Waterlogged Wood

Historic England Draft Guidelines on the Excavation, Recording, Sampling and Conservation of Waterlogged Wood

Summary

This guidance is aimed at those working directly with, or encountering, waterlogged archaeological wood in England's terrestrial and coastal/marine settings, for example, archaeological contractors and wreck licensees. It is relevant for local authority archaeologists and other heritage managers responsible for approving and monitoring work undertaken on these sites in relation to the planning process. Additionally, it is applicable for landowners and site managers wishing to understand how waterlogged archaeological wood identified on their sites should be dealt with.

This document explains what waterlogged wood is and why it is important, and outlines the methods and approaches required to investigate it and make decisions about how it should be managed. Specific recommendations are provided on the excavation, recording, sampling, selection, storage, assessment, analysis, conservation and curation of waterlogged wood.

The guidance is not intended to replace the requirement for those undertaking excavations on sites containing waterlogged wood to take advice from waterlogged wood specialists. Rather it sets out the main stages of archaeological projects where a specialist would need to be involved and highlights the type of work that would be undertaken at each stage. It is intended to provide a guide to best practice for approaching these sites, so that those dealing with them are fully prepared for what they might encounter and have the budget, specialists and experience to deal with them.

Further guidance on dealing with waterlogged artefacts can be found in Historic England's (2018) *Waterlogged Organic Artefacts Guidelines on their Recovery, Analysis and Conservation* document.

Contents

Introduction

This section explains what the term waterlogged wood means and discusses why waterlogged wood is important.

What is waterlogged wood?

Waterlogged wood is wood, either in its natural state, or having been used or modified by people, that survives on archaeological sites in wet or waterlogged environments. Waterlogged wood is most often found in bogs and wetlands, maritime settings, palaeochannels (old river channels), urban waterlogged deposits, and pits and wells within otherwise 'dry' occupation sites. Finds within these contexts can vary from large complex structures, including ship remains, trackways, building foundations and domestic assemblages, to smaller individual artefacts.

Although the wood may appear well preserved, biological and chemical degradation will have occurred, with the wood cells now filled with water in place of the original cellulose. The long-term preservation of archaeological wood in the ground requires wood to be permanently waterlogged as this excludes oxygen and helps reduce biological decay. To minimise further physical and chemical degradation during and after excavation, waterlogged wood needs to be dealt with promptly through the fieldwork and post-excavation phases.

Why is waterlogged wood important?

Until the modern period wood has been the pre-eminent material for buildings and fuel and has formed a large part of material culture. Yet for such a widely used and ubiquitous material, its survival in the archaeological record is incredibly rare. Therefore, when wood is preserved through waterlogging, the detail and information it provides can be exceptional.

Waterlogged wood discoveries are important because they provide evidence of the main raw material used for structures, artefacts and fuel throughout most of human existence. Analysis of wooden remains provides unique and significant information about material culture, economy, industry, buildings, technology, the environment and access to resources.

Wood can be analysed in combination with other palaeoenvironmental data sources to increase our understanding of the wider landscape and past climatic conditions. It can give direct evidence of the character of the local treescape and how this has changed over time. It can also provide information on woodland management, the sourcing, selection, and use preferences of wood as a raw material, and imported products.

Waterlogged wood is valuable for scientific dating. It can provide samples for radiocarbon dating, and several tree taxa can be used for tree-ring dating (dendrochronology), which can produce precise calendrical dates. The identification of some non-native wood types can also help to date sites.

Displaying and interpreting conserved waterlogged wood increases the museum visitor's understanding of landscapes, settlements and human activity by providing material evidence of worked wooden structures and artefacts.

Waterlogged wood thus represents an informative, but extremely rare resource. It is therefore imperative that archaeologists allocate to it the resources and forethought that it deserves.

1. Overview of key points

This section provides a synopsis of the guidance within this document. It is not exhaustive and readers are encouraged to read the specific sections for detailed advice.

Project planning (Section 2)

- Sites with waterlogged wood often require a specific approach compared with “dryland” equivalents due to their vulnerability and complexity.
- They can take longer to excavate, require more specialist involvement and have additional lengthy post-excavation processes.
- Early engagement with stakeholders and specialists is recommended.
- Written schemes of investigation (WSIs) and project designs (PDs) for sites known to contain waterlogged archaeological wood (or where it is suspected) should include strategies for dealing with waterlogged wood.
- The wood specialist(s), dendrochronologist, conservator and the repository should all be named in these documents and for large or complex sites should be involved in the production of the WSI / PD.
- Timely and rapid decisions need to be made when dealing with these sites to control costs and limit degradation of the wood.
- Projects should have an archaeological archiving selection strategy and a data management plan from the outset.
- Collecting institutions need to be involved early and throughout so that they can be involved in discussions with the project team about selection / de-selection, conservation, display and storage.
- Unexpected discoveries of waterlogged wood require a swift response from project managers; an evaluation of the site’s character and significance to inform decisions on an excavation strategy and the need for any additional specialist or conservation input.

Evaluation (Sections 3 and 4)

- Characterising the site, its extent, date, significance and state of preservation is key for any evaluation including those containing waterlogged wood.
- Where evaluation is not followed by a further phase of excavation, the wood assemblage will still require prompt recording, assessment and, if necessary, may also require analysis, conservation and archiving.
- Evaluation of sites containing waterlogged archaeological wood need to be extensive enough to identify any spatial differences in significance and preservation.
- The assessment of the state of preservation is based on visual and physical inspection which can be augmented by additional specialist analysis.
- It is good practice for decision-taking about the future management of sites containing waterlogged archaeological wood to take into consideration the significance of the material, the state of preservation and whether any future

changes (natural, development, land-use change) will impact on future preservation and significance.

Excavation (Section 5)

- There are two main approaches for the excavation and recording of waterlogged wood: Pathway 1 – full recording on site with sampling and active discard taking place alongside, and Pathway 2 – minimal on site recording with the material retained for post-excavation recording.
- These strategies can be implemented on a site-wide scale, or at a smaller scale, by context/feature/group or even for individual items.
- Decisions regarding the application of Pathway 1 and/or Pathway 2 should be made by the project's lead wood specialist / wood specialist (technology and morphology), in conjunction with the excavation and management team.
- Pathway 1 front-loads the recording, sampling and some selection decisions on site, minimising the need for medium term storage. It requires a wood specialist to be on site most of the time, working with a team familiar with waterlogged wood.
- Pathway 2 results in the removal of most or all the material from the site for off site recording. It is particularly applicable for sites where a wood specialist is not able to be present on a permanent or regular basis.
- As waterlogged wood is delicate and often encountered in soft deposits, specific methods are required for its excavation, including maintenance of high moisture levels, using temporary access infrastructure such as platforms and avoiding the use of sharp-edged metal tools.
- Lifting and transportation needs to be undertaken sensitively to avoid damage to waterlogged wood. Transportation of wood submerged in water (in buckets or boxes) can cause damage and should be avoided. Smaller items or samples can be transported in water in sealable plastic bags. Larger pieces of waterlogged wood should be packaged in such a way that evaporation of water during transportation is minimised.

Recording and sampling (**Section 5)**

- Every excavated piece of wood should be given a unique site wood number and those numbers should be recorded on site plans and elevations. Once a wood number has been assigned, a wood recording sheet should be completed for each individual piece or group.
- The following information must be recorded whilst the wood is in situ:
    - context, feature, plan, drawing and/or photography numbers
    - setting (horizontal, vertical etc.), orientation and inclination
    - surface condition with areas of excavation and pre-excavation damage or breakage clearly distinguished
    - a sketch guide marking the position of significant details (e.g. joints, nails, pegs) and showing how broken or fragmented pieces refit to allow reassembly, and
    - relationship to other timbers in a structure.

- More detailed recording takes place after lifting, either on site (Pathway 1) or off site (Pathway 2). This recording should include basic site information; appearance and state of preservation; natural feature; woodworking evidence; and functional interpretation.
- Sampling often happens immediately after wood recording. Samples are taken for species identification (and possibly also used for radiocarbon dating), woodland management, environmental indicators and dendrochronology.

Nautical Archaeology (Section 5)

- While the general approaches of this document also apply to ship or boat remains, working on underwater sites or in intertidal zones requires additional input and expertise.
- A nautical archaeological specialist should be engaged in any project where boat and ship remains are encountered.
- Due to the nature of these types of sites, sampling can often occur where only part of the vessel is visible, so needs to be carefully considered.

Timescales and temporary storage (Section 6)

- All wood should be recorded promptly; wood recording should be completed before the written assessment is prepared, preferably within 12 months of excavation. Material should be submitted for conservation within 36 months of excavation; it is recommended that wooden artefacts are fast tracked.
- All physical tasks relating to the wood, e.g. sampling and production of graphics should be completed within 36 months of excavation. Analytical tasks e.g. microscopic species identification, growth rate / season of felling and dendrochronology should be finished within 48 months of excavation.
- The time waterlogged wood spends in temporary storage should be minimised as extended periods of storage, even in optimum conditions, will result in degradation of the wood. Storage is also a costly project expense. A storage plan should be in place from the start of the project.
- A range of storage options are available and wood in storage needs to be checked and monitored to ensure that it stays wet; water must be free of contaminants.

Post-excavation Assessment and Analysis (Section 7)

- A post-excavation assessment should include assessment of the quality and nature of the record generated during excavation, an assessment of the wood's state of preservation and significance to inform analysis and should identify possible conservation strategies (through a conservation assessment).
- It should provide a statement of potential, addressing the suitability of the assemblage for analysis of woodworking evidence, wooden technology, woodland reconstruction and the potential for scientific dating.
- A post-excavation assessment helps generate an accurately costed and timetabled post-excavation programme of analysis and reporting.

