

Centre for Archaeology Report 27/2002

**The Tree-Ring Dating at Abbey House, Buildwas Abbey,
Shropshire**

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ISSN 1473-9224

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Summary

The ruins of Buildwas Abbey sit on the banks of the river Severn in Shropshire (SJ 642044). The abbey church and remains of the claustral buildings were placed in the care of the State in 1925. To the north-east of the guardianship area lies 'Abbey House', occupied since the suppression of the monastery, and currently used as a social club for employees of Ironbridge Power Station, owned by TXU Europe Power. A grade I listed building, Abbey House may well incorporate a thirteenth-century, and later, abbot's residence.

The ground plan of Abbey House can be thought of in terms of four main units. The two primary elements form an L-shaped, two-storey integrated residence. Within this, running north to south, and covered with a four-bay roof, is a broad rectangular range here described as the West Block. At its south-east corner, a narrower rectangular range with a six-bay roof runs eastwards. This is currently designated the East Block. The third element in the plan is made up of a group of subsidiary structures springing from the south-west corner. Finally, there is a series of post-suppression additions in the north-east angle between the West and East Blocks.

Nineteen timbers were sampled from three areas in Abbey House. The roof over the East Block produced two precise felling dates of spring AD 1377 and the chronology **BUILDWS1** spanning the years AD 1311-76. The roof over the West Block produced two precise felling dates of winter AD 1547/48 and six others with incomplete sapwood have felling date ranges consistent with this date, all combining to form the chronology **BUILDWS2** spanning the years AD 1374 to 1547. Finally, two samples from a splat-baluster staircase within the West Block produced an averaged felling date range of AD 1688-1717 and the chronology **BUILDWS3** spanning the years AD 1563 to 1687. A number of reused moulded timbers were also assessed for dendrochronology, but problems of access and poor ring counts prevented their successful sampling.

Keywords

Dendrochronology
Standing Building

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THE TREE-RING DATING AT ABBEY HOUSE, BUILDWAS ABBEY, SHROPSHIRE (SJ 642 044)

Grid reference: SJ 642 044 (Fig 1)

Owner: TXU Europe Power

Date sampled: 22 November 2001

Buildwas Abbey

Buildwas Abbey was founded for a community of Savigniac monks by Roger de Clinton, bishop of Coventry (d. 1148), in 1135 (Thompson 1937). Twelve years later, along with all other houses of the Savigniac congregation, Buildwas was absorbed into the Cistercian order. The transformation of the site was achieved under Abbot Ranulf (1155–87), with the abbey church and main claustral buildings raised during this period. In common with Cistercian houses across England, the early Buildwas economy was based on agricultural estates, worked by lay brothers based at grange centres. Although the revenues were never very large, the economy was generally sound. In the later Middle Ages these estates tended to be leased out as the abbey moved towards a *rentier* economy. Buildwas was suppressed in 1536, and three years later the site and most of the abbey property were granted to Edward, Lord Grey of Powis.

The church, which is very well preserved, was of the characteristic twelfth-century Cistercian form, raised on the so-called ‘Bernardine’ plan. It comprised a short, square-ended presbytery covered with a two-bay rib vault, transepts with two diminutive eastern chapels to each, a crossing with a low tower (almost certainly an addition to the original plan), and a nave of seven bays. Around 1200, the presbytery was remodeled, and in the fourteenth-century a large chapel was added to the south side of the nave.

The main cloister buildings were situated on the lower ground to the north of the church. In the east range, where much of the ground floor survives, there was a book room and sacristy adjacent to the church. North of this is the nine-bay rib-vaulted chapter house, and beyond an inner parlour followed by the monks’ day room. The upper floor of this range housed the monks’ dormitory. The north range of the cloister was occupied by the monks’ refectory, orientated east to west. Finally, the west range was separated from the cloister by an enclosed lane. Occupied by the lay brothers, the range itself seems to have been of three storeys, though all but the basement level has been lost.

North and east of these main guardianship remains, there are substantial traces of other monastic buildings in the grounds of Abbey House (Fig 2). There are, for example, further elements of the east range, running out as foundations in the turf towards the river Severn. In particular, however, there is a group of very important buildings around what appears to have been a small, open cloister court. On the north of this court, partly obscured by post-monastic structures, is a five bay thirteenth-century pointed arcade resting on drum piers. This almost certainly formed part of the abbey’s infirmary complex. On the east side of the court lies Abbey House, in a position which suggests it served as the abbot’s residence.

The combined siting of infirmary and abbot’s residence outside the east claustral range is a pattern which can be paralleled at numerous Cistercian houses both in Britain (Robinson 1998), and across Europe. Yet in Britain there are few examples where the abbot’s residence survives other than in ruin. There is, therefore, considerable potential for fuller understanding through a programme of investigation at Buildwas.

Description of Abbey House

Hitherto, there has been nothing by way of a comprehensive analysis of the structure of Abbey House. Consequently, all reference to chronological sequences must be regarded as tentative at this stage.

Early and later-Victorian plans of Abbey House, notably those by Potter (1847), Hills (1862) and Paul (1900) indicate that the medieval building comprised two ranges, set out at right angles. A number of clues suggest these ranges were contemporary. Notably one might cite the row of at least five thirteenth-century trefoil-headed lights, with roll-moulded outer jambs, and a continuous head mould, which runs along the south face of the building and links the two blocks. And, as confirmation that these were not introduced as a confection during the Victorian period, one might note an early nineteenth-century drawing by John Buckler (d. 1851) in which the windows were of just their current form (BL Additional, 27,765, f. 120).

The stonework in south face of the East Block seems to retain evidence of five mini-gables, with alternating trefoil and quatrefoil openings, in a dormer arrangement not wholly dissimilar to the thirteenth-century hall at Stokesay Castle (Fig 3). Again, the openings, and an indication of the gables, were given by Buckler. The original roof over such an arrangement is likely to have been of five bays, though this was replaced by the present six-bay roof. At the time of the replacement, the dormers were removed, but the upper windows were incorporated in the new construction by means of raising the walls heads just under 1m. The present roof in the East Block is an excellent example of arch-braced construction, with a single clasped purlin, diminished principals, and cusped windbraces (Figs 4 and 5). The east end truss is encased within the masonry gable end wall, but is accounted for in the truss numbering. This numbering does not run sequentially, but instead runs from west to east with I, II, III, III, VII, V, and the east end obscured (VI). Interestingly, the windbraces are also numbered, I–XII, from west to east on the north side, and returning clockwise on the south side, tagged I–XII, from east to west. Within this report the trusses are numbered 1–7 from west to east (Fig 6). An interesting anomaly is that the sides of arch-braces are all chamfered, except for those in truss 2, which is plain. The purlin on the north side extends by about 0.3m beyond truss 1, where it extended with a similar bridled scarf joint to another section which is picked up at its western extremity by the present roof over the West Block. Although the last section of purlin is of like dimensions to the others, it is not chamfered, whereas the short projecting end to which it is jointed is, which must leave its phasing open to question.

