their day-to-day life. The minutiae of many common daily activities (such as certain types of food preparation, or agricultural practices) would be lost to us without oral history. When conducting an interview, you will have to strike a balance between letting people follow their own memory trails (which may provide you with information you haven’t anticipated) and keeping them on track so that you get information which is useful to you. For best results, interview people in an environment where they feel comfortable (such as their own home) or take them into the field to visit the site to identify specific features and try to prompt their memories with visual cues. If you can’t take people into the field, take some photographs of the site to show them during the interview and perhaps prompt them that way.

Wherever possible, ask open questions—that is, questions which require more than a simple ‘yes’ or ‘no’ answer—because these will elicit the most information. If you don’t think your question has elicited enough information, try following up with exploratory queries such as: ‘Tell me more about ...’, ‘Explain what you mean by ...’, ‘Give me an example of ...’ or ‘What date/year did that happen?’ For the same reason, don’t ask leading questions (‘The house was painted red, wasn’t it?’). These essentially tell people the answer, or supply a potential answer for them rather than allowing them to explore their own memories of the event. Once you have asked a question, wait and listen to the response. Even if the urge to interrupt—either to clarify a point or to ask another question—is great, don’t. Make a note of the point and follow it up later.

In all interview situations, you will have to make some judgements about the reliability of the information and not simply accept everything at face value. In local historical archaeological research people sometimes tend to repeat other
(usually secondary, written) histories. Make sure the stories you are being told are not simply being rehashed from someone else’s already published book or, if they are, that you trace them back to their original source.

The ethics of good practice are particularly important when conducting an oral history interview (see ‘Archaeologists and ethics’ in on page ##). The interviewee is providing you with information, but you must be sensitive to the effects it may have on them or others. If a memory is painful or difficult to recall, or simply embarrassing, don’t press the issue. Keep a close watch on the body language of the person being interviewed, as this will tell you how comfortable they are with the whole process.

At the beginning of the interview, you must be very clear about the nature of the project, the purpose of the interview and how you intend to use the information. Identify yourself and the interviewee by name at the beginning of the tape or at the beginning of your notes, and also note down basic particulars about the person you are interviewing. How old are they? Where were they born? Without knowing at least how old they are, you will not be able to correlate information about events that happened to them at certain stages of their lives to calendar dates/years.

At the end, you must ask the interviewee for their permission before you reproduce any part of it, or make it available in any kind of public document. This process is called ‘informed consent’ and is particularly important when you are interviewing Indigenous people. When obtaining informed consent, you need to give an outline of your project and make sure people understand that their participation is voluntary and that they can change their mind at any time about participating. Sometimes you may need to obtain a signed consent from your interviewees.

It is also important that you minimise any potential harm to participants. This includes physical harm, subjecting people to undue stress, or undermining their
self-esteem. While archaeology seems pretty innocuous on the surface, our job is actually writing the story of other people’s pasts and some of these stories might have the potential to hurt people. You need to ask yourself what kinds of precautions have been taken to keep risk to a minimum: does your study involve particularly vulnerable subjects who may require special consideration?

Finally, if you are interviewing people you will need to give them the option of being anonymous and you may need to take special measures to ensure their privacy. This is particularly so if you are working with Indigenous people, who are often very cautious about how they will be portrayed by researchers (see ‘Recording Indigenous oral histories’ below). Some Indigenous groups will not consent to research being undertaken unless they have a certain amount of control over the process and the presentation and published form of the results that will arise from the research.

**Recording Indigenous oral histories**

The methods used to record Indigenous oral histories are comparable to those used to record any oral histories. In dealing with Indigenous people or communities, there are several specifics that you should bear in mind, however:

- Indigenous people often think it is rude to ask direct questions. They are therefore likely to be under more stress than non-Indigenous people when a formal interview is being conducted.

- It is important to leave room for people to shape the interview process themselves. This can be done by allowing people to go off on tangents, or talking about the things that are important to them (but which may not be of immediate importance to you). Often, this will deepen the quality of the interview and is part of establishing trust between the interviewer and the person being interviewed.
• If people avoid answering a question, it is usually because it is not something they wish to answer. Don’t harass them, and take constant note of their body language as this will give you a clue as to how comfortable they are feeling during the interview.

• Sometimes people may know the answer but will not have a right to speak on that particular topic. In this case, they may direct you to the person who does have a right to speak, by saying ‘Ask Joe’ or ‘Mary might know about that’. This is not a refusal to help you, but Indigenous protocol for dealing with information in a system of restricted knowledge.

**Assessing the degree of significance**

Both the degree of significance (how much value does a place have?) and its scale (how widely valued is it?) are ranking systems that are imposed upon the nature of significance: a place can be argued to hold certain types of value, but an assessment must also take into account how important these values are (i.e. are they all equally important or are some more defensible than others?). In other words, in terms of the appropriate categories of significance that you have identified, does the place have a little or a lot? How important is one site when compared to other, similar sites both locally and elsewhere? This is analogous to a mapping of values.

Degree is therefore the first threshold that must be crossed to determine whether or not a site is significant when it is compared to other, similar sites elsewhere. Assessing the degree of significance partly rests on evaluating the site against three further moderators of cultural heritage value: representativeness, rarity and integrity. **Representativeness** is an assessment of whether or not a place is a good example of its type, illustrating clearly the attributes of its significance (whatever they may be). **Rarity** is an assessment of whether the
place represents a rare, endangered or unusual aspect of our history or cultural environment that has few parallels elsewhere. Thus a place that has historical significance might be representative of the historical development of a region, but might not be rare, in that many other similar places might also exist in the region. **Integrity** is an assessment of how physically intact a place is and therefore the extent to which the values are preserved in, and can be connected to, the fabric of the place and is based on the concept that less negative interference is better. Integrity will be affected by the factors that are contributing to the survival of fabric and deterring from it, so is essentially an evaluation of what might have negatively or positively affected the fabric, setting, design, or layout of the place over time. Throughout this process you need to keep in mind that modification does not automatically equal a loss of significance, however. If the values that make a place important are linked to its changing nature and form (i.e. the place’s evolution, its growth, or its changing nature and use), then physical evidence of modification might actually be contributing to its significance.

When articulating a degree of significance for a place or an object, James Kerr (2013) and the NSW Heritage Branch (2009) suggest using a ranking system of exceptional, high, moderate or little, with clear justifications for each one. Something that is exceptional, for example, should be rare or outstanding in both its local and state context, have a high degree of intactness and be able to be interpreted relatively easily (NSW Heritage Branch 2009: 4). Something that is judged to be of little significance, on the other hand, might have aspects that detract from its significance and be difficult to interpret.

Such a ranking might apply to the different categories of value for a site as a whole (e.g. a place might be assessed as having exceptional historical significance, little archaeological significance, but no aesthetic significance), or to individual parts or components within a site (i.e. later intrusions might be
determined to have less aesthetic significance than evidence from earlier periods). In the latter situation—i.e. a complex site that has a range of values attached to different parts or portions of it—you might have items or areas that need to be ranked against each other. One way to cope with this situation is to create zones to bound these different areas. These can be ranked in terms of their relative significance and thus be used as the first step in determining the level of physical intervention (defined as disturbance to the surface and subsurface remains) which is permissible within each. For example:

- **Zone 1,** represents the areas of highest significance, containing the rarest, oldest or best preserved tangible remains, or the areas/objects with the strongest intangible social or spiritual values. No work should be undertaken in these areas that would adversely affect these remains.

- **Zone 2,** covers the areas of medium significance, containing those features which are not so well preserved or informative. Physical intervention in these areas should be limited, guided by appropriate conservation principles and conducted in a sympathetic and responsible manner.

- **Zone 3,** covers all those areas assessed as being of low cultural significance, including all those areas which have been heavily altered during the most recent phases of the site’s life, or those which are severely limited in both the quality and quantity of information which they can convey. Maintenance or rehabilitation measures undertaken here should be guided by the Burra Charter principle that physical intervention be kept to a minimum.

**Assessing the scale or level of significance**

This type of threshold is usually a statutory mechanism to decide whether a site meets the minimum level of significance required in order to make it on to a
local, state, national or world heritage list (see ‘Working with the legislation’ on page ##). This is in effect an assessment of the scale of the community who value the place. Obviously a site that is only valuable at the local level (e.g. only the people in that particular town think it’s important) may meet a threshold for a local level of significance and protection, but not for state, national or international levels of significance. Just because a site is only valued by a local community, however, does not mean that it is valued less (i.e. that the degree of its significance is lower), or that the nature of its significance is compromised in any way:

Local heritage makes the greatest contribution to forming our living historic environment, more so than the small number of outstanding items of state, national or world significance. Greater than the sum of its parts, the varied collection of local heritage in an area enriches its character and gives identity to a neighbourhood, region or town in a way that cannot be reproduced. (NSW Heritage Office 2008: 4)

Another is to determine how the place compares to other similar places. Again, this is linked to representativeness, and can be carried out at several different scales of analysis. There can often be confusion between local and regional in terms of comparing sites. Regional is not a term favoured by state agencies because it doesn’t link directly to any legislated lists, which exist only at local, state, national and world levels. Agencies therefore only allow comparisons of places against each other at local or state scales. Unfortunately, there is often quite a divide between local and state, which fails to take into account the regional quality of much Australian development and history. As a scale of analysis and comparison, regional is larger than local, but smaller than state, and can often be much more meaningful in the assessment of values, even if it does
not provide a guideline for deciding whether or not a place meets the threshold for entry on a statutory list.