- Tasks undertaken at this analysis stage include completion of graphical recording, data analysis, dating and wood identification, specialist reporting and publication.
- Following analysis and publication, wooden items not selected for conservation and archiving should be dispersed.

Conservation (Section 8)

- Conservation treatments convert waterlogged wood into a stable condition that allows it to be studied or displayed through the replacement of water with a chemical, followed by drying in a controlled manner, so that the overall shape and dimensions are retained
- The selection and implementation of wood conservation treatments should only be undertaken by a suitably experienced conservator**.** The choice of conservation treatment will be determined by the size of the timbers, availability of equipment, budget, and timescales.
- All recording, sampling and analysis should be completed before conservation starts.

Archiving and curation (Section 9)

- The project conservator and archive repository should be involved at the earliest opportunity in projects that may generate collections of archaeological wood that merit conservation, display or archiving as this ensures that costs and time can be identified and made available for conservation, display or storage.
- Early conversations and planning will also help to reduce the time and cost of temporary storage.
- Once conserved, archaeological wood needs to be kept in stable conditions without extremes or fluctuations of temperature and humidity.

2. Project planning

2.1 Why sites with waterlogged wood need different approaches

Sites that produce waterlogged wood are significantly different from the more common ‘dryland’ sites. From the moment of exposure, waterlogged wood finds are extremely vulnerable to further, and often rapid, deterioration, and therefore require immediate stabilisation measures.

Sites with waterlogged wood take longer to excavate, require more specialist involvement and have additional lengthy post-excavation processes. This will inevitably mean that project costs will be higher.

It is therefore crucial that the cost implications are identified as early as possible in the project planning process. For commercial projects it is important that the developer is not shielded from such cost implications.

If waterlogged wood is unexpectedly encountered during fieldwork, the guidance outlined in this document also need to be followed.

This guidance follows the principles set out in the British Standard on *Managing waterlogged wood encountered on archaeological sites* BS EN 16873 (BSI 2016) and elaborates on many of the points made therein.

2.2 Written schemes of investigation and project designs

Written schemes of investigation (WSIs) and project designs (PDs) for sites known to contain waterlogged archaeological wood (or where it is suspected) should include strategies for dealing with waterlogged wood. These should include:

- methodologies for excavation
- recording
- sampling
- assessment
- temporary storage
- post-excavation assessment
- analysis
- selection for conservation and
- archiving

The wood specialist(s), dendrochronologist, conservator and the repository should all be named in these documents and for large or complex sites should be involved in the production of the WSI / PD. For an excavation where the intention is to conserve and archive waterlogged wood, the archive repository should be consulted during the production of the WSI / PD. These same specialists and the repository should also input into the selection strategy for archaeological archiving.

2.3 Desk-based assessment (DBAs)

Where desk-based assessments are carried out in advance of fieldwork there are some sources of information that may help to predict the presence of waterlogged wood. Data from the British Geological Survey (BGS) (see its Geoindex (onshore)), Natural England (including the England Peat Map) and aerial remote sensing (e.g. lidar) are useful for identifying where waterlogged archaeological remains might be expected. Examples of such contexts include alluvial, river terrace, or peat deposits or palaeochannels.

For marine / coastal locations, data from the BGS's Geoindex (offshore) can be used to infer the preservation / likelihood of waterlogged wood based on sediment type. Other sources include UK Hydrographic Office or the National Marine Heritage Record. Known intertidal peat deposits are shown in Historic England's Intertidal and Coastal Peat Database (https://historicengland.org.uk/research/current/heritage-science/intertidal-peat-database/).

Where available, borehole data (BGS, research, and commercial) will provide more detail on a location's stratigraphy, which could be drawn together into a deposit model (Historic England 2020). The results of previous excavations may provide information not only on the presence of waterlogged deposits, but also on the state of preservation of the wood remains and possibly information on the burial environment. Generally, as broad an evidence base as possible should be considered.

[Box text – The term *state of preservation* is used throughout this document to describe an understanding of the wood's condition / deterioration / degradation. It is the term used in Historic England guidance on Preserving archaeological remains (2016), and in the British Standard on Cultural Heritage - Assessment and monitoring of archaeological deposits for preservation in situ (BS EN 17652:2022). It is defined in the British Standard as the "current state of the archaeological deposits, and artefacts and ecofacts that they contain, which will depend on both current and historical rates of degradation." Although used consistently throughout this document, it may be used interchangeably with condition / deterioration / degradation by those working on waterlogged wood.]

2.4 Project Timescales and costs

When working with waterlogged wood, all parties should realise that failure to make timely and rapid decisions will prove to be more costly and will lead to continued degradation of the wood. Rapid decision making is needed for effective planning to anticipate realistic costs for excavation, recording, illustration, transportation, packaging and temporary storage. Those involved should include the Wood specialist(s), Archaeological consultants (if involved), Local Authority Archaeologists, Archaeological archive manager, Conservator, and Collections curator from the receiving Collecting institution/repository.

Ongoing costs of storage and specialists' time need to be considered at the planning stage to account for unexpected delays. A clearly defined end goal needs to be in place as wood cannot remain indefinitely in temporary storage. It is recommended that any wood requiring conservation is submitted within a maximum of 36 months

from excavation and wherever feasible, as soon as the recording and sampling has taken place.

Collecting institutions need to be involved in the early stages of the project so that decisions by the project team regarding discarding or keeping material can be made in relation to how it will be displayed or stored post conservation.

If excavated timber needs to be stored either on site, or prior to recording / assessment, the preferred method is to store under water, preferably in a cool, dark location. Cold storage (5°C) when not submerged in water is suitable in the very short term but is expensive and will not prevent the wood from drying out.

2.5 Unexpected discoveries

Unexpected discoveries of waterlogged wood will impact on a project's costs and timetable and will require specialist involvement. Therefore, a swift response with the project executive's input is required. Rapid evaluation of the site's / assemblage's character and significance will be needed to inform decisions on an excavation strategy (or on the continued preservation of the wood in the ground), and the need for any additional specialist or conservation input.

2.6 Specialisms and what they involve

Waterlogged wood is preserved in a wide range of settings (e.g. marine, intertidal and terrestrial environments; natural and anthropogenic deposits), with variable site types and dates (e.g. from ships to settlements; from prehistory onwards). Due to this, a wide range of specialist advice may be needed.

Consideration needs to be made to timescales to accommodate specialists' availability to undertake the work and to budgets to accommodate the costs, which may be uncertain.

The following section lists the main specialisms relevant to waterlogged wood. It is possible that individuals will have expertise in more than one of these, but do not assume that this is always the case and therefore be sure to establish this as early in the project as possible. Whilst specialists should be involved throughout the project, they may need to be brought in part way through the project due to unexpected discoveries.

Lead wood specialist: A wood specialist who has oversight of a project's waterlogged wood. They lead on the recording, sampling, provision of advice, and co-ordination of the wood-related activities and their respective specialists.

Usually this is the wood specialist with wood technology and morphology expertise.

Wood specialist (wood technology and morphology): Recording, assessing and reporting on the range and character of wood working evidence (conversion, tool kit etc) and wood working technology, alongside the nature and morphology of the raw material used.

They may also report on unworked wood from archaeological contexts.

This specialist may often operate as the Lead wood specialist; a point of contact for and helping co-ordinate other specialist involvement.

Laboratory-based wood recording (wood anatomy): Wood identification using high power microscopy (usually up to x400) to identify wood types, based on their anatomical features, normally examined from thin sections; identifications are usually to genus level.

Additional analysis and recording to look at timber selection and woodland management, the presence or absence of bark, pith and tyloses, and the wood's state of preservation (e.g. insect damage, iron deposition, and evidence of compression). May also undertake sampling for radiocarbon dating.

Dendrochronology: Examination of annual growth rings using microscopy to reveal the age of the wood and to provide an estimate of the date of felling. It is advisable that the dendrochronologist has appropriate experience of working with waterlogged archaeological assemblages.

On the samples that they receive (which is usually only a selection of the total wood assemblage) they can also carry out recording and analysis of wood types and anatomy (ring counts, ring widths, seasonal variation, presence of bark etc., sub-sampling from a dendro sample for radiocarbon dating).

Conservation: Advising on lifting, packaging and temporary storage. Determining the wood's state of preservation. Stabilising timbers and artefacts for display or storage. Assisting with decision making on discard.

Local authority archaeologist: Ensuring compliance with planning permissions, health and safety and archaeological regulations (sometimes known as Planning archaeologist or Archaeological curator).

Collections curator: Arranging receipt to the repository's collection for curation, and subsequently caring for the material in permanent storage or on display. Assisting with decision making on discard.

Nautical archaeologist: Advising on "the physical remains of any waterborne vessel irrespective of the material they are constructed from, the totality of the remains or the environment where they are found." (CIfA 2014a)

Radiocarbon dating: Providing advice on this technique, including sample selection and submission (see Bayliss and Marshall 2022). Can also have expertise in wiggle matching and Bayesian modelling.

Material sciences: The specialism(s) required will depend on the material(s) to be investigated e.g. surface treatments (organic, inorganic), caulking, basketry, textiles (threads, fabrics), construction / building techniques specialist.

2.7 Responsibilities of the contractor

Although specialist advice is essential throughout, the principal contractor will be expected to carry out much of the work required to excavate waterlogged wood, including (but not limited to):

- revealing / excavating the wood,
- keeping the wood wet and covered as necessary during excavation, and
- planning, photographing and possibly 3D modelling the deposits.