Objectives of dating

Abbey House is an important grade I building, adjacent to a guardianship monument, and clearly part of the overall medieval monastic complex. Fuller understanding of this building is an essential prerequisite to site management and the preparation of a full conservation plan. The house is owned by TXU Europe Power, who employ an Environmental Advisor, responsible for an educational 'nature trail' based around the abbey site. In addition, English Heritage is currently preparing a new guidebook to Buildwas Abbey, as well as carrying out a broader survey of the abbey buildings and surrounding landscape. All of these have important educational and outreach objectives.

Four specific and primary objectives have been identified for the Abbey House dendrochronology survey. The first of these is to determine the date of construction of the roof over the East Block, variously cited as between the fourteenth and fifteenth centuries in the current literature. Secondly, it should determine the date of construction of the roof over the West Block, and confirm whether the short length of purlin between the two roofs was coeval with the earlier East Block roof, or if it belongs to the replacement period. Thirdly, it is considered important to determine whether a splat-baluster staircase, positioned within the West Block, is contemporary with the roof above, or if it is a later insertion (Fig 7). Finally, it is hoped the moulded ceiling beams reused in the first-floor ceiling

of the West Block might be dated, in order to determine if they may have originated from an earlier roof over this area.

The dendrochronological survey was commissioned by the Centre for Archaeology Scientific Dating Service of English Heritage following a request from Richard Bond and David Robinson, Historical Analysis Research Team, English Heritage, who are engaged in a reappraisal of the Abbey complex.

Assessment

The East Block roof was initially assessed for dendrochronological potential, prior to sampling. Although the roof is virtually complete and easily accessible, almost all of the principal timbers including all principal rafters, purlins, collars, and common rafters were found to be constructed from fast-grown boxed-heart trees between 15 and 40 years old. The windbraces and some arch-braces were found to be constructed from somewhat slower-grown trees, some in excess of 100 years old. Very little sapwood remained, indeed the only timbers which had not been thoroughly defrased during earlier repair works were two arch-braces.

The roof over the West Block was found to have been constructed of timber much better suited for dendrochronology with timbers having been converted from larger trees with between 100 and 200 growth rings. However, little sapwood remained, the most noticeable exception being one of the principal rafters to truss 2. Some of the roof however was constructed of re-used timbers, such as the tiebeams, and much of the structure was concealed behind later plaster finishes.

The staircase between the two ranges was constructed of suitably slow-grown timber, but very little was accessible for sampling without unduly disfiguring the finely-polished woodwork. However, the lower part of the staircase was accessible from below and one of the strings exhibited a heartwood/sapwood boundary and in excess of 100 growth rings.

The reused timbers forming the ceiling of the West Block were also assessed, but those accessible were not considered suitable for successful dendrochronological analysis, primarily due to the fact that the timber was not exceptionally slow-grown, did not exhibit any sapwood, and was not oriented to allow for satisfactory sampling. However, it was noted that the majority of the reused timbers related to a moulded ceiling which had been turned upside-down, perhaps reflecting a later desire to have a flat plaster ceiling. A number of carved timbers, probably relating to an early cornice, were noted in the beer cellar under the staircase (Fig 8), but were inaccessible for sampling due to shelving and beer barrels.

Methodology

Sampling of selected primary-phase timbers was carried out with a 16mm hollow coring bit. The dry samples were sanded on a linisher using 60 to 1200 grit abrasive paper, and were cleaned with compressed air, to allow the ring boundaries to be clearly distinguished. They were then measured under a x10/x30 microscope using a travelling stage electronically displaying displacement to a precision of 0.001mm, rounded to the nearest 0.01mm.

After measurement, the ring-width series for each sample was plotted as a graph of width against year on log-linear graphs. The graphs of each of the samples in the phase under study are then compared visually at the positions indicated by the computer matching and, if found satisfactory and consistent, are averaged to form a mean curve for the site or phase. This mean curve and any unmatched individual sequences are compared against dated reference chronologies to obtain an absolute calendar date for each sequence. The ring-width series were compared on an IBM compatible computer for statistical

cross-matching using a variant of the Belfast CROS program (Baillie and Pilcher 1973). A version of this and other programmes were written in BASIC by D Haddon-Reece, and latterly re-written in Microsoft Visual Basic by M R Allwright and P A Parker.

In comparing one sample or site master against other samples or chronologies, t-values over 3.5 are considered significant, although in reality it is common to find demonstrably spurious t-values of 4 and 5 because more than one matching position is indicated. For this reason, dendrochronologists prefer to see some t-value ranges of 5, 6, and higher, and for these to be well replicated from different, independent chronologies with local and regional chronologies well represented. Where two individual samples match together with a t-value of 10 or above, this may suggest they originated from the same tree.

Once a tree-ring sequence has been firmly dated in time, a felling date, or date range, is ascribed where possible. With samples which have sapwood complete to the underside of, or including bark, this process is relatively straight forward. Depending on the completeness of the final ring, ie if it has only the spring vessels or early wood formed, or the latewood or summer growth, a *precise felling date and season* can be given. If the sapwood is partially missing, or if only a heartwood/sapwood transition boundary survives, then an *estimated felling date range* can be given for each sample. The number of sapwood rings can be estimated by using an empirically derived sapwood estimate with a given confidence limit. A recent review of the geographical distribution of dated sapwood data from historic building timbers has shown that a 95% confidence range of 11-41 rings is more appropriate for Shropshire (Miles 1997a).

It should be remembered that dendrochronology can only date when the tree died, not the date of construction for a building or artefact. The interpretation of a felling date relies on having a good number of precise felling dates rather than just one or two. Nevertheless, it was common practice to build timber-framed structures with green or unseasoned timber and construction usually took place within twelve months of felling (Miles 1997a).

Sampling strategy

Following the preliminary assessment, the building was sampled on 22 November 2001. Whilst most of the timbers to the East Block roof had insufficient growth rings for successful cross-matching, a few arch-braces and a number of windbraces did have the minimum number of growth rings and were therefore targeted. In particular, two of the arch-braces from truss 2 retained complete sapwood, as did the western extension of the purlin on the north side adjacent to truss 1. Therefore, 10 samples were taken from this range, although a number of these were noted to have areas of distortion which might make cross-matching difficult.

The West Block roof looked more promising, with the majority of the principal timbers having adequate ring counts but only one retained complete sapwood. In addition to sampling principal rafters and purlins, a section of wall plate and a strut as well as a re-set stud were sampled.

The reused elements were inspected, but apart from a trial core or two, were not sampled due to problems of access. However, should the building ever be opened up further, then the opportunity should be taken to sample these elements.

Details of all timbers sampled are presented in Table 1, and locations are shown in Figures 6 and 7.