[[INSERT FIGURE 10.3 HERE]]

**Figure 10.3:**

### Setting boundaries for significance

All sites are located within a social and a physical setting, as well as a visual and a spatial one. While the cultural landscape aspect of significance assessment encourages us to view individual sites as nodes in a wider mnemonic landscape of movement and meaning, this creates obvious problems for heritage management. The idea of landscape is not limitless, and for administrative purposes (which is the backbone of all heritage management), boundaries have to be drawn somewhere and defined accordingly. So how do you determine where significance begins and ends? There are a number of ways to define boundaries for significance as part of the heritage assessment process:

- Relatively, in terms of the level of significance—i.e. whether a site meets an agreed threshold for significance within any of the identified categories of significance, and what this means for how significant the place is (i.e. is it important locally, state-wide, nationally or globally?) (see ‘Significance thresholds’ above).
- Legally, in terms of the lot boundaries (or curtilage) of the site.
- Geographically, in terms of a heritage curtilage that protects the significance of the site. This may or may not be the same as the second point above.
- Visually, in terms of the visual catchment of the site, or the spatial area that contributes to the site’s ability to demonstrate various qualities (historical, architectural, technical, etc.). While closely linked to
geographic curtilage, this can be much wider, in that views to and from the site, even from a great distance away, may be assessed as being a critical part of its significance.

These four kinds of boundary are most frequently used to mean the heritage setting of a place, not just its absolute legal boundaries. The Xi’an Declaration on the Conservation of the Setting of Heritage Structures, Sites and Areas, adopted by the 15th General Assembly of ICOMOS in October 2005, acknowledges the contribution of setting to the significance of monuments, sites and places, and defines it as:

... the immediate and extended environment that is part of, or contributes to, [a heritage site’s, structure’s, or area’s] significance and distinctive character. Beyond the physical and visual aspects, the setting includes interaction with the natural environment; past or present social or spiritual practices, customs, traditional knowledge, use or activities and other forms of intangible cultural heritage aspects that created and form the space, as well as the current and dynamic cultural, social and economic context. (Principle 1)

This is a very broad definition, however, since it encompasses the entire purview of CHM. For the purposes of a more practical assessment process it is ‘the physical and visual aspects’ of the setting that are important. The Heritage Office of NSW labels such a setting a heritage curtilage and defines it as:

The area of land (including land covered by water) surrounding an item or area of heritage significance [and] which is essential for retaining and interpreting its heritage significance. It can apply to either: land which is integral to the heritage significance of items of the built heritage; or a precinct which includes buildings, works, relics, trees or places and their setting. (NSW Heritage Office 1996: 3)
In establishing where an appropriate curtilage might be, the NSW Heritage Office (1996: 9) recommends considering:

- historical land subdivision practices;
- the location of archaeological features;
- visual, physical, historical and functional links between the place and other important features in the area; and
- the setting, view and landmark qualities of the place.

James Semple Kerr (2013: 40), however, argues against using the word ‘curtilage’ because of its ambiguity, and suggests instead either the term ‘boundary’ (if the purpose is to provide a precise identification of the extent of a place, such as when defining its legal boundaries, or the limits of the significant fabric of the place), or ‘setting’ (if the purpose is to provide a more general description of a surrounding area). He defines setting as:

... an area surrounding a place whose limits may be determined by sensory criteria: for example, visual (enclosing ridgelines, roofscapes or plantations), auditory (adjacent waterfalls or gravel quarries) and olfactory (tannery district). (Kerr 2013: 49)

Such sensory criteria aren’t random associations, but must contribute to the heritage values of the place. Assessing a place within its setting will often be crucial to determining the full nature and extent of its significance.

Obviously such factors as auditory and olfactory and particularly visual associations will be closely linked to aesthetic significance, since they allude to the experiential setting of the feature/place and the relationship between a place and its surroundings. In the US and sometimes the UK, a visual catchment is often called a viewshed, although this term tends to have a specific meaning in the archaeological literature as a method of determining the visibility between sites in a landscape for archaeological purposes (i.e. to reconstruct past
landscapes and human behaviour within them) and does not necessarily relate to heritage management. It is also closely tied to GIS applications and the virtual modelling of landscapes. Parks Canada defines a visual catchment as a **viewscape**, including ‘vistas, views, aspects, visual axes and sight lines that may (or may not) be framed by vertical features or terminate in a focal point [and] that are important in defining the overall heritage value of the landscape’ (Parks Canada 2010: 67). The last is the important phrase here: ‘that are important in defining the overall heritage value of the landscape’. In other words, such associations must be shown—via a well argued, well researched and evidence-based statement of significance—to be central to the significance of the place, and not just random or serendipitous associations.

**Writing a statement of significance**

Once you have collected and evaluated all of the available information, it needs to be written up into a formal statement of significance. The assessment of significance is not an exercise in subjectivity, and statements of significance *must* be evidence-based. It is not an unanchored claim for significance (the ‘everything is equally important syndrome’), but a reasoned argument based on the historical, archival and social research you have conducted, your fieldwork recordings and other observations, and given the limitations of your project. Statements also need to be clear, easy to understand and to the point—’pithy’ as James Kerr would say. As a result, they are not easy things to write. The major mistake that many suffer from is repeating details from the historical background or other previous sections of the CHMP—going over old ground, rather than using that as the evidence base from which the statement is constructed. Kerr (2103: 18–19), with his usual flair, phrases it this way:
Less experienced practitioners can find the statement of significance difficult because it means taking thought and nailing their colours to the mast. They tend to regurgitate historical and descriptive matter or laboriously respond to standard criteria and historic themes of dubious relevance. If you have qualms, re-read the draft first stage with the provisionally tailored criteria in mind and progressively note down the major reasons why the place is significant. Then polish the notes into a pithy statement of less than a page—taking care to eliminate any repetition. ... Claims made in an assessment of significance must be supported by information contained in the analysis, by reference to existing reliable research, or by the attachment of specific justifying arguments to the assessment. It is helpful if a reader can refer back from a paragraph in the statement of significance to that part of the text which best supports it.

Since you cannot formulate appropriate management recommendations without a sound statement of significance, it is important to get this phase right. A statement of cultural significance is the summary of the outcome of the cultural significance assessment process. It indicates why a place is important (i.e. what its historic, social, scientific, spiritual or aesthetic values are), who holds these values, and explains in detail the nature and relative degree of importance of each of these values. There is no set formula for writing one, but the *Protecting Heritage Places Workbook* (Australian Heritage Commission 2000: 39–40) has these tips to keep in mind:

- A statement of significance should be concise, easy to read, and address all of the heritage values of a place.
• It should present the overall significance of a place in a summary statement and then support this summary with subsidiary statements for specific features or aspects.

• It should indicate clearly the gaps in the available information, so that the basis for the assessment can be clearly understood.

• It should refer to, or cite, evidence supporting the assessment to ensure that the statement is credible.

• For Indigenous places the voices of the appropriate Indigenous people should be clearly expressed in their own words.

A summary of the significance assessment process

As an overall summary, the NSW Heritage Office (2001: 6–7) identifies eight steps to the cultural heritage significance assessment process (Figure 10.4):

1. Summarise what you know about the site, place, or artefact.

2. Describe its previous and current uses, associations with individuals or groups and its meaning for those people.

3. Assess significance using valid heritage assessment criteria (for example, in NSW this would mean using the state heritage assessment criteria).

4. Check whether you can make a sound analysis of heritage significance based on this.

5. If you can, determine the level of significance. If you can’t, find out whether there are other sources of information which might be helpful.

6. Prepare a succinct statement of heritage significance.

7. Get feedback from all interested parties.

8. Write up your information.
The Australian Heritage Commission published several specific sets of guidelines that are still in use when assessing particular categories of archaeological sites. Pearson and McGowan’s (2000) *Mining Heritage Places Assessment Manual*, for example, dealt with some of the specific problems associated with assessing historical mining sites and *Tracking the Dragon* (Australian Heritage Commission 2002a) covered the identification and assessment of Chinese heritage sites in Australia.

If you find yourself in the situation of having to assess a place’s significance but without the time and resources to conduct a thorough community survey, or find that your time has run out before you could track down all the relevant people, it is perfectly acceptable to note in your report that you couldn’t assess some categories of significance with the information you had to hand (but note that this should not be a substitute for not doing the work in the first place). If you do this, however, you will need to stipulate that it isn’t because these places have no significance, just that more research needs to be done before this can be adequately evaluated. This could be as simple as inserting a phrase such as ‘More information will need to be collected before an accurate assessment of the significance of ... can be determined.’

As a final note, in all situations the process of assessing significance must be made as credible as possible. As a result, in all of your assessments, you will need to be explicit about your terms and precisely what they mean, as well as outlining any limitations on your assessment which may have influenced your decisions.

Figure 10.4: The cultural heritage significance assessment process
Developing conservation policies

Once you have assessed the significance of a place and been able to articulate this in a statement of significance, the next step is to develop conservation policies that are a natural extension of a place’s value. A conservation policy is essentially a set of statements that articulates the obligations that arise from the statement of significance. Given the nature, degree and scale of a place’s significance:

- What degree of change (if any) is appropriate at the place?
- What principles and practices of conservation, as outlined in the Burra Charter, are appropriate?
- What is the physical condition of the place and how will this affect the timing and nature of conservation options?
- What constraints and opportunities exist that might affect the future of the place (for example, what are the owner’s needs, available resources, the current and proposed uses of the place, potential threats, etc.)?
- What alternatives exist for retaining the cultural significance of the place?