The balance of recording, lifting, sampling and packaging of the wood carried out by the contractor versus that carried out by the relevant specialist will depend on the recording pathway selected (see Section 5.1).

The contractor will normally be responsible for the transport and storage of the assemblage during the post-excavation process and the submission of the material for conservation or possible donation, re-burial or discard.

2.8 Important considerations when planning a project

Timeliness: The delicate nature of, and special storage conditions required by waterlogged wood means that completing the recording process as soon as possible after excavation is essential. This can mean that front-loading tasks relating to wood is often required, with priority given to that over other material types. Tasks relating to wood may need to be dealt with in a quicker timeframe than that followed by the rest of the project. In some cases, wooden artefacts and other significant items may have to be dealt with on a fast-track process, in a shorter timeframe than the bulk of the wood assemblage.

Early engagement: Often, multiple specialists will need to examine the same samples or objects, so managing competing demands (e.g. species identification, dendrochronology, illustration and photography, and submission for conservation), will be necessary to ensure these are all done in an appropriate order and within good time. Early engagement with stakeholders and specialists will help this process. All parties need to be consulted at the onset of the project, including the receiving Collecting Institution, the various wood specialists, and archaeological conservators.

Data Management Plan: Every project will have a Data Management Plan (DMP) (see the Dig Digital toolkit for managing digital data https://www.archaeologists.net/digdigital) written at the start, to ensure that thought is given to the types of data produced and how they are managed. Excavating a site with lots of waterlogged wood will generate a lot of digital data, so time spent at the beginning ensuring that the data are captured in the most effective way in order to transfer seamlessly into the digital archive, will save a lot of duplication and additional data handling at later stages.

Selection Strategy: Applying a selection strategy throughout the lifespan of the project will help make on-going informed decisions on retention and discard of the working project archive, ultimately refining it for final deposition as the project archive. These decisions will be made based on advice from the project specialists, and ultimately will ensure the considered and justified retention of the most significant remains. This consideration process occurs throughout the lifespan of a project and ultimately ensures that the decisions and rationale for keeping / not keeping remains is documented. Using CIfA's Toolkit for Selecting Archaeological

Archives (CIfA and Historic England n.d.; https://www.archaeologists.net/selection-toolkit/toolkit-overview), which includes a checklist of tasks and considerations, will help with this process.

Workflows: Figure 1 shows the workflow for a typical project dealing with a waterlogged wood assemblage. It can apply to an evaluation or a full excavation. Often, the tasks – and their respective specialist input(s) – will ebb and flow throughout a project, with some (particularly conservation) contingent on previous tasks having already been completed. It is therefore important to keep track of work schedules and communicate regularly with the project specialists. Although Local Authority archaeologists are not included in the workflow diagram, they are integral to the process, from their discussions about and approval of the initial WSI, to on-going engagement and monitoring, through to final project approval, as set out in the WSI and relevant planning conditions.

Figure 1. See separate figure file on consultation webpage.

Be aware that excavation (including planning, photography and 3D modelling) and post excavation work of waterlogged sites will be more costly than a 'standard' excavation, due to the preservation of organic materials and the necessary specialist conservation requirements. It will therefore need to be costed accordingly.

It is also essential to:

- prepare a written strategy for the excavation and post excavation processes and workflows, including the excavation technique, preservation during excavation (covering and watering *in situ* material to keep it wet), planning (manual / 3D modelling), and
- identify named individuals to cover each specialist input required and involve them in the preparation of a written strategy if required (wood technology, dendrochronology, species identification, illustration).

3. Evaluation excavation

The purpose of any evaluation is to characterise the site, understand its extent and date, and assess the significance and state of preservation of the remains.

This is true regardless of whether it is an evaluation of a site with an expected presence of waterlogged archaeological wood, or if waterlogged wood is identified during an evaluation where it was not expected. Whether or not the evaluation is followed by a full excavation, the wood assemblage will still require prompt recording, assessment and, if necessary, may also require analysis, conservation and archiving.

An evaluation excavation involves evaluating the character of the exposed wood and undertaking targeted recording to answer initial questions about the remains' state of preservation, origin (anthropogenic / natural), date, and function etc, in order to inform a future excavation strategy (if deemed necessary and/or appropriate) or the site's continued preservation.

It is useful to establish as early on as possible whether the wood is anthropogenic in origin, naturally accumulated or a mixture of both, as this will help determine the amount of recording and post-excavation analyses needed. Naturally-accumulated material can be of significance in its own right – helping set the scene of contemporaneous human activities, by providing evidence of the plants and animals inhabiting the landscape (e.g. beaver-gnawed wood). However, the scope and research questions of the project will determine the extent to which natural deposits are considered.

An evaluation of a site containing waterlogged archaeological wood needs to be extensive enough to be able to make appropriate decisions on subsequent actions. If waterlogged wooden artefacts are uncovered, they should be recovered immediately to prevent rapid deterioration of their condition. Where larger structures such as worked wood platforms are encountered, enough needs to be excavated to understand the depth and character of the deposit. If complex sites or structures are uncovered in evaluation trenches, discussion between the site archaeologists, wood specialists, conservators, local authority archaeologists and the collecting institution may be required to determine the amount of evaluation needed.

The presence of a lead wood specialist on site will be vital for characterising and assessing the significance of waterlogged wood and advising on further action. Early consideration should be given to selecting an appropriate excavation pathway (Pathway 1 / Pathway 2) – see Section 5.1.

Significant waterlogged wood deposits should be sampled for scientific dating, wood identifications and assessing the state of preservation. Samples for assessment should cover the range of material from across the extent of the site. Sampling for the state of preservation should be undertaken following discussions with and under the guidance of the project's [wood] conservator.

For the purposes of scientific dating (for example to get a spot date for an undated assemblage to help understand its significance), expert advice should be sought from the lead wood specialist, radiocarbon dating specialist and/or dendrochronologist.

4. Assessment and decision-taking following evaluation

The results of the evaluation excavation and the investigation of the waterlogged wood both on site and from the samples recovered, are used to inform the assessment of the significance of the remains, their state of preservation and to consider the impact of any development or land-use changes on them.

More detailed guidance on these topics is also covered in the Historic England guidance on Preserving Archaeological Remains (https://historicengland.org.uk/images-books/publications/preserving-archaeological-remains/).

A further key part of this assessment stage following evaluation is the production of a catalogue of the material excavated.

4.1 Significance

The assessment of significance of waterlogged archaeological wood is critical for making decisions about how to deal with the wood following its discovery and should be carried out by the lead wood specialist. Guidance on assessing significance is given in the Historic England Advice Note on Statements of Heritage Significance (https://historicengland.org.uk/images-books/publications/statements-heritage-significance-advice-note-12/heag279-statements-heritage-significance/) and the Good Practice Advice note on Managing significance in decision-taking (https://historicengland.org.uk/images-books/publications/gpa2-managing-significance-in-decision-taking/gpa2/). It is essential to include advice from relevant specialists in assessing significance.

One way to consider the significance of waterlogged archaeological wood is to use the values set out in Historic England's conservation principles (https://historicengland.org.uk/advice/constructive-conservation/conservation-principles/). These are Evidential value; Historic value; Aesthetic value; and Communal value. Another option would be to consider whether the wood has archaeological interest, as set out in the NPPF (MHCLG 2023).

The reason for thinking about waterlogged wood using these criteria is that the actions you might take if the wood assemblage had a high level of evidential value (or archaeological interest) might be very different to those where you had already learnt everything through recording and sampling and all that remained were aesthetic values.

Such differentiation may provide a useful focus for selection strategy discussions.

4.2 Assessing the state of preservation

Understanding the state of preservation of any wooden elements is essential for establishing how they should be handled on site, their potential for subsequent investigation and analysis, advising on a conservation approach, and providing an indication of further degradation (e.g. during temporary storage).

A comprehensive review of the multiple methods available to determine the state of preservation of wood has been produced by High and Penkman (2019), and a summary of the techniques is presented in Table 1. A wood specialist and/or conservator will also advise on the most suitable approach, and in most cases a multi-analytical approach is recommended.

Table 1. Summary of the main techniques used to assess the significance and state of preservation of waterlogged wood remains, and when they are usually carried out.

Technique	**When to use**	**Information provided**
Visual assessment	On site, during evaluation	Structural integrity; archaeological significance
Pin test	On site, during evaluation	Structural integrity; extent of deterioration
Thin section microscopy	Off site, during species identification	Species; assessment of physical structure; presence of fungi; presence of inorganic deposits
Scanning Electron Microscopy (SEM)	Off site, prior to conservation decisions	Assessment of physical structure; cellulose content; presence of fungi; presence of inorganic deposits
Maximum water content, density, wood shrinkage	Off site, prior to conservation decisions	Loss of wood substance (cellulose content)
Thermogravimetry	Off site, prior to conservation decisions	Cellulose content; inorganic content; lignin damage
SEM-EDX	Off site, prior to conservation decisions	As for SEM, but additional information on inorganic content
FTIR	Off site, prior to conservation decisions	Cellulose content; inorganic content; lignin damage
X-ray imaging	Off site, prior to conservation decisions	Internal decay; presence of internal features such as nails or voids
Py-GC/MS or EGA/MS	Off site, for detailed molecular analysis	Cellulose content; detailed analysis of lignin modifications
Residual ash analysis	Off site, prior to conservation decisions	Inorganic composition (by mass, individual elements not identified)
XRF	Off site, prior to conservation decisions	Inorganic composition (including identification of elements)

4.2.1 Visual and physical assessment

Visual and physical inspection of the wood is an essential and important starting point, with a particular reference to surface detail. The scoring criteria in Table 2 relate the state of preservation to whether the wood has the potential for: woodworking and wooden technology analysis; species identification and wood studies; and scientific dating (both dendrochronology and radiocarbon dating). Across categories, the boundary for meaningful analysis is a score of '3 moderate'.