Cross-matching and site chronologies

Of the ten samples taken from the East Block, four groups of timbers were found to match together. The two arch-braces from truss 2 were noted to have originated from the same tree on the basis of similar grain patterns. The south arch-brace was sampled thrice to obtain the maximum number of rings through to complete sapwood, two of the radii, *bld5b* and *bld5c*, being matched together as shown in Table 2 with the north arch-brace *bld4* to form the 66-year site chronology **BUILDWS1**.

Three windbraces (*bld3*, *bld8*, and *bld9*) matched together as shown in Table 3 to form the 118-year mean *bld389*. Two other arch-braces, both from truss 3, were noted to have originated from the same tree on the basis of similar grain pattern. Two samples (*bld6a* and *bld6b*) were taken from the south arch-brace and two from the north, *bld7a*, one being in two segments (*bld7b1* and *bld7b2*). Of these, samples *bld6a*, *bld7a*, and *bld7b1* were matched together as shown in Table 4 and combined to form the 103-year mean *bld67*. Finally, two other windbraces, *bld2* and *bld10*, matched together as shown in Table 5 to form the 86-year mean *bld210*.

None of these four means matched with each other, nor did they match with any of the remaining individual samples, although sample *bld1* from the north-western purlin did match with the hall roof samples (see below). The poor intra-site cross-matching where the only matches were probably single-tree matches only suggest that the timbers originated from diverse managed woodland or hedgerow sources.

Conversely, all seven timbers sampled from the roof of the West Block (*bld11* - *bld15*, *bld18*, and *bld19*) matched together satisfactorily as shown in Table 6 together with the extended north-western purlin from the adjoining East Block (*bld1*). These were combined to form the 174-year site master **BUILDWS2**. Here the timbers appear to have originated from two different woodland sources, with samples *bld1*, *bld11*, and *bld18* being from a different source to the remainder. This is shown by the poor matching between the two groups of samples as illustrated in Table 6.

Finally two samples taken from the staircase within the West Block matched together as shown in Table 7 and were combined to form the 125-year site master **BUILDWS3**.

Absolute dating

The site masters were then compared with over 1000 dated reference chronologies from the British Isles. The site master from the East Block roof, **BUILDWS1**, was found to match well, spanning the years AD 1311-76 (Table 8). The site master from the West Block roof, **BUILDWS2**, dated particularly well with local chronologies to span the years AD 1374-1547 (Table 9). Finally the site master from the staircase, **BUILDWS3**, dated to span the years AD 1563-1687 (Table 10). The dates spanned by the dated samples are shown in Figure 9. The predominance of local chronologies and the Shropshire regional master chronology suggests a local origin for the majority of the samples, particularly in the fourteenth- and sixteenth-century phases. The three site masters thus dated are given in Tables 11, 12, and 13.

Undated samples

The three other site means from the East Block roof, despite having between 86 to 118 rings, failed to match conclusively with any of the master chronologies. This is primarily due to the samples having areas of distress unique to individual trees. Such difficulties in dating material from the fourteenth century in Shropshire are not unusual given the dearth of dated chronologies from this period. Similar

difficulties have been experienced in dating fourteenth-century samples from the gatehouse at nearby Aston Eyre, where only 6 out of 14 samples dated (Miles and Worthington 1998).

Interpretation and discussion

Only two timbers sampled from the East Block roof dated, and although they both retained complete sapwood, they had in fact originated from the same tree. Some consideration must be given to the fact that these two dated arch-braces were square-sectioned, whereas all others in the roof had been carefully decorated with a heavy chamfer. Ideally it would have been desirable to have had some other chamfered arch-braces date, as well as some other structural members, just to confirm that the two dated arch-braces were not either re-used earlier timbers or later replacements. However, given that both of the principal rafters within truss 2 had consistent assembly marks together with the lack of any earlier carpenter's marks, and that the joints of the dated arch-braces were tight and properly formed with the collar and principals, the chance of them being replacements is highly unlikely. Similarly, the evidence of subsequent distortion on all surfaces of the arch-braces in question show conclusively that they had been fashioned whilst still green (Fig 10), and the profile of the arch matches exactly all of the other arch-braces in the roof. Therefore, the date of spring AD 1377 is likely to be representative of the roof as a whole, although the construction date could well be several years afterwards since only a single tree has dated which may have been stockpiled (Miles 1997a). Nevertheless, this date is at the earliest end of a century-wide date range postulated for this roof on typological evidence.

All timbers from the West Block roof dated, two of these retaining complete sapwood. Both of these produced the same felling date of winter AD 1547/8. A range of timbers were sampled from this roof, including principal rafters, lower purlins, struts, and a wall plate. All of those without complete sapwood nevertheless produced felling date ranges consistent with the AD 1547/8 felling date. One of samples to produce this precise date was from the section of infill purlin on the north side of the East Block roof beyond the west end truss. This timber was initially thought to have been coeval with the *c* AD 1377 East Block roof, given that it was of the same section and colour as the main run of purlins to which it had been jointed, and that it had been jointed with a similar bridled scarf joint. That the dendrochronological analysis has here shown that it actually dates to the *c* AD 1547/8 rebuilding of the West Block roof is not entirely unsurprising, in that the purlin extension is not chamfered, whereas the East Block roof to which it is jointed is carefully chamfered. Therefore, the obvious interpretation is that when the West Block roof was reconstructed in *c* AD 1547/8, a new linking purlin was cut to the same section as the East Block roof, and possibly fitted into an existing bridled scarf joint. Again, given that only two timbers have produced precise felling dates, some caution must be exercised in interpreting the date of construction too closely. Nevertheless, the fact that two different structural members have produced the same precise date suggests that the date of construction might be during AD 1548 or within a year or two later. This date again is almost a century earlier than the seventeenth-century date previously ascribed to this structure.

Both of the samples from the staircase dated, and whilst neither retained complete sapwood, they both produced consistent felling date ranges. The bottom string produced a felling date range of AD 1691-1721, derived from a heartwood/sapwood boundary date of AD 1680. A newel post had a heartwood/sapwood boundary date of AD 1672, but given that 15 rings of sapwood survived, a reduced felling date range of AD 1688-1713 could be given. By taking the average of the two heartwood/sapwood boundary dates, an averaged felling date range of AD 1688-1717 can be given for this phase. This has confirmed the postulated late seventeenth-century or early eighteenth-century date for this staircase, and has confirmed that it is not of the same phase of construction as the replacement roof above.

Summary conclusions and recommendations

It appears that Abbey House was initially constructed in the mid-to late thirteenth century, when English Cistercian abbots in general were beginning to move away from the main claustral complex, taking up residence in self-contained apartments to the east of the church and cloister (Robinson 1998, *passim*). At Buildwas, the abbot raised a well-appointed L-shaped building, to one side of a developing infirmary cloister. The southern façade retains elements of the primary arrangement, where a series of trefoil-headed windows gave light to ground floor chambers. The principal accommodation was presumably on the first floor, and might best be thought of as a hall and private chamber or chambers. It would be difficult to be certain which block or range was used for which particular function, though the southern windows with their initial gabled heads suggests the principal room here may have been the hall.