If there is more than one way to conserve the values, which alternative will be most effective given the constraints and opportunities you have identified?

The Burra Charter (Australia ICOMOS 2013a) and the associated Australia ICOMOS (2013d) practice note on developing policy contain detailed guidelines for developing and articulating conservation policy.

Managing the impacts of development

Once you have established how significant a place is and why, and articulated a statement of significance for it, the next step is to understand what impact development might have on those values. This will allow you to draw up a set of
management recommendations which indicate in detail how the place should be
treated and who is responsible (remembering that ‘managing’ is not necessarily
synonymous with ‘retaining’).

**Assessing impact/harm**

An ‘impact’, also known as ‘harm’, can be defined in many ways: as something
which will directly disturb a site (e.g. if a site is located in the middle of a
potential road corridor) and as something which is related to the development,
but which may only indirectly affect a site (such as when increased heavy-vehicle
traffic along a track might widen or change the course of the track, or generate
greater quantities of dust, thus affecting any sites nearby). You need to consider
the potential for both direct and indirect impact/harm carefully. **Direct harm**
may be from any activity which ‘disturbs the ground, including, but not limited
to, site preparation activities, installation of services and infrastructure,
roadworks, excavating detention ponds and other drainage or flood mitigation
measures, and changes in water flows affecting the value of a cultural site’ (OEH
2011: 12). **Indirect harm** needs to be assessed for the full subject area, which
includes the development itself and the areas around it. Examples of indirect
impacts ‘include, but are not limited to, increased impact on art in a shelter site
from increased visitation, destruction from increased erosion and changes in
access to wild food resources’ (OEH 2011: 12).

To assess impact/harm, you need to find as much information as possible
about the type of development, its size and scope and the degree to which it
might affect the values that you have assessed as being relevant to the site. For
NSW, DECCW (2010: 21) suggests an initial assessment based on the type of
harm, the degree of harm and the consequences of harm. More detailed
assessments, however, need to analyse this more carefully (see Table 10.1). The
information you need is not always easy to come by and you might have to quiz the builder, engineer or developer to work this out. You will also have to consider impacts in both the short and long term. Will people continue to visit/use this site? What impact is this likely to have? Will access tracks have to be continually maintained, even after the development work itself is completed?

[[INSERT TABLE 10.1 HERE]]

Assessing visual impact

In development terms the visual catchment can also relate to the visual impact of a development project on a heritage site or on the landscape around it. In this sense the visual catchment is a measure of the intrusiveness of new development—for example, how visible the construction of a new open cut mine will be, from where and by whom it can be seen, and how to mitigate against this (i.e. reduce the visual intrusion of the development on its surroundings). When a development project is especially tall, such as a mobile phone tower, or large in area, such as a mine, its visual catchment may be much larger and hence have a greater impact. The assessment of the degree of visual intrusion is usually conducted under a visual impact assessment, and is not normally the purview of archaeologists but of landscape architects, planners, or other heritage management specialists. Visual impact assessments involve assessing such factors as:

- The landscape character and context within which the proposed development will be viewed.
- The extent of the development that is visible and the visibility of its various components.
- The viewing audience (who is seeing it, why and from which viewpoints?).
• The duration of the viewers’ experience due to their activity (i.e. is it visible only quickly in a passing car, or permanently as a result of people living near it?).
• The distance of the viewers from the site.

Responding to a visual impact assessment often involves altering aspects of the development to render it less visible or intrusive, including landscaping and strategic plantings. One problem, of course, is that visual impacts can often literally be in the eye of the beholder. Does the visual impact of the proposed project offend anyone? Does it matter? What happens when the project comes down in several years? Does that also change the visual impact? (King 2002: 70–4). What does adjacent mean? How far away is far enough? As a heritage manager you need to be aware of how to assess a visual catchment relating to the significance values of a site, but also to be aware of the fact that development around heritage places is often regulated under heritage controls, even if the neighbouring properties are not heritage listed, simply because they can still form a significant part of the visual curtilage. This may restrict the scale, form, location and materials of new developments around heritage items.

The final thing to bear in mind is that assessing impacts not only involves determining the potential impacts on recorded sites (i.e. those that you know about), but also the impact on areas with archaeological potential. In other words, if you think there is a high likelihood of archaeological evidence existing in an area, even though you were not able to see any such evidence at the time of survey, or if the evidence you could see seemed limited, then flag this as an area of potential, and assess what impacts the development could have on it.
Developing management strategies

The final step in an archaeological assessment project is to develop management strategies which can be used to direct development or change in a responsible way. Management refers to any actions that will affect the heritage resource and may be actions which protect sites, actions which destroy sites (bearing in mind that collection and excavation are both forms of destruction and that the significance assessment process is as much oriented to identifying what is not significant, as what is), or actions that will change the development process so that it is more receptive to archaeological issues. Not all management relates to development, either—heritage sites which are also tourist destinations will require strategies to manage visitors to the site, and even the interpretation of heritage sites through signs and brochures is in part a management issue. In short, managing a site can involve any combination of seven separate but closely related issues (Australia ICOMOS 2013a):

**Conservation** involves all the processes of looking after a place which will retain its cultural significance. The main processes are maintenance, preservation, restoration, reconstruction and adaptation.

**Preservation** means maintaining the fabric of a place in its existing state so that it does not deteriorate. **Fabric** is all the physical material of the place: on an historic mine site, for instance, this would include the mine equipment, shafts and mullock heaps, the construction materials of the mine buildings, the waste products from the mining process which are still on-site and any archaeological materials (either on the surface or subsurface). Sometimes the setting of the site can also be defined as fabric, particularly if the setting is an integral part of the site’s cultural heritage significance (see ‘Settings for significance’ on page ##).

**Restoration** means returning the existing fabric of a place to a known earlier state (e.g. to a particular historical time period) by removing newer material or by reassembling existing components without introducing any new material.
Note that for Indigenous heritage restoration can be interpreted slightly differently, to include such activities as repatriating material, reintroducing ceremonies, or rebuilding significant places (Australian Heritage Commission 2002b: 17). In some instances, this may introduce new materials, and is more analogous to reconstruction.

**Maintenance** means the continual protection of the fabric, contents and setting of a place as it exists at that point in time. This should not be confused with repair, which may involve restoration or reconstruction. For Indigenous heritage maintenance may include activities such as restricting access to places to particular categories of people, allowing access to traditional resources, allowing access for ceremonies or other management practices to take place, or repainting rock art sites (Australian Heritage Commission 2002b: 16).

**Reconstruction** involves returning a place, as nearly as possible, to a known state by introducing outside materials (either new or old) into the fabric. A reconstruction should always be based on solid and thorough research, and should never be conjectural. If you don’t know or are not sure what went there, then you can’t reconstruct it.

**Adaptation** means modifying a place to suit proposed compatible uses, such as when an historic building is modified to become a museum, or an office. In addition, there is also **destruction**, which involves the removal of part or all of the site.

When it comes to deciding the current best practices for any of these issues, consult the Burra Charter. It is derived from a series of internationally recognised resolutions on site conservation, and adherence to its principles helps to ensure compliance with current conservation legislation. If you are not experienced with heritage conservation issues, the Burra Charter sets out some general guidelines for what measures are considered acceptable on heritage sites (including both Indigenous and historical), although particular restoration
processes may have to be carried out by specialists. For an excellent explanation on how Burra Charter conservation processes have been successfully employed on many heritage sites and the variations which are possible, see Marquis-Kyle’s and Walker’s (2004) easy-to-read guide, *The Illustrated Burra Charter* and the Burra Charter and Indigenous CHM practice note (Australia ICOMOS 2013b).

In essence, site management is an ethical process (see ‘Archaeologists and ethics’ on page ##), involving four key principles (Marquis-Kyle and Walker 2004):

1. **Respect for the significance of the fabric of a place** (i.e. don’t replace any original fabric unless there is no other alternative).
2. **Minimum intervention in the fabric of a place** (i.e. do as little as possible, but as much as is unavoidably necessary).
3. **Reversibility of treatment** (i.e. so that whatever is done can be undone with little or no damage).
4. **Full documentation of all actions taken**, including the rationale behind them (i.e. so that the complete history of the place and its treatment is known and can be referred to at any time).

Remember that all physical interference with a site, whether it takes the form of conservation, preservation, maintenance, restoration, collection, excavation or other destruction, can only be conducted following approval by the appropriate state or federal authorities. This is a legal requirement for sites in all states and territories that are protected by cultural heritage legislation. Sometimes you may be involved in work which is not typical, such as monitoring the excavation of building footings, or monitoring and recording the destruction of a site. In these cases, you will still require legal permission to conduct this work (see ‘Working with the legislation’ on page ##).
Strategies for managing work at cultural heritage sites

Management is about controlling the type and degree of interference at a site, so that the cultural heritage values of the place, their levels of significance and any essential physical changes can be properly balanced. Management strategies may be directed towards preventing any interference with the fabric of the site, require interference to be carefully conducted, or outline the way in which the site is to be destroyed. The process for preventing or limiting physical interference at a site is called mitigation. You should always outline your strategies for mitigation clearly. A developer may not be aware of proper conservation or preservation methods, and may not realise that erecting a 6 m high chain-link fence around the site (for example) might not be the most suitable option. This means that you will have to think through each stage of the management process, so that your recommendations are specific and not open to incorrect interpretation. If you recommend that a site be preserved, for example, how is this best achieved? If it is to be fenced, what is the best form of fencing? When should this fencing take place? Who should do it? How should it be done? Where should it be erected? If you are unsure of your options, take a look at recommendations for other, similar sites, or ask around to see what has or hasn’t worked elsewhere.