State of preservation	Woodworking / wooden technology analysis Section 7.3.2	Conservation Section 7.2.3	Wood studies Section 7.3.3	Scientific dating		Species identification Section 7.3.3
				Dendro	C14	
				Section 7.2.2		
5 excellent	+	+	+	+	+	+
4 good	+	+	+	+	+	+
3 moderate	+/-	+	+/-	+	+	+
2 poor	+/-	-	+/-	+/-	+/-	+/-
1 very poor	-	-	-	-	+/-	+/-
0 non-viable	-	-	-	-	-	-

Table 2. Visual and physical inspection grading scheme for assessing the state of preservation and analytical potential of waterlogged wood (originally devised by Maisie Taylor (Van de Noort et al. 1995), modified by Bamforth and Robinson Zeki). An object is assigned a grade (0–5) based on characteristics defined below in Table 3. This grade indicates its suitability for different types of archaeological analysis; (+) = suitable (-) = unsuitable. A threshold for conservation is also included, with items scoring '2 poor' or lower generally having insufficient preservation of woodworking evidence to warrant retention on that basis alone.

5	All original woodworking evidence will be present and clearly visible and well presented – it will appear 'as new'.
4	Primary and/or secondary conversion will be clear as well as fine detail such as tool facets and additional tool signatures or stopmarks. Use-wear will be apparent, if present.
3	Primary and/or secondary conversion will be clear, if present. Tool facets will be visible if present but will not preserve fine detail. Will be sampleable for species identification and scientific dating, if appropriate, and is likely to provide viable data.
2	The basic form of this material will be visible (e.g. roundwood, debris etc). Conversion may be apparent but clear faceting will not be visible. Will be sampleable for species identification and scientific dating, if appropriate, and may provide useful results.
1	The basic form of this material will be visible (e.g. roundwood, debris etc). Conversion may be apparent but clear faceting will not be visible. Will be sampleable for species identification and scientific dating, if appropriate, and may provide useful results.
0	Material that is barely recognisable as wood – typically occurs as 'dust', as a 'smudge' or as a 'shadow'. Will not be an entity that could be picked up and bagged.

Table 3 – Characteristics Key to Table 2 (After Bamforth and Robinson Zeki 2023)

Visual inspections and manual techniques such as pin tests, can be carried out on site during the evaluation (or later excavation) stage. One of the aims of these assessments is to establish the structural integrity of the wood and devise a lifting and excavation approach.

To establish the potential extent of wood survival or support a conservation and retention strategy, further analysis may be required to determine the cellulose content (loss of wood substance) and identify the presence of any inorganic salts. This would typically be carried out off site using samples that represent the spatial extent of the site.

High powered microscopy using thin sections is routinely used by an archaeological wood specialist to identify wood taxa. The same method can provide a basic idea of the state of preservation of the wood including how intact the physical structure is, identify types of decay, and reveal the presence of fungal hyphae or inorganic salts. A much clearer picture of the state of the wood cells can be obtained using a scanning electron microscope (SEM), often revealing how much cellulose remains within the cell walls.

There are well-established basic methods of determining the state of preservation of wood such as maximum water content, wood density and shrinkage metrics which reflect how much of the original wood substance has been lost (usually primarily cellulose).

4.2.2 Specialist analytical methods to assess the state of preservation

Most of the below mentioned techniques will not be applied routinely. An understanding of their potential and limitations is however useful when thinking about undertaking or commissioning specialist analyses.

Methods that employ specialist analytical equipment, such as thermogravimetry, Scanning Electron Microscopy-Energy Dispersive X-ray (SEM-EDX) or Fourier Transform Infrared Analysis (FTIR) are more sensitive and can provide an indication of both cellulose and salt content, as well as damage to the assumedly robust lignin skeleton. These methods can be carried out on much smaller samples (< 10mg for FTIR cf. > 0.5g for maximum water content). As such they should be considered as alternatives in cases involving small artefacts or when a greater range of sampling is required, for example if variations in preservation are suspected across a site.

Some assessment techniques can be extremely useful in particular cases. X-ray imaging is a non-destructive approach that is often employed prior to conservation as it can reveal the presence of tunnelling by marine boring organisms or internal features such as iron nails and joints.

In some circumstances, for example when the survival of wood over a defined period of time is in question, if the site is of particular significance, or to answer specific research questions, specialist analytical techniques such as pyrolysis gas-chromatography (py-GC/MS) or evolved gas analysis mass spectrometry (EGA/MS) can be used to reveal a detailed picture of deterioration of the more robust lignin

component of wood. Such advanced techniques are unlikely to be needed for most sites but may be valuable in certain circumstances.

Detecting both the presence and concentration of iron salts and sulphides is critical as they can cause both immediate and long-term problems in stored or conserved wood. Such salts are particularly common in wood excavated from marine environments or when iron nails or other attachments have been associated with the wood. Inorganic (salt) content is commonly determined by weighing the residual ash after a wood sample is burnt at high temperature in a furnace or by using X-ray fluorescence (XRF) spectroscopy. Inorganic components can also be revealed during microscopic analysis or FTIR analysis. If present, action must be taken to mitigate against accelerated decay caused by the formation of sulphuric acid or large crystals due to the presence of the salts.

4.3 Factors affecting the survival of waterlogged wood

The survival of waterlogged archaeological wood is dependent on a stable burial environment, which keeps the wood permanently waterlogged. This excludes oxygen and reduces biological decay.

Development or land-use changes can impact on the survival of archaeological remains through direct physical impacts (i.e. excavation of an area, or construction of building foundations), or through changes to the groundwater regime (through lowering groundwater or changing the flow). These potential impacts should be fully understood and taken into account when considering the harm to the significance of the site from any proposals.

4.4 Decision-taking

After an evaluation where waterlogged archaeological wood has been identified and recorded and an assessment of significance and the state of preservation has been undertaken, a decision about how to manage the site and material will be made.

- If the waterlogged wood has no remaining evidential or other values present (or no archaeological interest) and therefore no further information will be gained from additional investigations, then following completion of the recording / reporting, and decisions about selection and archiving, no further action is needed.
- Where the assessment of the state of preservation and an understanding of any potential impacts demonstrates that development, land-use changes or existing site-use will not harm the long-term preservation or significance of the site, waterlogged wood can be left in its existing location and the site managed to ensure survival. Further details of this aspect of the decision-taking process are outlined in the Historic England guidance on Preserving Archaeological Remains (https://historicengland.org.uk/images-books/publications/preserving-archaeological-remains/).
- Where there is still archaeological interest (or evidential value) which can be realised through excavation and analysis and the decision is taken to excavate the site, waterlogged wood will either be recorded and then

discarded, or recorded, conserved, archived and potentially displayed. There will also be cases where some of the assemblage is selected for retention and the remainder discarded. These are all selection strategy decisions and underline the importance of holding selection discussions from the point of discovery of waterlogged wood on an archaeological site (Figure 1. Workflow chart)

- Aspects that might influence and have a bearing on these selection decisions include the significance and state of preservation of the wood; the cost of conservation and availability of storage space; and whether the conserved assemblage will provide opportunities for further recording to address new research questions in the future (remaining evidential value / archaeological interest).
- Where non-artefactual wooden items are recovered which look visually appealing and have a high potential to engage the public through their appearance (aesthetic values) but have limited further evidential value / archaeological interest, all those involved in the selection decisions to keep, conserve and display these items need to fully understand the costs and timescales involved.

5. Excavation, recording and sampling

This section sets out methods for excavation and recording, with two different pathways for recording and sampling. It covers excavation techniques, methods of *in situ* recording, advice on lifting, packaging and transportation. Specific guidance is also provided for nautical archaeological remains.

5.1 On and off site approaches

There are two main approaches for the excavation and recording of waterlogged wood. These are: Pathway 1 – full recording on site with sampling, selection and active discard taking place alongside, and Pathway 2 – minimal on site recording with the material retained for post-excavation recording. These strategies can be implemented on a site-wide scale, or at a smaller scale, by context / feature / group or even for individual items. It may be desirable to use a combination of the two methodologies for different areas within a single site, and specialist input during the excavation can help to ensure the correct balance between recording and sampling on site, and packaging and retaining for post-excavation recording.

Decisions regarding the application of Pathway 1 and/or Pathway 2 should be made by the lead wood specialist / wood specialist (technology and morphology), in conjunction with the excavation and management team. This decision will be informed by the significance and state of preservation of the wooden remains, research questions, availability of staff and expertise, site-specific timeframes, working conditions on site (e.g. weather, waterlogging, tide times), resources available for packaging and moving wood, and the availability of storage space.

As always, making timely decisions will work out cheaper than any unnecessarily lengthy temporary storage of wood.

5.1.1 Pathway 1: Full recording on site

The aim of this approach is to front-load recording, with sampling and selection decision making taking place on site. This minimises the need for medium term storage. This strategy requires a wood specialist to be on site most of the time, often working with a team familiar with waterlogged wood. On site recording will always include a:

- written record
- drawn record (sketches are often essential and illustration may be appropriate)
- photographic record. It can be beneficial at this stage to start on publication-quality end products.