In the late fourteenth-century, the East Block was modified, with the southern gables removed and a new roof, very much designed to be seen, erected. Of the arrangements over the West Block at this time we can say very little. Following the suppression of the abbey, the site and much of the monastic lands were granted in 1539 to Edward, Lord Grey of Powis. Soon afterwards, a fine plaster ceiling was inserted over the ground floor in the East Block, and it may have been at this time, or thereabouts, that a new roof was raised over the West Block.

Full analysis of these phases, and of all subsequent alterations has yet to be carried out. However, should the opportunity arise during any future repair works, additional timbers should be assessed for dendrochronology. This would be particularly useful in relation to the lower floors in the East Block, and any roof timbers in the West Block currently obscured by plaster finishes. Further samples from both areas might help to provide further replication and/or felling dates, which in turn could help refine the interpretation of phasing offered here. In addition to these, better access to the reused timbers incorporated in the first-floor ceiling of the West Block may well further elucidate the full structural development of the house.

Acknowledgements

Acknowledgements are given to Mr Tom Pickering (Buildwas Environment Trail) Ironbridge Power Station for allowing access to the building for sampling. Michael Worthington assisted both on site as well as in the laboratory. David Robinson provided much of the background text, and Richard Bond, Cathy Groves, and Alex Bayliss provided useful comments on early drafts of this report. Acknowledgements are given to English Heritage Centre for Archaeology, Sheffield dendrochronology Laboratory, and Dr Martin Bridge for both published and unpublished data.

References

- Baillie, M G L, and Pilcher, J R, 1973 A simple cross-dating program for tree-ring research, *Tree-Ring Bulletin*, 33, 7-14
- Bridge, M C, 1988 The dendrochronological dating of buildings in southern England, *Medieval Archaeol*, 32, 166-74
- Bridge, M C, 1996 List 69 - Tree-ring dates, *Vernacular Architect*, 27, 91-2
- Bridge, M C, 1998 *Compilation of master chronologies from the South*, unpubl computer file *SENG98*, University of London Dendrochronology Laboratory
- Bridge, M C, 1999 *Tree ring analysis of timbers from Hill Hall Theydon Mount Essex*, Anc Mon Lab Rep, 55/1999
- British Library, Additional Ms. 27,765 (J. C. Buckler, 'Cistercian Architecture')

- Fletcher, J M, 1978 Oak Chronologies for Eastern and Southern England: Principles for their Construction and Application: Their Comparison with Others in North-West Europe, in *Dendrochronology in Europe* (ed J M Fletcher), BAR, 51, 139-56
- Groves, C, and Hillam, J, 1997 Tree-ring analysis and dating of timbers, in *Multiperiod Saltmaking at Droitwich, Hereford & Worcester - excavations at Upwich, 1983-4* (ed J D Hurst), CBA Res Rep, 107, 74-88
- Haddon-Reece, D, and Miles, D H, 1993 *Working compilation of 190 British reference chronologies supplied by various researchers*, unpubl computer file MASTERAL, Oxford Dendrochronology Laboratory
- Haddon-Reece, D, Miles, D H, Munby, J T, and the late Fletcher, J M, 1993 *Oxfordshire Mean Curve - a compilation of master chronologies from Oxfordshire*, unpubl computer file OXON93, Oxford Dendrochronology Laboratory
- Hills, G M, 1862 Buildwas Abbey, *Collectanea Archaeologica*, 1, 99-112
- Hillam, J, and Groves, C, 1994 *Compilation of master chronologies from the North*, unpubl computer file NORTH, Sheffield Dendrochronology Laboratory
- Laxton, R R, and Litton, C D, 1988 *An East Midlands Master Tree-Ring Chronology and its use for dating Vernacular Buildings*, Univ Nottingham, Dept of Classical and Archaeol Studies, Monograph Ser, 3
- Miles, D H, 1995 *Working compilation of 71 reference chronologies centred around Shropshire by various researchers*, unpubl computer file SALOP95, Oxford Dendrochronology Laboratory
- Miles, D H, 1997a The interpretation, presentation, and use of tree-ring dates, *Vernacular Architect*, 28, 40-56
- Miles, D H, 1997b *Working compilation of 58 reference chronologies centred around Wales by various researchers*, unpubl computer file WALES97, Oxford Dendrochronology Laboratory
- Miles, D H, and Haddon-Reece, D, 1993 List 54 - Tree-ring dates, *Vernacular Architect*, 24, 54-60
- Miles, D H, and Haddon-Reece, D, 1994 List 56 - Tree-ring dates, *Vernacular Architect*, 25, 28-36
- Miles, D H, and Worthington, M J, 1997 Tree-ring dates, *Vernacular Architect*, 28, 159-81
- Miles, D H, and Worthington, M J, 1998 Tree-ring dates, *Vernacular Architect*, 29, 111-29
- Paul, R W, 1900 Buildwas Abbey, *The Builder*, 79, 292-94
- Potter, J, 1847 *Remains of Ancient Monastic Architecture in England*, London
- Robinson, D M (editor), 1998 *The Cistercian Abbeys of Britain: Far from the Concourse of Men*, London
- Siebenlist-Kerner, V, 1978 The Chronology, 1341-1636, for certain hillside oaks from Western England and Wales, in *Dendrochronology in Europe* (ed J M Fletcher), BAR, 51, 157-61
- Thompson, A H, 1937 *Buildwas Abbey, Shropshire*, London, HMSO
- Tyers, I, 1998 *Tree-ring analysis of oak timbers from the "Brewhouse" and "Refectory" at Nostell Priory, Near Wakefield, West Yorkshire*, Anc Mon Lab Rep, 20/98
- Worthington, M J, and Miles, D W H, 2001a *The Tree-Ring Dating of the Timber Croft, Pentre Hodre, Clun, Shropshire*, Centre for Archaeol Rep, 58/2001
- Worthington, M J, and Miles, D W H, 2001b *The Tree-Ring Dating of Upper Lake, Westbury, Shropshire*, Centre for Archaeol Rep, 42/2001