The process for outlining how a site may be destroyed often involves salvage, or the recovery of archaeological material prior to development. This should be a last resort. It is not an alternative to conservation (i.e. leaving the material in situ) and if you choose it your responsibilities will be far-reaching. Salvage is not just the process of excavating or collecting the material, but entails all of the subsequent analysis, conservation, curation and documentation work. You will be responsible for ensuring this is completed correctly and that all of the artefacts will be cared for in the long term, as well as that all of the information is archived, conserved and deposited adequately (see ‘Managing excavated
materials’ on page ##). In some states there is a time limit on how long you will have to analyse and write up the report. Once again, you are responsible for ensuring that everything can be finished within the allotted time period, so don’t recommend it if you can’t complete it. Salvage is only appropriate when all other avenues have been exhausted and where it will provide a substantial or unique contribution to archaeological research.

Considering that no archaeological survey is ever likely to uncover all the archaeological remains in an area (see ‘Determining effective survey coverage: what reveals, what conceals’ on page ##), you may wish to adopt a strategy that assesses the degree of this potential weakness and makes it into a central component of the project. The best way to do this is to make subsurface testing (see ‘Subsurface sampling’ on page ##) an upfront component of the project, so that you can examine an area in more detail prior to any work commencing. Another coping mechanism is to recommend monitoring (i.e. employing a heritage professional to watch the development process carefully and be alert to the uncovering of archaeological remains) for some areas of development. This is not usually considered an adequate replacement for evaluating subsurface archaeological potential through careful subsurface testing in the first place, however. If you suspect there might reasonably be archaeological evidence below the ground surface, it is your ethical responsibility to find this out before development commences. Note that in Victoria the monitoring of construction work at Indigenous sites is explicitly not considered to be an activity that should be included in a CHMP, since there is an expectation that all of the ‘upfront’ heritage work should have taken place to an acceptable standard before the CHMP is written.
**Buffer zones**

One strategy for managing the impacts of development at a site is to establish a buffer zone around it. This is an area of land that is set aside to avoid inadvertent physical damage during development activities (Ebregt and De Greve 2000: 7). The physical protection of a site is a different question to the protection of culturally significant social, aesthetic or intangible values that have been assessed as belonging to that site. Therefore, buffers are required for two principal purposes:

1. To protect a site and its values physically.
2. To protect the cultural uses of a site.

While it may seem to be straightforward, a simple metric (e.g. ‘x number of metres’) is insufficient to determine a buffer zone. This is because factors other than distance need to be taken into account. The main ones to consider are functionality and the cultural uses of the site, its visual relations to other features and sites and connectivity between the site and other places or features near and around it, as well as its vulnerability (Table 10.2). These criteria are based on the UNESCO (2008: 40) criteria for buffer zones around World Heritage sites, but have been adapted for sites that are not World Heritage sites and for an Australian context that includes Indigenous sites and places. Deciding on an appropriate buffer zone will rely on other aspects of your significance assessment, such as social, spiritual and aesthetic values and assessments of visual curtilage (see ‘Assessing the nature of significance: The Burra Charter’s categories of cultural significance’ on page ## and ‘Setting boundaries for significance’ on page ##).

[[INSERT TABLE 10.2 HERE]]
The functionality or cultural uses of the site refer to how it is used by the community within which it is embedded. An Indigenous site, for example, may be used to teach young people about their ancestors and religion. Some sites may be a place where people go to mourn. Other sites are places where people gather to commemorate their pasts at a particular place, so replication is an important part of their experience of that place. In such cases any change in a buffer zone can be highly contentious.

For Indigenous sites it may sometimes be necessary to determine a socio-cultural buffer zone to protect traditional practices at, and uses of, a site. In many parts of Australia, Indigenous people see buffers as safety zones that protect people from creation beings (powerful creatures who created the Earth) and guardian spirits (the spirits of their forebears). Moreover, the cultural use of the site can be related to gender, so a ‘gender buffer’ may be necessary to protect the functionality of the site. This would still translate to a physical boundary and will be linked to the nature of the site. A site in which the body of the ancestor lies primarily under the ground, as with the Dreaming site of a woman’s breast near Wugularr in the Northern Territory (Figure 10.5), for example, requires a very wide buffer in terms of development, as quarrying activities would be effectively digging into the body of the ancestor. There are gender differences, as well: Figure 10.5 shows the closest that women without high-level cultural knowledge can go to this site, while the distance for men is considerably further.

[[INSERT FIGURE 10.5 HERE]]

**Figure 10.5: Women with high-level cultural knowledge**

Visual relations, aesthetics and topography need to be factored into a buffer because they impact upon visitor experience. A site that is naturally protected by bushland, for example, will normally need to have this ambience preserved. Aboriginal people often wish to keep the bush around important and sacred sites so that people can learn in the same kind of setting as their forebears. In such
instances, the critical point is for the buffer to ensure that the essential cultural and ecological setting of the site is maintained to ensure an authentic experience for people who use the site for cultural purposes.

Vulnerability is the physical damage that may impact upon the site. This needs to be assessed in terms of direct and indirect impact or harm (see ‘Assessing impact/harm’ on page ##). From the perspective of direct harm, an appropriate buffer is one that ensures development does not physically undermine a site or place. Determining a buffer may need to take into account, for example, the impact of vibrations or dust, changes in watercourses or any activity that may physically damage the site. From the perspective of indirect harm, an appropriate buffer is one that maintains the integrity of the site or place in relation to its wider cultural uses or functionality. Moreover, the possibility of inadvertent and unpredicted damage needs to be assessed for both direct and indirect impact.

**Drafting management strategies**

Throughout the process of developing management strategies, you need to keep in mind all of the options that are available to you: monitoring, salvage (collection), test excavation, subsurface survey, further surface survey, comparative analyses, further research, protection, conservation or destruction.

When drafting your management strategies, do the following:

- Clearly separate which recommendations are mandatory because they arise out of legal requirements and which are simply desirable from an archaeological or management point of view (Haglund 1984: 2.4).
- Clarify all the alternatives which you can see and rank these in terms of preference from an archaeological or management point of view (Haglund 1984: 2.4).
• For any recommendations which entail allowing damage to the archaeological material, you will need to argue clearly for these based on your archaeological assessment of the site. In other words, it is not sufficient to simply state that the site is ‘unimportant’ or ‘small’, and therefore can be disturbed (Byrne 1997). You must provide clear and well-argued reasons for allowing any impact on a site or artefact.

• Clearly separate short-term from long-term management recommendations.

• You may also wish to recommend that a site which has been preserved during development is audited (checked) regularly to ensure that your recommendations were sufficient. Sites may be audited in both the short and long terms to ensure that they are being sufficiently cared for.

• If you are recommending zones of significance or areas to be preserved or protected, make sure you show these clearly on a map. The developer will need very clear guidelines as to what to do, and the more specific you are, the less chance there is of any mistakes occurring. If you only recommend that ‘Site A’ be fenced, without specifying how, when and exactly where, then you will be to blame if the developer unwittingly destroys any part of the site or its significance in the process.

• If you are contracted to work on a large site, or for a company which employs many subcontractors to carry out particular tasks, it is the company’s responsibility to ensure that their subcontractors comply with the heritage management recommendations. If you are worried by this, you could outline a protocol for subcontractors to follow, or specify in your report that all subcontractors should be bound to the same recommendations.

• If you believe that further work or research is required before a proper assessment of the impacts of the development can be made, then clearly
state this as a recommendation. So that there is no room for misunderstanding, be as clear as you can about the scope and type of work considered acceptable or unacceptable, and any protective measures which you think need to be instituted.

- Finally, think about whether your site is part of a suite or complex of sites (see ‘Landscapes and intangible values’ on page ##). This is probably more likely with Indigenous sites, which are commonly thought of as part of a wider network of places which cannot be separated, but this might also be applicable to historic sites, if there are others of the same age or purpose or with complementary functions in the area. When formulating your management recommendations, you need to consider the effects that changes made to one site will have for other sites in the complex.

**Useful resources**


www.icomos.org/australia, the website of the Australian branch of the International Council on Monuments and Sites, has the Burra Charter, all of the practice notes to accompany it and the seventh edition of the *Conservation Plan* all available online.

http://www.environment.nsw.gov.au/Heritage/publications/, the website of the NSW Heritage Office, has a wide range of free guides to assessing and managing places of cultural significance, including guides to the photography of heritage places, historical research on heritage places and preparing thematic histories. Even though its contents are intended specifically for NSW, they contain many useful general principles.
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Walker, et al., 2009.


Appendix 1

The relationship between scale, measurement and the size of a feature on a drawn plan

The tables below show this relationship in various ways—the point is to understand the size of what you want to draw and how it can best be represented on a scaled plan.

Table A1.1: The relationship between the scale at which a plan or map is drawn and the real distance this represents on the ground. In this table you can see that, at scales of 1:250 or larger, something which is 50 cm long is far too small to plot accurately onto a plan.