This approach can significantly reduce the time spent on post-excavation recording. To make this work, sampling, selection and discard strategies need to be prepared in advance, where possible, based on the best available information, and regularly reviewed and updated by project members and stakeholders as the excavation

progresses. The main drawbacks of this method are that cleaning and recording of material are done on site in sometimes less than perfect conditions.

Material should be retained where potential for further analysis or possible conservation has been identified. A sufficient volume of the assemblage needs to be retained to address not only analytical tasks identified during the excavation process, but also to allow questions emerging from the assessment process to be addressed. All potential artefacts should be kept intact and not sampled on site (Historic England 2018).

Where selection and discard decisions are made during excavation, it is important that sufficient sampling is undertaken for identification / woodland management studies (this can often include most items that will be discarded), dendrochronology (generally all items identified as having dendrochronological potential) and radiocarbon dating. To ensure that sufficient sampling is undertaken for dendrochronology, advice should be sought by the lead wood specialist / wood specialist(s) from the dendrochronologist. It should be remembered that different selection criteria apply to radiocarbon and dendrochronology samples (see Bayliss and Marshall 2022, English Heritage 2004)

5.1.2 Pathway 2: Minimal recording on site, specialist post-excavation recording

The aim of this approach is to remove most or all the material from the site, for it to be recorded off site during the post-excavation stage. This ensures that the recording of the assemblage can be carried out by a wood specialist when they are not able to be present on site on a permanent or regular basis.

The advantages of this methodology are that wood can be cleaned properly before recording and sampling, and that there is a break to allow a reasoned strategy for sampling, analysis and selection for conservation to be developed, informed by assessment of the whole assemblage and some dating evidence. The main disadvantages are that temporary storage facilities are required for the complete wood assemblage, and that the wood specialist may not see all the material in the ground. Due to the degradation that wood suffers in temporary storage, and to minimise information loss, it is essential that post excavation recording is completed in a timely manner, preferably within 12 months of excavation, and prior to the preparation of the written assessment. Adequate time needs to be allocated for integrating the wood data into the site record e.g. incorporating wood data / photogrammetry into a GIS database, as checking and cleaning data can be time consuming.

5.2 Excavation techniques

The delicate condition of waterlogged wood presents a series of practical challenges during the excavation process. Throughout the period between exposure and lifting, wet wood will begin to desiccate, split and decay unless remedial action is taken. For this reason, the minimum possible area of wood should be exposed at any one time, considering the size of the excavation team and the need to understand and plan the deposits.

Waterlogged wood is delicate and cannot support the weight of a person standing on it. Furthermore, wood is often encountered in particularly soft deposits (such as peat); excavating in these areas can sometimes require the installation of temporary infrastructure, such as walkways and access platforms.

During excavation it is essential that the wood be kept shaded, sheltered and wet, to prevent desiccation. Exposed wood should be sprayed with water on a regular basis. The frequency of re-wetting should be increased in direct sunlight and/or in high winds, to mitigate the drying effect. To protect exposed wood overnight or when not directly under excavation, it should be carefully covered with an absorbent, water-soaked material (e.g. polyether foam or capillary matting) then covered with plastic sheeting (preferably black). The absorbent material requires regularly spraying so that it does not wick water out of the wood. In low temperatures, an additional layer of insulating foam should be used to prevent freezing of both the absorbent material and the wood. Temporary shelters (such as gazebos) can be effective during excavation in terms of preventing rapid desiccation of the wood from direct sunlight.

Maintaining a high moisture content on site for long periods can be very difficult. In these circumstances, erecting an enclosed shelter can be considered as a method to maintain humidity and moderate temperatures. A shelter may also help prevent flooding by rainwater and can accelerate on site recording by creating better conditions for paper-based or digital recording.

Most significantly, a shelter can allow a larger area of the site to be exposed at the same time, increasing the ‘window’ through which interconnected elements of the site can be understood, a difference which can have a radical impact on interpretation. The cost of erecting a stable enclosed shelter can be high, however, for large sites, the costs of the staff time spent wrapping and unwrapping wood each day soon add up; at Must Farm, the (cost of the) time saved each morning and night covered the cost of the structure. Erecting an enclosed shelter may not always be appropriate and in high temperatures, the effect of a sweltering shelter on both the waterlogged wood and the archaeologists will need to be effectively managed.

Waterlogged wood is highly susceptible to damage during the excavation process itself. The use of sharp-edged metal tools, such as trowels and spades, can cause irreparable damage and so should not be used for uncovering waterlogged wood in deposits such as peat. Instead, wooden or plastic spatulas, sponges and hands are a practical alternative. In most clay and gravel sites the use of metal tools is inevitable but special care should be taken in their use as even relatively robust oak (*Quercus*) timbers can be badly damaged.

Thorough cleaning of delicate wood surfaces *in situ* should not normally be attempted unless with particular care. Water sprays can be used in some deposits to help excavate and clean around wooden structures; access to water is therefore essential. Wood should be photographed as soon as possible after exposure and cleaning, before any detail starts to degrade, and before recording, lifting and sampling commences.

5.3 Initial on site recording

Regardless of the excavation pathway chosen, some on site recording is required. Every excavated piece of wood should be given a unique site wood number and those numbers should be recorded on site plans and elevations. The exceptions to this are groups of wood remains such as wattle panels or collections of brushwood or woodchips that are going to be described and sampled as a group rather than individually. In the case of hurdle panels, it is useful to assign one wood number to the sails (= upright rods) and one to the weavers; any individual samples within a sail or weaver group can be assigned an individual identifier (a, b, c… etc) later, during analysis. A general site policy for such group numbering should be developed before the beginning of the excavation. The numbering of wooden remains is best achieved using waterproof labels attached with stainless steel, corrosion-resistant pins.

The location of wood should be recorded in plan where the wood is used structurally or where there is a pattern in the deposition of wood which is relevant to its interpretation (e.g. collapsed, partially intact wattle, aligned brushwood bundles, scatters of woodchips). Photogrammetric recording of complex structures can be highly effective. This method allows for the generation of orthographic images from which numbered, digital plans can be created, as well as 3D models. While these techniques can save recording time on site, they require additional time in post-excavation to integrate data. A large digital data set will normally result from such techniques and their application should be carefully considered, mentioned in the DMP and agreed with the repository for the digital data.

Once a wood number has been assigned, a (paper or digital) wood recording sheet should be filled in for each individual piece or group. The information that must be recorded whilst the wood is *in situ* should include:

- context, feature, plan, drawing and/or photography numbers
- setting (horizontal, vertical etc.), orientation and inclination
- surface condition with areas of excavation and pre-excavation damage or breakage clearly distinguished
- a sketch guide marking the position of significant details (e.g. joints, nails, pegs) and showing how broken or fragmented pieces refit to allow reassembly, and
- relationship to other timbers in a structure.

5.4 Lifting

The lifting of waterlogged wood requires careful handling because the material will often have little inherent strength and may have cracks and weaknesses that are not apparent on the surface. Lifting of very delicate objects should be done under the guidance of a conservator.

As much of the surrounding deposit as possible should be removed and fragile sapwood and bark should be secured with pins or bandages before lifting. Wood should be lifted onto a surface that can be used to support the piece for transportation to temporary storage or to a working area if final recording and

sampling is being carried out on site. Oak heartwood usually remains quite hard and strong but is also heavy and can have hidden cracks. Oak sapwood is softer and is highly vulnerable to damage.

Ideally, long timbers should not be sawn into shorter pieces, but if this is necessary, either to disassemble a structure or to allow safe movement of large or heavy items, markers should be left on both sides of the cut to indicate the correct realignment. Sawing at a slight angle also helps later realignment.

5.5 More detailed recording

Following lifting, more detailed recording and sampling of the wood by the wood specialist may occur on site (Pathway 1, above) or off site (Pathway 2, above). Before recording, the wood should be cleaned carefully. Sponges, soft brushes, sprays and flowing water are all effective in removing sediment. This may be undertaken by the specialist, or for efficiency, it may be beneficial for archaeologists with experience of working with waterlogged wood to clean the wood ahead of a specialist visit, to maximise recording time. Where artefacts have been selected for conservation, protective or supportive sediment should be left in place, with fine-grained cleaning undertaken by the conservator.

Recording should be undertaken using a (paper or digital) wood recording sheet, adding details to the information recorded whilst the piece is *in situ*. Different recording forms are appropriate for different types of wood assemblages. Examples of sheets suitable for recording timbers from urban contexts and converted and unconverted wood from disparate non-urban contexts are provided online [we are hoping to include an example of each in the guidance]. Completion of wood recording should be carried out by a wood specialist or by trained personnel. Where different individuals are involved in recording, emphasis should be placed on ensuring the terminology and categories used are internally consistent.

In full recording, the information required should include:

Basic site information

- Context and associations
- Planning, drawing and photography numbers
- Setting (horizontal, vertical, angled, etc.)
- Orientation and inclination (in degrees)

Appearance and state of preservation

- Size and shape (dimensions and sketch)
- Damage, breakages and number of pieces (pre- and post-excavation)
- Evidence of insect, fungal or plant damage (pre- and post-excavation)
- Surface condition (from fresh to weathered)
- Surface features, wear, charring, paint, and presence of bark, bark edge or sapwood

Natural features

- Natural growth features, growth ring estimate and pattern, and timber quality
- Features resulting from management practices e.g. coppiced heels
- Taxonomic identification (established at the analysis phase following microscopic analysis, except where oak is identified on site by wood specialist or another trained person)

Woodworking evidence

- Conversion type and method, including sketched cross-section
- Evidence of working, degradation or damage (ancient or modern) at ends
- Evidence of felling and cutting of log to length
- Evidence for shaping and finishing of timbers, including measurement of selected tool marks and recording of stop marks and tool signatures
- Evidence of joints, nails, pegs
- Traces of wear

Functional interpretation

- Purpose within structure or context
- Features indicative of reuse or modification from the item's original purpose

As part of the recording process, the production of measured sketches, technical drawing and/or photography will often be appropriate to efficiently document details. Whilst some of this may be undertaken on, or in parallel to, the wood recording form, technical drawing (face and edge line drawing) / illustration, and photography / 3D modelling may be identified as tasks to be undertaken during the analysis phase. The specialist will determine the required approach to graphical recording to ensure that the archive is representative and proportionate. Recording should be completed within 12 months of excavation.