Table 1: Summary of tree-ring dating of Abbey House, Buildwas Abbey, Shropshire

Sample number & type	Timber and position	Dates spanning	H/S bdry	Sapwood complement	No of rings	Mean width mm	Std devn mm	Mean sens mm	Felling seasons and dates/date ranges (AD)
<i>East Block Roof</i>									
<i>bld2</i>	c N E wind brace T1	1-74			74	1.84	0.92	0.235	
<i>bld3</i>	c N W wind brace T2	2-105		H/S	104	1.72	1.07	0.254	
* <i>bld4</i>	c N arch-brace T2	1311-1376	1354	22¼C	66	2.28	1.10	0.198	Spring 1377
<i>bld5a</i>	c S arch-brace T2	-			32	2.18	0.92	0.216	
* <i>bld5b</i>	c ditto	1312-1374	1358	16	63	2.48	1.16	0.218	
* <i>bld5c</i>	c ditto	1363-1376		+14¼C	14	2.04	0.80	0.273	Spring 1377
<i>bld6a</i>	c S arch-brace T3	1-87			87	1.43	1.22	0.232	
<i>bld6b</i>	c ditto	-			63	2.80	2.00	0.287	
<i>bld7a</i>	c N arch-brace T3	35-103		+6 NM to H/S	69	1.17	0.52	0.198	
<i>bld7b1</i>	c ditto	25-80		+6 NM to H/S	56	1.12	0.49	0.219	
<i>bld7b2</i>	c ditto	-			23	1.37	0.45	0.211	
<i>bld67</i>	mean of <i>bld6a</i> + <i>bld7a</i> + <i>bld7b1</i>	1-103			103	1.53	1.08	0.193	
<i>bld8</i>	c S E wind brace T3	22-118		H/S	97	2.00	1.15	0.262	
<i>bld9</i>	c N E wind brace T4	1-102		H/S	102	1.96	1.03	0.232	
<i>bld10</i>	c S W wind brace T7	10-86		H/S	77	1.50	1.03	0.221	
<i>bld210</i>	mean of <i>bld2</i> + <i>bld10</i>	1-86			86	1.61	0.83	0.210	
<i>bld389</i>	mean of <i>bld3</i> + <i>bld8</i> + <i>bld9</i>	1-118			118	2.02	1.03	0.232	
* = BUILDWS1 Site Master		1311-1376			66	2.40	1.03	0.204	Spring 1377
<i>West Block Roof</i>									
† <i>bld1</i>	c Extension of N purlin bay 0	1460-1547	1527	20C	88	1.91	0.86	0.237	Winter 1547/8
<i>bld11a</i>	c E principal rafter T2	1456-1546	1522	24	91	2.30	0.53	0.168	
<i>bld11b</i>	s ditto	1537-1547		+11C	11	1.86	0.42	0.166	Winter 1547/8
† <i>bld11</i>	mean of <i>bld11a</i> + <i>bld11b</i>	1456-1547	1522	25C	92	2.28	0.54	0.166	Winter 1547/8
† <i>bld12</i>	c E lower purlin bay 1	1383-1526	1526	H/S	144	1.14	0.47	0.214	1537-67
† <i>bld13</i>	c E lower purlin bay 3	1425-1529	1529	H/S	105	1.71	0.92	0.203	1540-70
† <i>bld14</i>	c E principal rafter T4	1422-1517	1517	H/S	96	1.95	0.68	0.197	1528-58
† <i>bld15</i>	c E strut T3	1422-1523	1523	H/S	102	1.33	0.49	0.198	1534-64
† <i>bld18</i>	c E re-used post T3	1450-1518	1518	H/S	69	1.89	0.92	0.222	1529-59
† <i>bld19</i>	c E outer wall plate bay 3	1374-1515	1515	H/S	142	1.25	0.82	0.255	1526-56
† = BUILDWS2 Site Master		1374-1547			174	1.60	0.48	0.182	Winter 1547/8
<i>West Block Staircase</i>									
§ <i>bld16</i>	c N stair string 1 st flight	1563-1680	1680	H/S	118	1.29	0.37	0.187	1691-1721
§ <i>bld17</i>	c N E newel post 2 nd flight	1587-1687	1672	15	101	1.30	0.67	0.257	1688-1713
§ = BUILDWS3 Site Master		1563-1687			125	1.29	0.44	0.207	1688-1717

Key: *, †, § = sample included in site-master; c = core; s = slice; = within 10 rings of centre; ¼C, ½C, C = bark edge present, partial or complete ring; ¼C = spring (ring not measured), ½C = summer/autumn, or C = winter felling (ring measured); H/S = heartwood/sapwood boundary - last heartwood ring date; std devn = standard deviation; mean sens = mean sensitivity. Sapwood estimate of 11-41 rings used (Miles 1997)

Table 2: Matrix of t -values and overlaps for components of *BUILDWS1*

<i>Sample:</i>	<i>bld5b</i>	<i>bld5c</i>
<i>Last ring</i>	1374	1376
<i>date AD:</i>		
<i>bld4</i>	<u>10.56</u>	<u>9.55</u>
	63	14
	<i>bld5b</i>	<u>6.78</u>
		12

Table 3: Matrix of t -values and overlaps for components of *bld389*

<i>Sample:</i>	<i>bld8</i>	<i>bld9</i>
<i>Last ring</i>	1118	1102
<i>date AD:</i>		
<i>bld3</i>	<u>6.72</u>	<u>9.66</u>
	84	101
	<i>bld8</i>	<u>10.25</u>
		81

Table 4: Matrix of t -values and overlaps for components of *bld67*

<i>Sample:</i>	<i>bld7a</i>	<i>bld7b1</i>
<i>Last ring</i>	1103	1080
<i>date AD:</i>		
<i>bld6a</i>	<u>7.86</u>	<u>4.84</u>
	53	56
	<i>bld7a</i>	<u>5.82</u>
		46

Table 5: Matrix of t -values and overlaps for components of *bld210*

<i>Sample:</i>	<i>bld10</i>
<i>Last ring</i>	1086
<i>date AD:</i>	
<i>bld2</i>	<u>4.68</u>
	65

Table 6: Matrix of *t*-values and overlaps for components of *BUILDWS2*

<i>Sample:</i>	<i>bld11</i>	<i>bld12</i>	<i>bld13</i>	<i>bld14</i>	<i>bld15</i>	<i>bld18</i>	<i>bld19</i>
<i>Last ring</i>	1547	1526	1529	1517	1523	1518	1515
<i>date AD:</i>							
<i>bld1</i>	<u>5.30</u> 88	<u>1.66</u> 67	<u>2.21</u> 70	<u>0.61</u> 58	<u>0.86</u> 64	<u>7.82</u> 59	<u>3.55</u> 56
<i>bld11</i>		<u>4.22</u> 71	<u>4.87</u> 74	<u>1.00</u> 62	<u>2.46</u> 68	<u>2.80</u> 63	<u>5.02</u> 60
		<i>bld12</i>	<u>8.44</u> 102	<u>4.67</u> 96	<u>9.78</u> 102	<u>2.08</u> 69	<u>3.31</u> 133
			<i>bld13</i>	<u>3.82</u> 93	<u>7.42</u> 99	<u>2.38</u> 69	<u>5.42</u> 91
				<i>bld14</i>	<u>4.66</u> 96	<u>2.85</u> 68	<u>4.30</u> 94
					<i>bld15</i>	<u>1.81</u> 69	<u>3.22</u> 94
						<i>bld18</i>	<u>3.84</u> 66

Table 7: Matrix of *t*-values and overlaps for components of *BUILDWS3*

<i>Sample:</i>	<i>bld17</i>
<i>Last ring</i>	1687
<i>date AD:</i>	
<i>bld16</i>	<u>7.13</u> 94

Table 8: Dating of *BUILDWS1* against reference chronologies at AD 1376.