<table>
<thead>
<tr>
<th>Scale of plan</th>
<th>Real measurement</th>
<th>Scaled measurement</th>
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<tbody>
<tr>
<td>1:25</td>
<td>50 cm on the ground = 2 cm on the plan</td>
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<tr>
<td>(1 cm on the plan = 25 cm on the ground)</td>
<td>1 m on the ground = 4 cm on the plan</td>
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<td></td>
<td>2 m on the ground = 8 cm on the plan</td>
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<td></td>
<td>3 m on the ground = 12 cm on the plan</td>
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<td>5 m on the ground = 20 cm on the plan</td>
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<td></td>
<td>10 m on the ground = 40 cm on the plan</td>
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<td></td>
<td>50 m on the ground = 2 m on the plan</td>
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<td>50 cm on the ground = 1 cm on the plan</td>
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<td>3 m on the ground = 6 cm on the plan</td>
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<td>50 m on the ground = 1 m on the plan</td>
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<td>50 cm on the ground = 0.6 cm on the plan</td>
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<td>1 m on the ground = 1.2 cm on the plan</td>
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<td>2 m on the ground = 2.4 cm on the plan</td>
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<td>3 m on the ground = 3.6 cm on the plan</td>
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<td>Scale</td>
<td>Distance on the ground</td>
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<td></td>
<td>3 m on the ground = 0.39 cm on the plan</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5 m on the ground = 0.65 cm on the plan</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10 m on the ground = 1.3 cm on the plan</td>
<td></td>
</tr>
<tr>
<td></td>
<td>50 m on the ground = 6.5 cm on the plan</td>
<td></td>
</tr>
<tr>
<td>1:1000</td>
<td>1 m on the ground = 0.2 cm on the plan</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 m on the ground = 0.4 cm on the plan</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3 m on the ground = 0.6 cm on the plan</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5 m on the ground = 1 cm on the plan</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10 m on the ground = 2 cm on the plan</td>
<td></td>
</tr>
<tr>
<td></td>
<td>50 m on the ground = 10 cm on the plan</td>
<td></td>
</tr>
</tbody>
</table>
1 m on the ground = 0.1 cm on the plan
2 m on the ground = 0.2 cm on the plan
3 m on the ground = 0.3 cm on the plan
5 m on the ground = 0.5 cm on the plan
10 m on the ground = 1 cm on the plan
50 m on the ground = 5 cm on the plan

Table A1.2: The size of real world features (column 1) when represented at specified scales. Grey shaded cells are those that can be realistically represented on a paper plan.

<table>
<thead>
<tr>
<th>Feature size (m)</th>
<th>1:5000</th>
<th>1:2500</th>
<th>1:1000</th>
<th>1:500</th>
<th>1:250</th>
<th>1:100</th>
<th>1:50</th>
<th>1:25</th>
<th>1:10</th>
<th>1:5</th>
</tr>
</thead>
<tbody>
<tr>
<td>(cm)</td>
<td>(cm)</td>
<td>(cm)</td>
<td>(cm)</td>
<td>(cm)</td>
<td>(cm)</td>
<td>(cm)</td>
<td>(cm)</td>
<td>(cm)</td>
<td>(cm)</td>
<td>(cm)</td>
</tr>
<tr>
<td>200</td>
<td>4.0</td>
<td>8.0</td>
<td>20.0</td>
<td>40.0</td>
<td>80.0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>50</td>
<td>1.0</td>
<td>2.0</td>
<td>5.0</td>
<td>10.0</td>
<td>20.0</td>
<td>50.0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>20</td>
<td>0.4</td>
<td>0.8</td>
<td>2.0</td>
<td>4.0</td>
<td>8.0</td>
<td>20.0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>0.0</td>
<td>0.0</td>
<td>0.1</td>
<td>0.2</td>
<td>0.4</td>
<td>1.0</td>
<td>2.0</td>
<td>4.0</td>
<td>10.0</td>
<td>20.0</td>
</tr>
<tr>
<td>0.1</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.1</td>
<td>0.2</td>
<td>0.4</td>
<td>1.0</td>
<td>2.0</td>
</tr>
</tbody>
</table>

Table A1.3: The maximum dimensions of a real world feature that can be drawn to scale, based on the shortest dimension of a plan drawn at particular page sizes.

<table>
<thead>
<tr>
<th>Intended map scale</th>
<th>Intended plan size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A5 (14.8 × 21 cm)</td>
</tr>
<tr>
<td>1:5000</td>
<td>740 m</td>
</tr>
<tr>
<td>1:2500</td>
<td>370 m</td>
</tr>
<tr>
<td>1:1000</td>
<td>148 m</td>
</tr>
<tr>
<td>1:500</td>
<td>74 m</td>
</tr>
<tr>
<td>Scale</td>
<td>Distance 1</td>
</tr>
<tr>
<td>-----------</td>
<td>-----------</td>
</tr>
<tr>
<td>1:250</td>
<td>37 m</td>
</tr>
<tr>
<td>1:100</td>
<td>15 m</td>
</tr>
<tr>
<td>1:50</td>
<td>7 m</td>
</tr>
</tbody>
</table>
Appendix 2

Archaeological toolkits

Preparing for your first (or next) field trip

Before you go into the field consider what equipment will be essential to collect your data, what other equipment might be necessary given where you’re going, and anything else you might need.

A basic fieldwork kit (see below) may be generic, but other suggestions will depend on where you’re working: in some inland areas, you may find that a fly-veil worn over your hat will save your sanity, and in spinifex country long gaiters which protect your lower legs will be a godsend. Don’t embark on any fieldwork without making sure you have all the right equipment and without preparing sufficiently well—there is nothing worse than reaching a difficult and isolated site only to realise that there are no spare batteries, or that you forgot to bring the site recording forms.

The basic fieldwork toolkit

- Good boots
- Hat and water bottle
- Sunscreen and insect repellent
- Lightweight, long-sleeved cotton shirts
- Prismatic compass
- Global Positioning System (GPS) (with spare batteries)
- Relevant topographic maps for the area (preferably current editions at 1:50,000 or 1:100,000 scale)
- Recording forms, field notebook, pens and pencils
• Scale ruler
• Protractor (either a 360° full circle, or a square Douglas protractor are best)
• Clipboard
• Photographic scales (at least one 50 cm and one small scale for artefact photography)
• A 2 m ranging pole (preferably collapsible or telescopic for ease of carrying)
• A roll of flagging tape (preferably the bio-degradable kind) and/or individual artefact flags
• Graph paper
• Camera (with spare batteries)
• A 30 m tape measure and a 5 m retractable tape measure
• Ziplock® plastic bags, in various sizes
• Hand brush for cleaning hard surfaces
• Gardening gloves and secateurs for clearing away vegetation
• A basic fieldwork first-aid kit:
  • Flashlight (with spare batteries)—a small one that tucks easily into a corner will do
  • Tweezers for removing splinters, thorns, prickles or ticks
  • Bandage tape and a small pair of scissors to cut it with
  • Several triangular and roll bandages
  • Band-Aids®
  • Cream for itches and bites
  • Thermometer
  • Matches or a lighter
  • Anaesthetic spray
  • Betadine or other antiseptic ointment
  • Paracetamol and codeine tablets (in case someone is allergic to one)
• A small first-aid handbook: these come in travel sizes and will provide instructions on what to do in most emergencies
• Pocket knife

The basic surveying toolkit

• At least two 25 m, 30 m or 50 m tape measures (larger sizes are best)
• At least two 5 m, 8 m or 10 m retractable tape measures (larger sizes are best)
• Compass
• Nylon builder’s line/string
• Plastic clothes pegs (for fixing a tape measure to a string baseline)
• Tent pegs, or wooden stakes (for fixing the ends of a baseline)
• Mallet
• Plumb-bob
• Ranging rod
• Drawing equipment (scale ruler, protractor, A3 graph paper, mylar drawing film and a drawing board)

Optional

• Levelling instrument (dumpy or total station)
• Level booking forms (if using a dumpy)
• Tripod
• Stadia rod or prism staff
• Walkie-talkies

The basic excavation toolkit

• 10–12 cm drop forged pointing trowel. Make sure that the neck and blade are cast in one piece, otherwise it will break
• Hand-shovel or dustpan
• Plastic buckets
• Secateurs
• Dental picks/plasterer’s tools
• Fine, soft paintbrushes (in a range of sizes for cleaning large areas and for reaching into small cavities)
• Hand-brush or whisk, for cleaning hard surfaces and brushing-up soil
• Spring balance (for weighing buckets)
• Carpenter’s string level (for making sure baselines are horizontal)
• Nested mesh sieves (in a range of sieve sizes—10, 5 and 2 mm are the most common)
• Plastic sheeting, to cover the site or lay out deposits
• Knee pads (or foam squares) to make excavation more comfortable
• Soil pH test kit
• Munsell soil colour chart
• Recording forms
• Clipboard
• Artefact tags (aluminium or polyethylene)
• Nails (for securing tags to the walls of trenches if necessary)
• String and line level (for marking the edges of trenches and for establishing baselines for drawing sections)
• Spikes or tent pegs or chaining arrows, for marking out the trenches
• Mattock, pick or shovel (for removing turf or for backfilling)
• Drawing equipment (see Chapter 9)
• Photographic equipment (see Chapter 9)
• Tape measures, in a range of sizes
• Ziplock® plastic bags, in various sizes
Optional

- Wheelbarrows
- A stepladder (you may need to stand on this to photograph trenches from above)
- A hand sprayer (you may want to wet the walls of the trenches to observe differences in soil colour)
- Artefact processing equipment (plastic basins, drying trays, toothbrushes)
- General site equipment (chairs, folding tables, canvas or shade cover)

The basic photography toolkit

- A square of black, non-reflective, cotton material (velvet is ideal)
- A range of small scales (e.g. 10 cm or smaller) for photographing small objects
- A 1 or 2 metre scale for photographing large objects
- A three-in-one collapsible gold and silver reflector and diffuser
- Information board and chalk
- Blu-tack®
- Lens tissue
- Lens cleaner
- Cotton wool buds
- A small packet of tissues
- A squeeze bulb, or blower brush
- Two pieces of chamois, for cleaning the outside surfaces of the camera
- A sable or camel hair brush for cleaning the camera lens
- Spare camera batteries