5.6 Sampling

Sampling usually happens immediately after wood recording and in general samples should be taken as soon as is feasible and appropriately stored (see Section 6). Samples are taken for species identification (and possibly also used for radiocarbon dating), woodland management, environmental indicators and dendrochronology. The same sample can sometimes be used for multiple analyses, for example, a single section of a complete small diameter branch can be used both for wood identification and producing a ring count, or a dendro sample can be used for wood identification, radiocarbon dating and oxygen isotope dendro. Samples are often not taken at this stage from items / artefacts selected for later drawing, photography or conservation.

In some cases, it may be possible for experienced wood anatomists to identify the wood using anatomical features visible at the surface, thus avoiding the need for destructive sampling; this is especially relevant to wooden artefacts of high significance.

5.6.1 Sampling for species identification

It is standard practice for small samples to be taken for microscopic, laboratory-based wood identifications to be carried out. Sometimes it is possible for wood specialists to identify oak (*Quercus* spp.) in the field, from features that are visible macroscopically; in which case sampling for identification may not be necessary – although the wood may still require sampling for other scientific purposes. Samples should be taken from well preserved knot-free sections of the wood and, at the very least, a complete annual ring is needed. If the wood is badly preserved a larger sample should be taken.

Every piece of worked wood should be sampled for identification, although if the worked group is large with repetitive characteristics, a subsample might be appropriate. The wood identifications should be completed within a maximum of 48 months of excavation.

5.6.2 Sampling for woodland management

The age and growth rates of the wood can be used alongside species information to reconstruct the character of the woodland that was being exploited. Often the same specialist who is undertaking the laboratory-based wood identification will also be undertaking any woodland management recording, usually on the same sample. The samples should be taken from a position where the largest number of annual growth rings are present, and in the case of roundwood a complete cross section, avoiding knot holes and side branches. This same sample can also be used for the wood identification.

The sampling strategy will be determined by the lead wood specialist. Where use of coppiced material is suspected (from the presence of long, straight, young stems), the age and size of the roundwood should be determined from samples taken from the widest end of each stem. A minimum of 20 such samples is required for any meaningful analysis from a single wood group or context. For wattle panels it is advisable to sample every sail and at least 20 rods (weavers) (if possible). Microscopic woodland management analysis should be completed within 48 months of excavation.

5.6.3 Sampling for environmental indicators

Sampling of wood for evidence of fungal, bacterial or beetle attack can help to reconstruct the environment in which the wood was deposited and determine whether timber was stored before use.

The choice of sample location is very important and should be determined in consultation with the relevant specialists.

5.6.4 How to bag and label samples

Best practice is to individually bag each wood sample in its own, labelled sample bag, with water to keep it wet. As much air as possible should be excluded before sealing; this can easily be done by immersing the bag in water up to the seal before closing. Clear, re-sealable grip-lock / grip-seal types with write on panels are the

most practical and convenient. If multiple samples come from a single overarching group (e.g. a particular wattle panel) then multiple sample bags can then be grouped together in a larger sample bag, for convenience.

In exceptional situations, if it is not possible to individually bag samples, then multiple samples from the same wood group may be placed in the same bag. Ideally, these will be of approximately equal dimensions and should be no more than ten at a time. In this case, the number of fragments should be written on the labels so that it is clear if any subsequent fragmentation has occurred, in which case it might be possible to refit fragments.

Each sample bag should be labelled clearly on the outside with waterproof permanent black marker pen, as well as having a waterproof, tearproof (Tyvek) label included in the bag itself. Labels in the bag should not be pinned to the sample (and should absolutely not be pinned to the cross-sectional surface of the sample).

5.7 Packaging for transportation

On site storage will depend on space, facilities, and the duration of the excavation, but wherever feasible, storage conditions should follow those outlined in Section 6. For transportation, waterlogged wood may have to be repackaged, as transporting it submerged in water in buckets or boxes can cause damage to the wood itself due to movement.

Smaller items or samples can be transported in water in sealable plastic bags (as described in Section 5.6.4).

Larger pieces of waterlogged wood should be packaged in such a way that evaporation of water during transportation is limited. This can be achieved by wrapping in layers of bubble wrap (bubbles facing away from wood) or polythene sheets. Applying a layer of wet, absorbent material (such as foam or capillary matting) next to the wood first will further help to keep it wet.

When loading the transportation vehicle, care should be taken as even wrapped wood can be damaged. Particular attention should be paid to the order of packing with larger, heavy items at the bottom and lighter, smaller ones at the top, using cushioning in between where required.

Once the material has reached its storage destination, its packing will need to be assessed, and any repackaging carried out as necessary.

5.8 Nautical Archaeology

Although the general approach outlined in this guidance document also applies to ship or boat remains encountered on underwater sites or in the intertidal zones, it is recognised that the working conditions in these environments can be challenging, especially with regards to *in situ* recording. Not all ship remains present as articulated hull structures but may be found partially or largely disassembled. Ship timbers may be found reused in revetments, as well linings and in a wide range of other structures. The recording, assessment and analysis of these would still benefit from specialist nautical archaeology input.

A nautical archaeological specialist (as defined in CIfA 2014 Standard and guidance for nautical archaeological recording and reconstruction) should be engaged in any project where boat and ship remains are encountered. The nautical archaeologist should be involved in the production of the project design or WSI, where ship or boat remains can reasonably be anticipated. They should contribute to methodologies on excavation and recording, as well as sampling strategies for wood identification and dendrochronology from a specialist nautical point of view. Most archaeological teams will not have these skills which is why the involvement of the specialist from the outset is crucial.

Wood recording sheets that reflect the specific shipbuilding technology should be used to capture information on site prior to sampling or recovery; for example, a sheet designed for recording a medieval clinker-built vessel should be used where that type of ship is being excavated.

Sampling strategies should follow current guidance (Domínguez-Delmás et al 2019) with most sampling being undertaken after completion of detailed post-excavation timber recording. Any sampling of nautical timbers on site, for example for dendrochronological spot dating, should be carefully considered, as the full extent of the remains may not have been exposed or recorded yet and later detailed recording may be jeopardised by the spot sample taken.

More generally and wherever possible, samples should be taken from areas which do not include fasteners or other technological information and which avoid bifurcating timbers whose curvature will be crucial to future reconstruction efforts. Dendrochronologists should be made aware of the potential need for the samples' return for conservation alongside their parent timbers and discouraged from freezing samples for surface preparation.

In cases where substantial boat or ship remains are not going to be preserved in their original location, plans should be made to recover the remains for detailed off site recording in controlled conditions. Prior to that, a three-dimensional record of the *in situ* remains should be produced that is of sufficient accuracy and resolution to show the spatial relationship between articulated timbers (or fragments thereof), and their identity (through use of labels).

6 Timescales and temporary storage

Temporary storage refers to the period of storage of un-conserved waterlogged wood from its recovery / removal from site to the time of its conservation or discard. Such storage should therefore be for a limited time and not be seen as a permanent solution. Ideally, waterlogged wood should be analysed and conserved (or deselected) within 36 months.

Storage arrangements should be a key part of the planning stage of the project and involve the relevant conservator and lead wood specialist. A temporary storage plan should be in place which includes timescales for specialist work, continued monitoring and future purpose (conservation or disposal). Storing for too long, even in wet conditions, whilst post-excavation procedures are debated, will result in degradation of the wood until the wood is in too poor a state to conserve or study. Extended temporary storage will also increase planned storage costs. Figure 1 Workflow provides suggested maximum timeframes for various tasks to be completed within.

Methods of temporary storage, are:

- Wet, cold and dark storage – this is the ideal condition.
- Wet storage – fully submerged in water, be it in a tank, bucket or box, for example.
- Cold storage – placed in a cold storage unit at a temperature of 5–8^{o}C to reduce decay by micro-organisms. Smaller items can be submerged, and large items wrapped (wet-packed).
- Wet packed storage – if it is not possible to fully submerge or place items in cold storage, they should be wrapped with well soaked, absorbent material and polythene, sealed, then stored inside and kept as cool and dark as possible.

Whichever option is being used, waterlogged wood in storage needs to be checked and monitored to ensure that it stays wet and that the water is free of contaminants (debris, algae, microbiological activity). The potential for the development of bacterial *Legionella* needs to be recognised and a risk assessment should be prepared in advance, along with a regular programme of monitoring.

Wet storage is preferable to cold storage. Cold storage may not always be available and continued use of a cold store will increase storage costs due to high demands on electricity, plus it will not prevent wood from drying out.

Identification information should always be clearly visible, whatever the storage method, and it is essential to keep a precise and up-to-date record of where individual pieces are stored.

Timbers from a marine environment can be stored directly in fresh water, which will need to be changed frequently, with chloride levels checked before the wood goes into conservation.