	<u>Reference chronology</u>	<u>Spanning</u>	<u>Overlap</u>	<u>t-value</u>
†	MWNLOCK4 (<i>Miles and Haddon-Reece 1994</i>)	1315-1415	62	5.02
*	EASTMID (<i>Laxton and Litton 1988</i>)	882-1981	66	5.07
*†	MWNLOCK2 (<i>Miles and Haddon-Reece 1993</i>)	1290-1407	66	5.21
*	SENGLAND (<i>Bridge 1988</i>)	1083-1589	66	5.42
†	MWNLOCK5 (<i>Miles and Haddon-Reece 1994</i>)	1320-1435	57	5.47
	MASTERAL (<i>Haddon-Reece and Miles 1993</i>)	404-1987	66	5.66
*†♣	UPWICH2 (<i>Groves and Hillam 1997</i>)	946-1415	66	6.21
	PENTREH (<i>Worthington and Miles 2001a</i>)	1189-1465	66	6.83
	WALES97 (<i>Miles 1997b</i>)	404-1981	66	6.94
*†	PLOWDEN2 (<i>Miles and Haddon-Reece 1993</i>)	1330-1453	47	7.40
	OXON93 (<i>Haddon-Reece et al 1993</i>)	632-1987	160	7.91
	SALOP95 (<i>Miles 1995</i>)	881-1745	66	8.11
* Component of MASTERAL ♣ Component of WALES97 † Component of SALOP95				

Chronologies shown in bold are composite chronologies

Table 9: Dating of *BUILDWS2* against reference chronologies at AD 1547.

	<u>Reference chronology</u>	<u>Spanning</u>	<u>Overlap</u>	<u>t-value</u>
	ASTNEYR3 (<i>Miles and Worthington 1998</i>)	1357-1612	174	6.01
	SENG98 (<i>Bridge 1998</i>)	944-1790	174	6.46
	BAYTON (<i>Bridge 1996</i>)	1348-1525	152	6.50
	ALCASTON (<i>Miles and Worthington 1998</i>)	1389-1556	159	7.91
	WALES97 (<i>Miles 1997b</i>)	404-1981	174	8.01
†	HGROVNR9 (<i>Miles and Haddon-Reece 1994</i>)	1442-1590	106	8.42
	CALLGHTN (<i>Miles and Worthington 1997</i>)	1335-1569	174	8.57
†	ASHWOOD (<i>Miles and Haddon-Reece 1994</i>)	1419-1619	129	8.81
†♣	GIERTZ (<i>Siebenlist-Kerner 1978</i>)	1341-1636	174	8.84
*†	WOLVERTN (<i>Miles and Haddon-Reece 1993</i>)	1325-1580	174	9.00
	UPRLAKE (<i>Worthington and Miles 2001b</i>)	1418-1546	129	9.01
	SALOP95 (<i>Miles 1995</i>)	881-1745	174	10.57
* Component of MASTERAL ♣ Component of WALES97 † Component of SALOP95				

Chronologies shown in bold are composite chronologies

Table 10: Dating of *BUILDWS3* against reference chronologies at AD 1687.

	<u>Reference chronology</u>	<u>Spanning</u>	<u>Overlap</u>	<u>t-value</u>
	WALES97 (<i>Miles 1997b</i>)	404-1981	125	5.34
*	MC19 (<i>Fletcher 1978</i>)	1399-1800	125	5.40
	NOSTELL2 (<i>Tyers 1998</i>)	1535-1743	125	5.57
	NORTH (<i>Hillam and Groves 1994</i>)	440-1742	125	5.72
	OXON93 (<i>Haddon-Reece et al 1993</i>)	632-1987	125	6.05
	SENG98 (<i>Bridge 1998</i>)	944-1790	125	6.21
*	EASTMID (<i>Laxton and Litton 1988</i>)	882-1981	125	6.28
	HILLHAL2 (<i>Bridge 1999</i>)	1525-1681	119	6.31
	SALOP95 (<i>Miles 1995</i>)	881-1745	125	6.96
	MASTERAL (<i>Haddon-Reece and Miles 1993</i>)	404-1987	125	7.98
* Component of MASTERAL				

Chronologies shown in bold are composite chronologies

Table 11: Ring-width data for site master curve *BUILDWS1*, dated AD 1311-1376, East Block Roof, Buildwas Abbey, Shropshire - mean of samples *bld4* + *bld5b* + *bld5c*
66 rings, starting date AD 1311

<i>ring widths (0.01mm)</i>											<i>number of samples in master</i>									
272	403	338	447	376	352	301	257	277	277		1	2	2	2	2	2	2	2	2	2
215	245	212	183	148	133	180	175	187	256		2	2	2	2	2	2	2	2	2	2
311	308	282	368	545	487	374	428	376	317		2	2	2	2	2	2	2	2	2	2
358	287	165	256	297	291	285	271	290	157		2	2	2	2	2	2	2	2	2	2
150	111	136	154	133	124	164	169	169	105		2	2	2	2	2	2	2	2	2	2
102	243	327	288	220	184	122	101	203	179		2	2	3	3	3	3	3	3	3	3
125	122	143	165	125	81						3	3	3	3	2	2				

Table 12: Ring-width data for site master curve *BUILDWS2*, dated AD 1374-1547, West Block Roof, Buildwas Abbey, Shropshire - mean of samples *bld1* + *bld11* - *bld15* + *bld18* + *bld19*
174 rings, starting date AD 1374

<i>ring widths (0.01mm)</i>											<i>number of samples in master</i>									
155	93	126	152	160	211	148	44	41	39		1	1	1	1	1	1	1	1	1	2
56	61	79	82	95	96	102	151	157	128		2	2	2	2	2	2	2	2	2	2
60	66	111	200	290	275	224	288	170	305		2	2	2	2	2	2	2	2	2	2
240	198	212	180	189	253	181	156	119	102		2	2	2	2	2	2	2	2	2	2
143	181	163	132	161	140	178	183	187	211		2	2	2	2	2	2	2	4	4	4
201	222	180	172	271	216	224	262	278	181		4	5	5	5	5	5	5	5	5	5
238	247	191	122	99	90	112	129	119	154		5	5	5	5	5	5	5	5	5	5
219	185	144	145	151	169	195	235	192	174		5	5	5	5	5	5	6	6	6	6
236	179	222	188	213	171	227	173	167	165		6	6	7	7	7	7	8	8	8	8
129	152	162	192	159	177	231	158	164	147		8	8	8	8	8	8	8	8	8	8
171	238	195	167	150	184	138	146	125	142		8	8	8	8	8	8	8	8	8	8
166	175	161	193	137	133	142	131	143	136		8	8	8	8	8	8	8	8	8	8
150	142	195	137	129	136	137	114	115	111		8	8	8	8	8	8	8	8	8	8
134	151	128	105	120	168	138	153	165	162		8	8	8	8	8	8	8	8	8	8
144	137	97	96	131	176	123	144	174	144		8	8	7	7	6	5	5	5	5	5
167	130	126	154	184	155	152	198	183	193		4	4	4	3	3	3	2	2	2	2
163	167	173	171	170	160	162	223	135	128		2	2	2	2	2	2	2	2	2	2
142	136	125	96								2	2	2	2						