The basic illustration toolkit

- Technical pencil or lead pencils, preferably HB or the hardest of the B series
- Clean, soft erasers
• Pencil sharpener (if you aren’t using retractable pencils)
• Scale ruler with a range of scale conversions
• Graph paper (preferably A3 size)
• Masking tape
• Invisible or ‘magic’ tape
• Protractor (a full circle or square ‘Douglas’ protractor is easiest)
• Permatrace (translucent drawing film) or other mylar film
• Drawing board—you can make one easily from plywood covered with laminated graph paper
• Blu-tack®
• Scissors
• Clothes pegs
• String
• Nails
• Carpenter’s line level

**Optional**
• Portable camp-stool, to sit on while you are drawing.
• Planning frame: this is a square timber frame with an internal metric grid-work of string. It is most useful for drawing rock art panels and detailed horizontal surfaces such as excavation squares.
Appendix 3

Sample recording forms

Survey: Environmental background information
Survey: Historic sites
Survey: Indigenous sites
Survey: Open sites
Survey: Culturally modified trees
Survey: Quarries
Survey: Headstones
Survey: Rock art
Architecture
Excavation (Contexts)
Level booking form (dumpies)
Photography
Appendix 4

Rim diameter chart for historic ceramics

[[PLS INSERT FIGURE A4.1]]

Please note: This chart must be enlarged by 140% (to A3 size) to be accurate.

Using a rim diameter chart
Guides to dating common historical artefacts

Dating common historical artefacts

All artefacts come in a wide range of shapes, sizes and materials. In many cases changes in the manufacturing process have led to changes in the form, style and components of an artefact over time. Any of these changes, if their history is known, can be used to date an artefact, and by extension, the site on which it is found (although with many caveats, depending on how the site was formed and what has happened to it since). It is not possible here, of course, to provide a detailed list of the many variations which have occurred over time in the production of every common historical artefact. What we intend here is simply a guide to some of the more generally known changes in artefact manufacture or morphology that can suggest a rough date or date range. In many cases these ranges will be so broad that you will need to research your particular site and its artefacts in more detail. Most artefacts will not be dateable to a more specific point in time without further background research into specific manufacturers and the local situation.

Dating bottle glass

Most dating techniques for bottle glass are based on changes in manufacturing techniques, particularly changes to the moulding and finishing processes and the methods of sealing different kinds of bottles. This section presents an outline of some of the major technical innovations that help to date bottles, rather than a
history of particular brands, trademarks or factories. When attempting to date a site from the bottle glass contained within it, you should also take into account the fact that empty bottles were frequently re-used throughout the nineteenth century. Research suggests that bottles continued to be used, on average, for around 4.5 years before they were discarded (Adams 2003: 44).

[[INSERT TABLE A5.1 HERE]]

**Dating ceramics**

Fragments of ceramic are almost as ubiquitous as fragments of bottle glass on historical archaeological sites. Rough date ranges can be suggested based on colour and in some instances on pattern (see Samford 1997). Blue was the most common colour for printed decoration on English ceramics during the nineteenth century, although black, brown, purple, green and red were introduced in the 1820s and 1830s (Samford 1997: 20–2). For example, blue transfer printed wares have a date range of at least 1784–1859, black of 1785–1864, brown of 1818–1869, red of 1818–1880, green of 1818–1859 and purple of 1814–1867 (Samford 1997: 20). These date ranges, however, refer to mean beginning and end production dates only, not the total date range for production of a particular colour and merely serve to bracket an artefact to its most popular production period. Furthermore, such ranges only date the artefacts, not necessarily the site itself. When interpreting ceramics from an archaeological site, bear in mind that ceramic table- and kitchenwares were often carefully curated and only discarded when eventually broken beyond further use. They can therefore be much older than the site in which they are found—Adams, in fact, estimates the average lifespan of ceramics to be on the order of 15–20 years (Adams 2003: 60).
Patterns will only be able to provide a date if you can identify who made them. For this you will have to search pattern catalogues, such as Coysh and Henrywood’s (1982) *Dictionary of Blue and White Printed Pottery* or Godden’s (1967) *Illustrated Encyclopedia of British Pottery and Porcelain*. Many patterns may not be able to be identified.

The earliest underglaze printed pattern (standardised in 1790) was the Willow Pattern, and from 1814 onwards it was the cheapest available transfer printed pattern in the potters’ price fixing lists (Miller 1991: 8). It became so ubiquitous that it is still in use today. Other types of decoration can be dated, but only approximately: transfer prints to 1790s–1860s; plain whiteware 1850–1900; decals 1890s–present; reproduction transfer prints 1890s–present; hand-painted, floral polychromes 1780s–present; embossing 1850–1890; coloured glazes 1930s–1960s. Moulding or embossing was particularly popular between 1850 and 1890 on clear-glazed, white, ironstone vessels.

Trademarks are also important chronological indicators, although it would be impossible to document every known trademark in the history of ceramics manufacture. When you record a trademark make sure you describe the design and wording of the mark itself and indicate whether it is stamped (impressed), incised, or hand painted. You should also include the colour of the trademark. Lists of British ceramic trademarks can be found in various editions of Geoffrey Godden’s (1993) *Encyclopaedia of British Pottery and Porcelain Marks* and similar catalogues are available for Australia and Europe.

[[INSERT TABLE A5.2 HERE]]

A system for registering ceramic designs came into effect in 1842. Up until 1883 this system used a registration diamond to indicate the precise date a
design was registered (Figure A5.1). Not all ceramics contained such a mark, however, so its usefulness as a dating tool is limited.

[[INSERT FIGURE A5.1 HERE]]

**Figure A5.1: How to read a ceramic registration mark**

From 1884 onwards the diamond-shaped registration mark was replaced by a simpler system, using the abbreviation 'Rd No' before the number. Note that this number only gives the date the design was registered, and therefore the vessel could have been made any time after that date. This system is still in use today and because the numbers changed from year to year, is a reliable guide to dating such marked ceramics (Table A5.3).

[[INSERT TABLE A5.3 HERE]]

**Dating tins and tin cans**

As with wax vesta matchboxes, no comprehensive study of tin making technology and local manufacturing changes has been carried out for the Australian region. Regional studies by historical archaeologists working in NSW (Heffernan and Smith 1996) and New Zealand (Ritchie and Bedford 1985) have provided some broad guidelines, supported by work for the US (Rock 1984, 1989).

[[INSERT FIGURE A5.2 HERE]]

**Figure A5.2: Dating tins and cans**

[[INSERT TABLE A5.4 HERE]]
Dating nails

Dating any nail is quite problematic. Unfortunately, nails rust very quickly, their heads can become distorted through use and they often break, separating the shaft from the head. All of these processes can alter or obscure their diagnostic features, making them less valuable as dating or identification tools. The manufacture of nails in Australia has progressed through a number of stages, from handmade (also known as wrought or forged) to mass-produced machine cut nails and machine-made drawn or wire nails. Given this transition and provided that the nails are sufficiently well preserved so that their method of manufacture can be identified from their shafts and/or heads, it is possible for them to serve as broad chronological markers.

Hand wrought nails were common up until the 1850s (and still in sporadic use after this date) and generally have hammered heads. Their shafts will taper on all four sides (although the taper will probably not be uniform), end in a point or a chisel shape and will vary in thickness along the length. Since the heads were spread by clamping the shaft in a vice and striking it with a hammer, the heads will not be uniform either (Wells 1998: 82–3).

Cut nails originated in the late eighteenth century and were machine cut from strips of metal plate. They will have square or blunt ends, and two tapering and two parallel sides. The head can be either hand hammered (if early, i.e. pre c. 1820) or machine-made (if later) and the neck is often pinched underneath the head where the shaft was clamped while the head was being made. They will also have burrs—slightly raised ridges of metal along some edges where the cutting machine has sliced through the metal plate. If you can’t see these burrs easily, try feeling the edges with your finger and detecting them that way. Burrs that occur on diagonally opposite sides of the shank predate 1830s/40s, while burrs found on the same side of the shank postdate the 1840s (Varman 1993: 150–2). Some specific patents, such as the Ewbanks nail, can be dated more precisely. Ewbanks
nails were rose-headed cut nails with various distinctive characteristics, including a rounded rather than blunt, square end, reinforcing ridges (tolerance ridges) along the lateral sides of the shaft for extra strength, and, after 1869, a four pointed star trademark added to the head turned 90° to the axis of the rose-headed facets (How and Lewis 2009: 835). They are uncommon in buildings after c. 1870 and seem to have gone out of use by WWI (Varman 1998: 159).

Wire nails were first imported into Australia around 1853 and became cheap, plentiful and widely used after the 1870s (Varman 1980: 36). They had replaced cut nails in popularity by the 1870s because they could be reused over and over again (Varman 1993: 146–7). They will have uniform round shafts and provide better subjects for dating, as their production resulted from the patenting of a specific invention (Varman 1980: 31). Jolt headed wire nails tend to date to after WWII (Varman 1993: 184).