On advice from a conservator, corrosion inhibitors can be added to the storage tank for wood containing iron to prevent deterioration of the iron during storage, which can also cause accelerated damage to the timbers.

Light should be excluded to reduce algal growth by using containers or tanks made of opaque materials with lids. This reduces the need for biocides which can be a health hazard and interfere with future analysis and conservation processes.

Water within containers and tanks may need to be changed regularly to minimise the build-up of fungi, bacteria and algae, or topped up due to evaporation; therefore, access to a water supply and a drain is essential. Covering these containers will also reduce evaporation.

Monitoring of timbers for levels of increased degradation during storage should take place periodically to assess conservation or study potential. Unwrapping and re-wrapping of timbers will need to be part of the timescale and associated costs.

Temporary stores should be within a structure that can prevent extremes of temperature. Freezing will cause damage to the wood structure, whilst warm conditions will accelerate bacterial and fungal growth.

7 Post-excavation Assessment and Analysis

A post-excavation assessment should include assessment of the quality and nature of the record generated during excavation, an assessment of the wood's state of preservation and significance to inform analysis and should identify possible conservation strategies (through a conservation assessment).

The post-excavation assessment is essential to ensure that a properly costed and timetabled post-excavation programme of analysis and reporting is developed, typically as part of an updated project design (UPD).

7.1 Post-excavation assessment

All wood recorded should be quantified at assessment. All wood submitted for assessment should be recorded prior to the submission of the written assessment report, with the recording completed within 12 months of excavation.

The report should have clear sections on:

- the size of the assemblage
- the methods used to record it
- the state of preservation
- the character and context of the assemblage
- a statement of potential
- recommendations of work to be undertaken at analysis and/or publication
- costings for the recommended work and
- a proposed timetable of works.

The report should give an account of the recording methodology and any variation in levels of recording or sampling which may affect the potential for various analysis tasks. The assessment should cover the wood's state of preservation, its character in terms of woodworking evidence and morphology and consider any available contextual information. It should provide a statement of potential addressing the suitability of the assemblage for analysis of:

- woodworking evidence (i.e. the raw material selection, tools and techniques used in modifying wood)
- wooden technology (i.e. the character and function of wooden products), and
- woodland reconstruction, tree ring studies and human-woodland relationship.

Recommendations at assessment should clearly list how many items require illustration, photography or 3D modelling and which samples should be selected for identification and/or tree ring studies. The selection of the latter may depend on the project's research questions and the wider environmental sampling strategy. They should also state which items have potential for scientific dating (ring-width and / or isotopic dendrochronology, radiocarbon) and which items should be considered for conservation, based on the input from the relevant specialists. Recommendations should also make clear what further reporting is required – i.e. which aspects of the dataset need analysis and further reporting. The recommendations should

correspond to the points made in the statement of potential about the significance of any aspects (or the whole) of the assemblage.

Depending on the requirements of the project, assessment reports relating to different wood specialisms (see Section 2.6) may also be produced at this stage.

7.1.1 State of preservation

The state of preservation should be assessed primarily with reference to analytical potential to inform recommendations for analysis phase tasks. In most cases, this will entail physical inspection by the wood specialist and reporting using an appropriate recording system (see Section 4.2, and Tables 2 and 3). In addition, assessing wood condition (especially its cellulose content) can assist in assessing the potential for scientific dating.

The secondary purpose of assessment of the state of preservation at the post excavation stage is to inform conservation decisions. For example, determining the cellulose content and identifying the presence of any inorganic salts, are both critical in informing strategies for conservation of material selected for retention.

7.1.2 Scientific dating

Any review of the dating potential of the assemblage needs to take account of samples taken during the fieldwork phase and information about how these samples and any retained wood assemblage relate to structural groups and stratigraphic phases. Other dating evidence (e.g. from ceramic assemblages) should also be considered in the assessment. There may be spot-dating results from initial analyses at evaluation or excavation phases.

Dendrochronology (ring-width and isotope): Usually, the lead wood specialist, in consultation with the project dendrochronologist, will assess the material for its dendrochronological dating potential, using wood type (oak / non-oak), ring count, and presence of sapwood and/or bark edge (English Heritage 2004). Oak is the most commonly used wood type for dendrochronology but where significant amounts of other wood types occur (e.g. conifers, beech, elm, ash) these should also be considered for dendrochronology, particularly bearing in mind the development of oxygen isotope dendrochronology which dates other types of wood (e.g. conifers, beech, elm, ash) with the same precision and increases the likelihood of dating non-oak timber (Loader et al. 2024; Bridge et al. 2019).

Radiocarbon dating: Where limited or no material is suitable for dendrochronological dating or the dendrochronological analysis proved unsuccessful, the use of radiocarbon dating should be considered. Samples from identified species, taken from near the bark edge of immature roundwood are preferred for individual radiocarbon dates. Multiple samples from more mature wood sections where the time interval between samples from single annual rings and the bark edge are known can be used for wiggle-match radiocarbon dating with potentially more precise results. Sampling for wiggle-match radiocarbon dating should be undertaken by a competent dendrochronologist acting on advice from the radiocarbon specialist to

identify the most appropriate number of sub-samples and the location of the sub-samples in the ring series.

It is best to seek advice on sample size directly from the dating laboratory, as sample size will depend on the condition of the wood (and its water content). If the wood is particularly badly preserved there is a potential that it may not contain sufficient cellulose for dating. Weights of 100–150 mg of waterlogged wood can suffice for AMS dating. This means that individual rings, often as a series of consecutive rings, can be sampled and dated.

Information on radiocarbon dating and chronological modelling can be found in Bayliss and Marshall (2022).

7.1.3 Conservation recommendations

The selection of wood for conservation should be discussed and agreed by the wood specialist(s), project manager, local authority archaeologist, conservator and the organisation who will receive the conserved wood. Wood selected for conservation will generally be recommended by the wood specialist within the assessment report. The rationale for selecting wood for conservation and archiving should be guided by the principles and values set out in Section 4.1.

Retention of whole, rather than sampled items for conservation is recommended. Wood selected for conservation should be submitted within 36 months of excavation, with some items (such as delicate wooden artefacts) requiring a fast track submission.

Selection criteria might include:

- the date of the material – very few examples of Palaeolithic, Mesolithic or Neolithic worked wood are encountered and as such, they are likely to be of high significance
- rarity and comparators – is the occurrence of the evidence conveyed by the waterlogged wood rare nationally or are there only a few conserved examples?
- the complexity and character of the woodworking – representative examples of artefacts, jointed material, decorated or deliberately marked material should be considered for conservation.

7.1.4 Timetabling recommendations

Timetabling recommendations for analysis should be made at this point so that the project's management team know what to expect in terms of scheduling specialist work.

7.2 Analysis

Further analysis will have been identified, quantified and costed during post-excavation assessment. Primary tasks include:

- completion of graphical recording
- undertaking further analytical tasks – tree ring studies, dendrochronology, wood identifications

- data analysis
- production of specialist reports

By this point the site's interpretation and phasing should be more refined; this knowledge should be shared with the specialists to help with the interpretation of their results.

The following sections describe waterlogged wood analysis activities that are not described in detail in other guidelines or covered by standard post-excavation practices.

7.2.1 Graphical recording (illustration, photography and 3D modelling)

Only a proportion of the wood assemblage will be selected for graphical recording at the analysis phase because all, or as much as possible, graphical recording should occur during the main recording stage of the project (see Section 5) when the state of preservation is optimal. For items for which this has not been possible, the need for further recording will have been identified in the assessment report. Graphical recording can include drawing, photography and 3D modelling.

The level of drawing detail required will depend on the character of the woodworking present and will be determined during the assessment phase. Technical drawing (edge and face drawing) is appropriate to record the form of converted timbers and the location of joints or pegs. These will record the timber's dimensions, an indication of the direction of the grain, and at least one cross-section. Cross-sections should show the pith, sapwood and ray or ring patterns where visible. Detailed illustration employing lines or shading to convey three-dimensional shape is appropriate to record artefacts, complex joinery or unusual morphology. This should record grain and growth features; areas of bark, sapwood and exposed heartwood; areas of decay, damage (ancient and modern), wear and compression; and the position and character of joints, holes, nails and toolmarks. The scale of the drawing should vary according to the size of the piece, from 1:1 to 1:20.

Scaled photography can complement drawing in the archival record and provide useful images for publication and dissemination. In addition to overall shots, the potential to document use-wear, joints and toolmarks through detailed shots is particularly valuable. Waterlogged wood can be a challenging material to photograph, and therefore this should be undertaken by someone experienced in photography.

Three-dimensional modelling provides an alternative form of recording. Current methods used include laser scanning, RTI (reflectance transformation imaging) and photogrammetric recording, which can record use-wear or toolmarks in fine detail. These different methods have varying benefits and cost / time implications. For more details on the techniques see https://historicengland.org.uk/advice/technical-advice/recording-heritage/.

7.2.2 Woodworking and wooden technology

Woodworking is a reductive technology, with wood removed from the raw material to produce the desired finished object. In the broadest sense, worked wood consists of

finished products (artefacts, structural timbers, stakes) and woodworking waste (woodchips, shavings, off-cuts). Marks left on the surface of the wood are used to determine the tools used, the approaches taken and the technology employed. This often consists of, but is not limited to, recording the primary conversion (whether the item is in the round or its cross section has been reduced or modified); the tools used in conversion (such as wedges for splitting, axes for hewing or saws); working to the ends (tool faceting from axes or flat surfaces from sawing); the cutting of joints; surface modifications or decoration (such as incised marks or paint).