Table 13: Ring-width data for site master curve *BUILDWS3*, dated AD 1563-1687, West Block staircase, Buildwas Abbey, Shropshire - mean of samples *bld16* + *bld17*
125 rings, starting date AD 1563

<i>ring widths (0.01mm)</i>											<i>number of samples in master</i>									
188	196	189	146	122	161	286	227	204	208		1	1	1	1	1	1	1	1	1	1
168	181	129	84	84	80	76	105	101	69		1	1	1	1	1	1	1	1	1	1
84	95	120	120	265	254	280	140	151	145		1	1	1	1	2	2	2	2	2	2
165	178	175	159	167	140	123	118	155	153		2	2	2	2	2	2	2	2	2	2
138	149	113	147	166	129	99	140	110	93		2	2	2	2	2	2	2	2	2	2
140	84	109	126	162	158	113	147	141	173		2	2	2	2	2	2	2	2	2	2
192	115	131	128	140	128	181	129	133	133		2	2	2	2	2	2	2	2	2	2
146	117	115	99	110	127	112	138	145	124		2	2	2	2	2	2	2	2	2	2
111	122	110	140	146	163	137	148	84	70		2	2	2	2	2	2	2	2	2	2
72	53	120	82	98	112	98	89	92	75		2	2	2	2	2	2	2	2	2	2
113	95	109	69	128	125	105	92	134	101		2	2	2	2	2	2	2	2	2	2
166	117	84	80	138	163	115	130	67	109		2	2	2	2	2	2	2	2	1	1
104	74	48	63	52							1	1	1	1	1					

Figure 4: Roof over East block of Abbot's Residence. Typical roof truss (English Heritage)

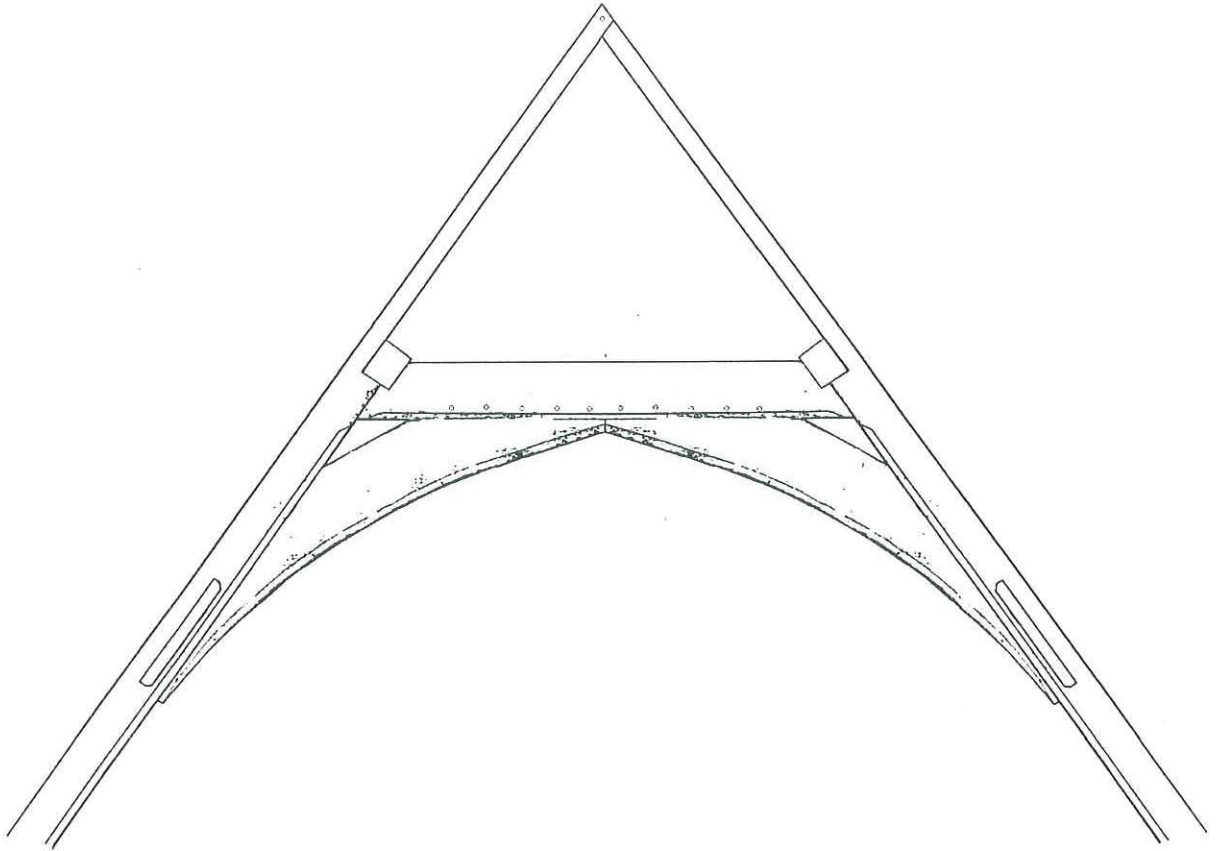


Figure 5: Roof over East block of Abbot's Residence. Windbrace/purlin arrangement (English Heritage)

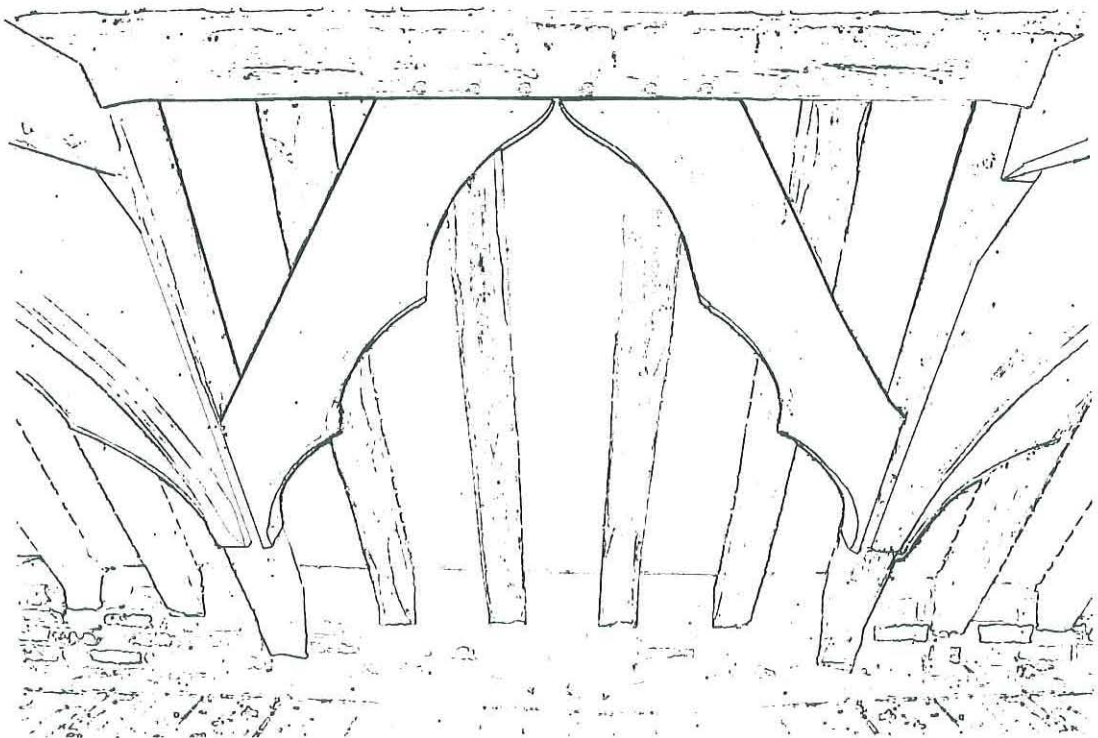
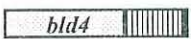