[[INSERT FIGURE A5.3 HERE]]

Figure A5.3: Dating nails

[[INSERT TABLE A5.5 HERE]]

**Dating clay tobacco pipes**

While clay tobacco pipes are relatively common on archaeological sites, they are not the best dating tools. The diagnostic features of a clay tobacco pipe are:

[[INSERT FIGURE A5.4 HERE]]

Figure A5.4: The parts of a clay pipe

Great variation in the shape and style of clay pipes has existed since the start of their manufacture and changes in bowl shape or stem length are not always reliable guides to their period of manufacture. Oswald (1975: 37–41) has produced a simplified bowl typology which is of some use when dating pipes,
although the many local variations in design and manufacture makes this only useful as a general tool.

[[INSERT FIGURE A5.5 HERE]]

Figure A5.5: Dating techniques for clay pipes (from Oswald 1975: 37–41)

**Dating metal match boxes**

The use of small tin boxes for storing matches was current from about the 1830s until the 1940s. No comprehensive study has been undertaken on wax vesta matchboxes, and therefore there are few guidelines available for dating. The most detailed studies have been completed by archaeologists working on historic mining sites in New Zealand (Bedford 1985; Ritchie and Bedford 1987) and the Northern Territory (McCarthy 1986). Without comparable regional studies from other parts of Australia, however, there is no better guide at present.

[[INSERT TABLE A5.6 HERE]]

**Dating buttons**

In terms of dating buttons, only broad trends are available based largely on manufacturing materials and particular patents.

[[INSERT TABLE A5.7 HERE]]

**References**


McCarthy, J., 1986, Pine Creek Heritage Zone Archaeological Survey. Unpublished report to the National Trust of Australia, NT.


Appendix 6

Nic Grguric’s guide to dating firearms-related artefacts

Firearms-related artefacts are frequently found on archaeological sites and, if properly identified, can provide reliable dating information, especially in terms of terminus post quem (TPQ) dates. In Australia, most firearms-related artefacts are of British origin, with a smaller range of firearms and ammunition of United States manufacture gaining popularity towards the latter part of the nineteenth century. This is helpful to archaeologists as it narrows the parameters when researching dating information, such as caliber types and headstamps. A cartridge case is the component which contains the gunpowder and projectile (the ‘bullet’) that together form a ‘cartridge’. They come in either bottle-necked form (illustrated), or straight-walled. Percussion caps are small copper or brass cup-shaped components which were used with percussion firearms. When struck by the ‘hammer’ of the firearm they created a small explosion that in turn ignited the gunpowder in the barrel, very much like a modern toy cap gun.

[[INSERT FIGURE A6.1 HERE]]

Figure A6.1: A. The parts of a cartridge case; B. The parts of a rifle projectile; C. The parts of a percussion cap

Owing to their use and discard, ammunition components are normally found deformed to a greater or lesser extent. For this reason, Table A6.1 below illustrates several of the ammunition components commonly used in 19th century Australia in various states of deformation as found, as well as some unfired (dropped) examples. In most cases the TPQ dates are very firm, however the end dates are approximate because some of these cartridges continued being
produced well after they were obsolete, and some are still commercially available today.

[[INSERT TABLE A6.1 HERE]]

**Identifying British rifling impressions on projectiles**

Fired projectiles often show rifling impressions on their sides which are imparted from the bore of the rifle. The grooves and projections in a rifled barrel will create an opposite impression on the sides of a projectile; for example, a bullet fired from a rifle with three grooves in its bore (like figure ‘A’ below) may show three raised impressions on its sides. The shape, number and width of these impressions can narrow down what model or pattern of rifle the projectile was fired from. Table A6.2 below shows cross-sections of four commonly-used British rifling styles of the 1850s to 1880s (British Militaria Forums nd).

[[INSERT TABLE A6.2 HERE]]

**British percussion cap crown markings**

Markings are sometimes found stamped or embossed on the crown (top) of military percussion caps. Table A6.3 below shows identified British military crown stamps (after Gooding 1997: 4).

[[INSERT TABLE A6.3 HERE]]
References


Appendix 7

Guidelines for producing technical reports

Consultancy reports tend to follow a fairly standard template and some states (such as Victoria and NSW) provide very specific guidance on the appropriate headings for cultural heritage management plans (CHMP) for Indigenous sites. Before you submit your report get feedback, particularly if you are working with other groups who have a vested interest in the project. Feedback may mean submitting a draft report to the client and to any other interested parties, and waiting for responses before you submit the final version. This gives all stakeholders an opportunity to comment. This is particularly important if you are working with Indigenous communities, as they are likely to have definite and often quite specific ideas about what they think are adequate management strategies. Before you submit your report, take your recommendations back to the community and carefully go through them together to make sure that everyone understands what is at stake and has an opportunity to comment on whether, and how, they think the recommendations are suitable or unsuitable.

Remember also that you are not just submitting your report to a client, but also to the government authority who administers cultural heritage in that state. The cultural heritage managers who work for these authorities (usually, but not always, archaeologists) are ultimately the people who will assess your report, and they will assess it according to whether it complies with current best practice guidelines. These are the people who are most likely to ask you for clarification on certain aspects of your work, to rewrite sections of your report or even to request that you do more research or fieldwork before they accept it. You
must also satisfy your client, of course, because they are paying for you to do an adequate job in the first place. A client is unlikely to be sympathetic if they have to pay more money because you did a substandard assessment to begin with, which later requires substantial reworking before the state government authority will accept it.

Finally, see how closely your report conforms to these best practice expectations:

- Have you used standard measures and terminology to describe sites and artefacts?
- Have you defined all your terms and categories, either in the body of the report or in a glossary?
- Have you been explicit about how you chose to define a site, and the way that you decided on the site’s boundaries?
- Have you outlined the logic of your sampling strategy?
- Have you shown clearly on a map where your sampling units/transects/excavation squares were located?
- Have you shown clearly on a map the location of all of your sites (unless requested to keep details of sites secret)?
- Have you been explicit about your methods during all phases of the project?
- If you have used a new method, have you been explicit about how you went about it and what its limitations were?
- Have you been explicit about the limitations you encountered during all phases of the project?
- Have you evaluated the effectiveness of your survey coverage?
- Have you evaluated the usefulness of your historical or ethnographic sources?
• Have you provided grid references for all of your sites (unless requested to keep details of sites secret)?
• Have you made your data accessible to reinterpretation (e.g. included all supporting material relevant to your data analysis as an appendix, such as your tables of raw data, your database and/or your recording forms)?
• Have you included details of all consultation undertaken with any parties or individuals as part of the project?
• If you obtained a permit to survey or excavate, have you included details of the permit number in the report?

Copies of reports should be lodged with major and local public libraries as well as government departments. This is not always possible, of course—particularly if your report contains secret/sacred or otherwise confidential information—but ideally you should supply one copy to the client or funding body, one copy to the appropriate state or federal heritage authority, copies to any interest groups who participated in the project, one copy to accompany the finds (if your project involved collection or excavation), and one copy to the nearest appropriate public archive or library (Birmingham and Murray 1987: 92). You should also give copies to Indigenous community groups, volunteer organisations and local historical societies. For some groups you may need to tailor the report and present it as a plain English, or community, report (see ‘Community reports’ below) as well as a technical report.

**Checklist for consultancy reports**

This is only one suggested format for a standard consultancy report. Not all categories will apply in every circumstance.
Title page

- Title of report.
- Client or group for whom it is prepared.
- Date.
- Author's name and address.

Acknowledgements

Summary

- Overview of project.
- Overview of results.
- Overview of significance.
- Overview of recommendations.
- Any restrictions on the use of the report or on the information contained within the report.

(Table of) Contents

(Table of) Figures

(Table of) Tables

Introduction

- Brief description of project.
- Where the project is located (e.g. brief statement of nearest town, or important geographical feature, state or area of state, borders of study area, etc.) and why the project was commissioned/carried out.
Who commissioned/funded the project.

Aims and scope of the study. Include any formal brief or informal instructions issued as part of the project.

Types of investigation conducted (e.g. field survey, Aboriginal consultation, excavation, document searches, oral histories).

When fieldwork, analysis and report writing took place.

Who undertook fieldwork, analysis and report writing.

Any constraints or limitations which were imposed on the project (e.g. bad weather, limited time, attitudes of landowners, particular instructions which limited the survey in any way, such as instructions from Traditional Owners to stay away from areas).

Any constraints or limitations of the data (including documentary sources) collected during the project (e.g. lack of suitable oral history informants, loss of data, inability to find certain information).

**Background information**

General description of study area (e.g. size, present land use, access, etc.).

General description of environment (e.g. geology/geomorphology, topography, watercourses, flora and fauna, relevant raw material sources, etc.).

Previous impacts on the study area (e.g. past logging, clearing, ploughing, mining, erosion, etc.).

Description of proposed development and associated works, including what activities could be expected to have an impact on the archaeology.

**Previous research**

Relevant ethnographic studies and findings within the region and the study area.
Relevant historical studies and findings within the region and the study area.
Relevant archaeological studies and findings within the region and the study area.
Relevant oral histories and findings within the region and the study area.

Methods

Research strategy and aims.
Detailed description of fieldwork methods for all stages of fieldwork. Outline clearly the equipment and techniques used to implement the research strategy (e.g. choice and location of sample areas, recording methods, collection methods, storage of artefacts/information, methods of analysis).
Discussion of any problems which arose during fieldwork, analysis or report writing.
Detail of the constraints on archaeological visibility during the survey.
Description of any decisions made in the field or the laboratory which changed the scope of the study.
Details of people involved.

Results

Summary of what was found or achieved (e.g. quantities, types, distribution).
Description of findings based on field notes and recording forms.
Relevant tabulations of data, photographs, illustrations.