Ship and boat timbers may retain surface treatments such as tars and paints which can be examined analytically. Waterproofing between timbers (caulking / luting) often comprise a matrix (e.g. tar) and component filler (e.g. animal hair, moss, plant remains, textile) which will require an appropriate range of specialist input. Pollen analysis of caulking material can also provide supplementary evidence of plant types used and vegetation source locations.

Analytical techniques specific to waterlogged organic artefacts are described in Historic England (2018).

7.2.3 Wood studies

Microscopic / laboratory-based analysis for wood identification, ring width studies and dendrochronology, should be considered together with the data on the gross morphology of the wood and the presence of natural features recorded during the main recording stage (such as side branches). This can provide valuable insights into the woodland environment, the resources being exploited or managed, and the wood selection strategies employed.

Although ideally every piece of worked wood should undergo a wood identification, for particularly large assemblages this might not be necessary or practicable; discussions should be held with the wood specialist(s) taking into consideration the level of contextual information available about the material and the potential of the remains to provide information about specific use / selection / woodland practices. For grouped deposits of woodworking waste or small roundwood, a more selective sample can be taken, sampled on a random basis to avoid over representation of the larger or better-preserved pieces.

7.2.4 Timetabling of analysis work

It is important to consider that for some types of analyses there are clear sequences and orders of work that will need to be respected. Any such lead times will therefore need to be factored into the project's programming in discussion with the specialists and their availability (Figure 1. Workflow chart).

7.2.5 Final reporting and publication

The final project report, also known as the archive report, should include:

- a quantification of the wood assemblage (as set out in the post-excavation assessment report),
- the methodologies undertaken throughout the work (recording, assessment and analysis),
- the results of analysis tasks,
- a discussion section integrating results of analysis tasks with phasing and site interpretation, and
- a selection and retention strategy and record of decisions taken for the archaeological archive.

Guidelines on producing specialist reports are available; from general guidance (see CIfA (2014b) and the CIfA *Toolkit for Specialist Reporting* (https://www.archaeologists.net/reporting-toolkit)), to the subject specific – for example see English Heritage (2004) for guidance on producing a dendrochronology report.

It is likely that other publications (e.g. monographs, journal articles) will also be produced as part of the project. These should include details of the excavation, the wood sampling strategy, investigative / analytical / conservation methods, and the specialist results. These should be pitched appropriately based on the anticipated audience.

7.3 Options for dispersal

Depending on the size and importance of the site and its assemblage, not all the materials that formed part of the Working Project Archive will (or should) be selected for deposition with the receiving repository as part of the project's final Project Archive. Throughout the project, the on-going Selection Strategy process will have considered, decided on, and documented what is to be kept and what is to be de-selected, all based on discussions with the project stakeholders, particularly the specialists.

There are several options for the dispersal of the de-selected material that is not to be kept as part of the project archive. In the case of [un-conserved] archaeological waterlogged wood these will most likely be:

- donation, where it can be used by research or training / teaching establishments as experimental / practise material
- discard, where the material is suitably disposed of, usually as part of routine waste collection procedures.

For de-selected wood that has been recorded using Pathway 1 (recorded *in situ*), the reburial and maintenance of that material in its initial location is, by default, a form of dispersal, unless specific mechanisms for management and monitoring are put in place to ensure the long-term preservation (as set out in Historic England 2016).

8 Conservation

The aim of any conservation treatment is to convert waterlogged wood into a stable condition that allows it to be curated, studied or displayed. This involves the replacement of water with a chemical followed by drying in a controlled manner, so that the overall shape and dimensions are retained. The exact treatment will influence the appearance of the wood after treatment.

The selection and implementation of wood conservation treatments should only be undertaken by a suitably experienced conservator. The choice of conservation treatment will be determined by the size of the timbers, availability of equipment, budget, and timescales. The immediate future use (storage or display) may also influence the conservation treatment.

Before conservation is initiated, all recording, sampling (e.g. for wood taxonomic identification), and analysis should have been completed. Any wood selected for conservation should be submitted within 36 months of excavation with items of high significance (such as artefacts) considered for fast-track submission.

8.1 Conservation techniques

8.1.1 Cleaning and Pre-treatment

Further surface cleaning may be necessary before any conservation treatment can be implemented. Just like on site, care must be taken not to damage the soft wood surface. Any new observations on tool marks, decoration or construction need to be shared with the relevant specialist. Timbers from the marine environment should go through desalination by regular water changes. Removing soluble salts will reduce the potential for salt efflorescence damage post-drying, such as surface spalling, and allow for improved impregnation.

Some timbers, especially those from marine environments, may be contaminated with iron salts from iron fittings or nearby artefacts and ship structures, which accelerate decay rates. Anaerobic bacteria also contribute to the presence of iron sulphides within the wood structure by breaking down abundant iron minerals in the soil and utilising sulphur from decaying vegetation. The resultant compounds in archaeological wood are unstable in the presence of oxygen and release sulphuric acid, which breaks down wood.

Removing or neutralising these compounds involves various chemical treatments which are important to limit post-conservation degradation.

8.1.2 Impregnation

Impregnation is currently the favoured method of conservation, where water within the weakened wood cells is replaced with a chemical to provide structural support on drying. Polyethylene glycol (PEG), a bulking agent, is the most commonly used material that can either be applied through immersion in tanks or by spraying. Depending on the application method, treatment times of months (immersion) to years (spraying) can be expected.

Lately, the increased costs and poor availability of PEG has not only increased overall conservation costs and prolonged treatment schedules, but also raised the need for the development of alternative methods.

8.1.3 Vacuum freeze-drying

Vacuum freeze-drying is the preferred method of drying waterlogged wood treated by impregnation. It is a controlled process which works by the sublimation of water avoiding drying by evaporation and the surface tension issues caused by this method. Wood that has been dried by vacuum freeze-drying will usually retain a natural colour and surface details with reduced shrinkage and surface cracking.

The main limitations of vacuum freeze-drying relate to the size of wood that can fit within the chamber. Larger structures may need to be dismantled or cut into sections to be able to dry using this method. There are few conservation facilities across the UK with freeze-dryers capable of drying large timbers. Freeze-drying equipment has a high energy use and costs for long drying processes may rise with increasing energy prices.

8.1.4 Controlled air-drying

This method should only be considered when timbers or structures are too large for drying in vacuum freeze-dryers and dismantling is not a viable option. Controlled air-drying is a high-risk approach and can result in significant warping, shrinkage and cracking of timbers.

Various methods of controlled air-drying have been implemented which generally use dehumidifiers to control the drying rate of timbers. Treatment tents for the specific size of the wooden structure can be created to fully control the drying environment e.g. *Mary Rose*.

Drying by this method can take several years and requires careful monitoring throughout. Tell-tales and total stations can be used for tracking structure movement and crack development.

9 Archiving and curation

Given the pressures on archaeological archives, it is essential that the conservator and archive repository are involved at the earliest opportunity in projects that may generate collections of archaeological wood that merit conservation, display or archiving. This ensures that costs and time can be identified and made available for conservation, display or storage. Early conversations and planning will assist reducing time in temporary storage.

The conservator will be able to advise on conservation options and storage and display requirements depending on the size and condition of the assemblage.

Whilst the wood itself forms an obvious part of the project archive, it is important to remember that it also includes all drawings/illustrations, original recording sheets, photographs, and data (e.g. specialist data in spreadsheets and associated metadata). These products should be quantified in the final project report, to be able to realistically cost for their archive deposition. Digital elements should be identified and listed in the project's DMP.

Multiple reports may be produced over the lifespan of a project, which will need to be considered as part of the Selection Strategy, with a view to being deposited as part of the project archive. These might include the post-excavation assessment report, the wood specialist reports, the conservation report, and the final project report.

As part of the online process registering and recording the excavation through OASISV (https://oasis.ac.uk/), the location of where the physical archive is deposited, is stated. On creation of the excavation entry, the local HER will automatically be notified. The project reports should be deposited with a recognised digital repository; in England this is usually with the Archaeology Data Service (ADS) which has Core Trust Seal status, https://archaeologydataservice.ac.uk/deposit-data/.

9.1 Storage and display

Continued care needs to be taken when handling and moving conserved archaeological wood, as some timbers remain fragile yet heavy.

Once conserved, archaeological wood needs to be kept in stable conditions (for example as set out in BS EN 16893:2018) so that it is not exposed to extremes or fluctuations of temperature and humidity.

In general, large environmental fluctuations over a short period (day–night cycles) should be avoided and a consistent environment aimed for. Stable values in the range of 40–65% relative humidity (RH) and 16–25°C, with fluctuations of no more than ±10% RH per 24 hours within this range, are recommended for display and storage (Bizot Group 2023). RH greater than 65% should be avoided as this will encourage the development of mould and efflorescence of soluble salts.

Wood is classed as a 'moderately sensitive' material to light, and 200 lux values are recommended (with an annual light exposure maximum of 450,000 lux hours).

For long-term storage, depending on the size of the timber, the wood can either be packaged using materials which allow for air exchange or be covered over in open storage. In either instance, the use of functional textiles (such as spunbonded high-density polyethylene (HDPE) a polyester-polyether membrane) should be used as these protect against water ingresses whilst allowing timber to breath. Cotton or linen fabric covers should be avoided as these materials are hygroscopic and can hold moisture on or next to the object and they are susceptible to mould and pests.

The use of cushioning materials is recommended as it will protect the vulnerable wood surface, support fragile pieces and minimise effects of a fluctuating environment. A framework can be built around the timber over which the covering material is hung.

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