Discussion

Summary of points of interest or major research problems emerging from the study.
Discussion of the evidence in regional and local perspective.
Implications of the findings and areas for future research.
**Assessment of significance**

☐ General statements of significance for the study area.

☐ Specific statements of significance for individual sites/areas (including whether further research is necessary to adequately determine significance).

**Statement of impacts**

☐ Implications of the probable effects of development on the study area and the findings (including both direct and indirect impacts).

**Recommendations**

☐ General management recommendations, including alternatives where possible (e.g. dealing with the study area in general or with particular zones or areas within it).

☐ Specific management recommendations, including alternatives where possible (e.g. dealing with individual sites or artefacts).

☐ Discussion of any issues or problems attached to these recommendations (e.g. client’s preferences, difficulties, attitudes, compromises, etc.).

☐ Identification of any legal requirements or processes which must be followed.

☐ **References**

**Appendices**

☐ Relevant additional information, including information which needs to be kept restricted.

☐ A glossary of any technical terms or definitions used in the report (including definitions of artefact types, attributes, measurements, etc.).
☐ Copy of the project brief and any other relevant information from the client outlining the scope of work, etc.

☐ Letters of advice outlining management recommendations/opinions from community groups (e.g. Indigenous Land Councils).

Reference

Appendix 8

Guidelines for producing interpretive materials

Interpretation is different from information—one is simply facts, the other is intended to tell a particular story, provoke ideas, create new associations or even jolt people into new understandings (Carter 1997: 6). The essence of good interpretation is that it reveals new insights into what makes a place or object special (Carter 1997: 6). Depending on the nature of your research, you might choose to produce a poster, pamphlet, a self-guided tour guide, an interpretive sign, or the text for a more formal guided tour. Regardless of which type of interpretation you choose, you will need to think through what you want to do and how you are going to do it, particularly in terms of how the interpretive story can be linked to physical artefacts or places.

The goal of any successful interpretation is to make the information you have support an interesting story or idea. It is best to do this by careful planning, rather than simply throwing a whole lot of information together and seeing what comes out. Start by focusing on what you want to achieve:

- What do you want people to know as a result of your interpretation?
- What do you want people to feel as a result of your interpretation?
- What do you want people to do as a result of your interpretation?

The core of interpretation is to capture the essence of a place or idea, not to tell people everything there is to know. If you try to present every interesting aspect of a place, people will be overwhelmed or bored, or both. At some point you will have to make a choice about what to interpret and what to leave out,
which will undoubtedly involve drastic editing. The best way to do this is to use some form of interpretation project planner to give your ideas structure and to force you to consider:

- Why you want to communicate with visitors?
- Who will your audience be?
- What does your site or object have to offer?
- What do you want to say?
- How best can you say or show it?

It is only by working systematically through these questions that you will be able to tread a concise path through the mass of material which you have no doubt collected. This is a central part of making sure that your story will be coherent and that the form and content of your interpretation will be focused and will actually achieve your objectives. If you don’t want to use a formal planner, try to write a storyline, breaking your narrative down into its component ideas, each of which can serve as the basis for a paragraph.

[[INSERT FIGURE A8.1 HERE]]

Figure A8.1:

Once you have a plan, you then need to write the text and design the layout for your interpretation. Writing good interpretive text requires a totally different approach to writing a consultancy report or academic paper. You are not only trying to make information available to a much wider audience than your professional peers but, more importantly, to make it meaningful for them. This is more easily said than done, however, and in the end you will never be able to cater for everyone. You will have to decide who is your priority and interpret for them. There are five key dimensions to consider when actually writing and designing your interpretive materials (Carter 1997: 40–1):
1. Make it grab attention (colour, font size, catchy or provocative titles, activities, things to handle). Audio or tactile labels, pictures and ‘hands-on’ components can actually double visitors’ attention spans.

2. Make it enjoyable (make it meaningful, make it personal—link it to people’s own lives if you can. Emotion is a powerful trigger which makes people pay attention and remember).

3. Make it relevant. Try to give greater dimension to your interpretation by telling the story from different perspectives or through the eyes of different people. Wherever possible, use stories and quotations to refer to real people and their lives and use dynamic photographs of people or activities, rather than static shots of buildings or scenery. The key to any good interpretation is to forge a connection between people then and people now.

4. Make sure it has a structure. Use everyday language—not everyday archaeological language!—so that everyone will understand. If you are going to use specialist terms you will have to explain them. The idea is to create a closeness between the reader and the material, not to distance them by making the text difficult to read or understand.

5. Try to keep your writing style personal and ‘chatty’, rather than formal and academic. In particular, try writing for an individual, not for the ‘general public’ or another archaeologist (Binks et al. 1988: 113). If you’re worried about the tone of your text, give it to someone else to read and listen to their comments. A good starting point is to look critically at other leaflets, posters or signs and decide what you think works and what doesn’t.

There are also various practical issues to consider when designing interpretive materials. In terms of legibility, some fonts work better than others,
and short, well-spaced paragraphs are much easier to read. Unless your text will be internally illuminated (e.g. from a light box), white or pale-coloured backgrounds with contrasting text work best. Give careful consideration to what illustrative material you include as well and don’t just duplicate what people can already see around them. Make your illustrations or photos complement the text and tell their own story (e.g. try using them to show what people can’t see or what things may have looked like at another time) (Carter 1997: 43–4).

**Tips for making your text work**

- People will seldom read more than 150–200 words at a time. Don’t be tempted to write long paragraphs—stick to short, sharp ones.
- Keep your sentences short—around twenty words each.
- Keep your titles short and sharp—a maximum of around five words for each heading.
- Keep your lines well-spaced so that the text does not look dense and crowded.
- Remember that the greater the distance between viewer and text, the larger the font size and the greater the spacing between words, lines and paragraphs will have to be.
- Break the text into plenty of paragraphs and keep them well-spaced, so that people can visually distinguish manageable parcels of information. Try to make each paragraph represent a particular idea or related set of points.
- Vary the font size you use throughout—e.g. a large font for titles, a lead-in sentence which is smaller than the title but still larger than the main text size, and then main or body text which is smaller again.
• The size of headlines and titles needs to be at least 30 point. For sub-headings use at least 16–18 point, and 12–14 point for general text.
• Only some fonts, like Helvetica and Times, are easy to read in long runs (Binks et al. 1988: 115). Restrict the use of more exotic fonts to titles or sub-headings.
• For overall consistency, try not to use more than two fonts.
• Make sure there are no spelling mistakes or typos—nothing looks worse! (see what we mean?)

**Tips for making your layout work**

• Keep text to a minimum and break up large columns of text with illustrations wherever possible.
• Many graphic designers use a preset grid in which the text and illustrations balance each other, so that the spacing between blocks of text and between images and text remains consistent (see Figure 10.4 on page ##).
• Remember that you don't have to fill up all the space. Blank or ‘white’ space can be used to emphasise different elements, particularly images.
• Wherever possible, convert written information to a graphic or visual form.
• Use large images that can attract attention from a distance.
• Use headings to attract attention or to emphasise main points.
• Include important or one-off information separately to the main text (in a box, like the tips in this book). Don’t bury it in a welter of other words.
• Make all aspects of the project work together—the choice of colour, font, style, design and materials can all tell a story apart from just the words.

Posters

One way of sharing information about your project is through presenting a poster, which can be exhibited at an archaeological or public meeting, or used as a standing display on the walls of a school or community office.

Tips for preparing a poster

Remember that posters are initially seen from afar and need to be designed so that people want to go closer to view them. The poster title and the images are what will draw the viewer, not large blocks of text (see ‘Tips for making your layout work’ on page ##).

• Keep your text to a minimum. The major mistake many people make is to try to fit their entire report (or thesis) on to their poster. Remember that people will not read blocks of more than 200 words at a time (see ‘Tips for making your text work’ on page ##).

• It can be helpful to think of a poster as telling the story in images more so than words. For the poster to be effective, you need the images to stand alone. Think of the adage ‘a picture tells a thousand words’ and only choose images that will convey the story you want to tell.

• Use no more than two or three sentences, in no less than a font size of 20 point, to explain each image.

• Use images to convey several forms of information at once. For example, an image of an archaeologist conducting fieldwork with an Indigenous
elder can convey information about local environment and collaborative relationships, as well as the way in which the actual task has been undertaken.

**Lyn Leader-Elliot’s tips for presenting the perfect poster**

Interpretive posters need a strong storyline and the best images you can find to attract attention and tell the story. Your first step is to answer these questions:

- What idea should the poster convey?
- What story will it tell?
- Who is it aimed at?
- What is the best way to convey the idea and tell the story to your chosen audience?
- Where will the poster be displayed? This will affect your design, choice of materials and colours.

**Images**

- Photographs, maps, cartoons, graphs and charts all have their place, depending on the ideas you are working with.
- Use clean, uncluttered design—don’t try to put too much in.
- Use empty space to separate different ideas.
- Keep related ideas, images and text together so that the poster is easy to read.

**Text**

- Choose a heading (title) which immediately conveys the main theme of your story.
- Focus on the main messages you want to convey—strip out the detail until you have the essence.
- Most people won’t read blocks of text on a poster.
• The amount of text will depend on the purpose of your poster and its audience. You may choose to use only a title and captions for your images, or you may want to include more text.

• Use simple language and sentence structures. Make every word count—you have very few to work with.

• Choose fonts and font sizes that are easy to read. Avoid italics, UPPER CASE and fussiness.

• And always make the images and text work together.

[[INSERT FIGURE A8.2 HERE]]

Figure A8.2:

References

Carter 1997
Binks et al. 1988