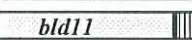



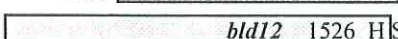

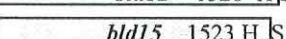

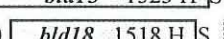

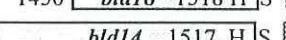

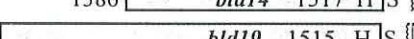
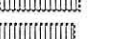


Figure 9: Dated samples in chronological position

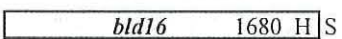

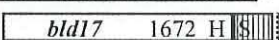

East Block Roof

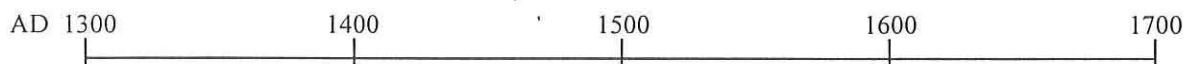
1311  *bld4*  1376 *Spring 1377*
 1312  *bld5*  1376 *Spring 1377*

West Block Roof





1460  *bld1*  1547 *Winter 1547/8*
 1456  *bld11*  1547 *Winter 1547/8*
 1425  *bld13* 1529 H S  1540-70
 1383  *bld12* 1526 H S  1537-67
 1422  *bld15* 1523 H S  1534-64
 1450  *bld18* 1518 H S  1529-59
 1386  *bld14* 1517 H S  1528-58
 1406  *bld19* 1515 H S  1526-56

West Block Staircase

1563  *bld16* 1680 H S  1691-1721
 1587  *bld17* 1672 H S  1688-1713



Key:

-  Heartwood
-  Surviving sapwood (incomplete)
-  Bark edge: season and year of felling
-  95% felling date range: 11-41 years (Miles 1997a)

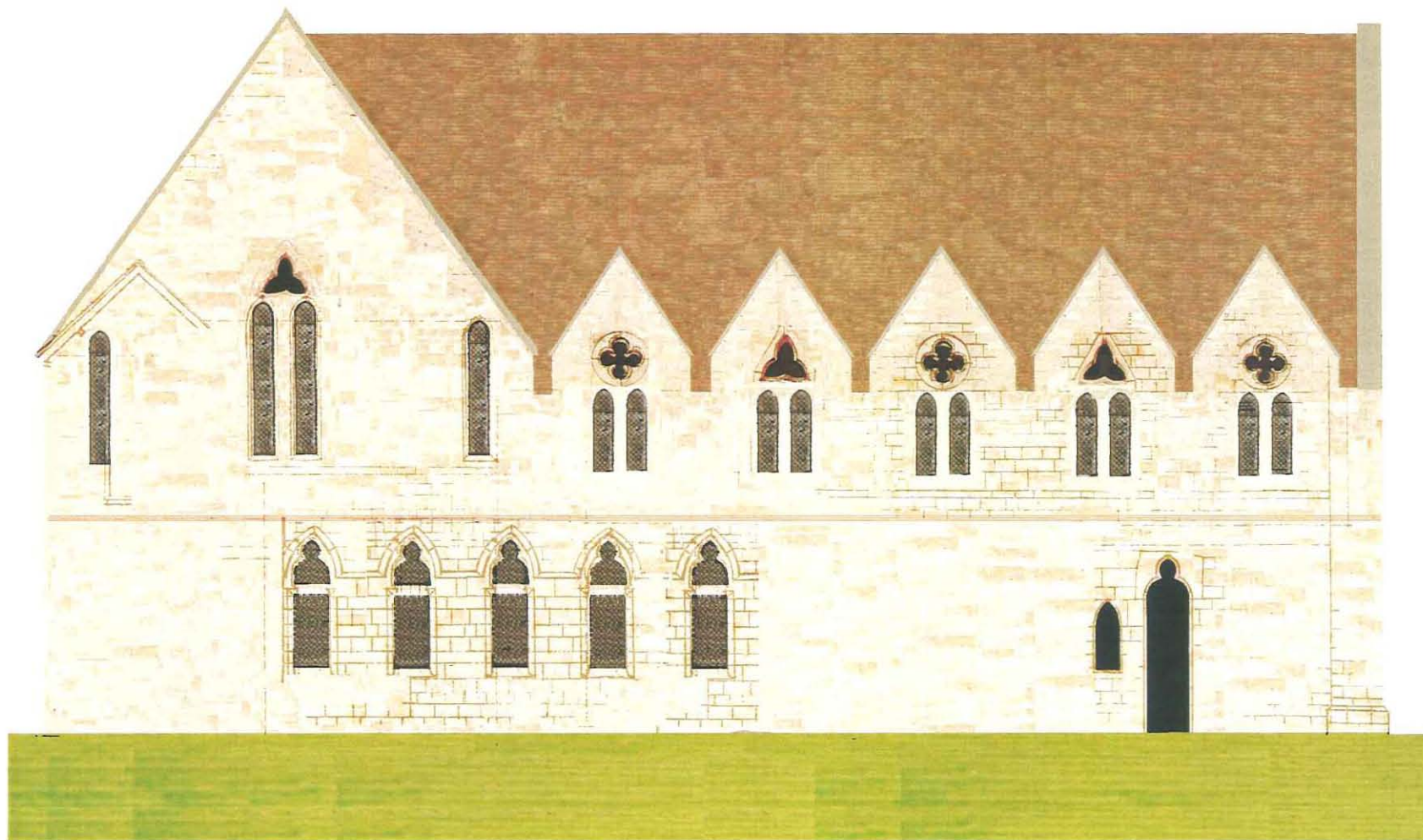


Figure 3: The Abbot's Residence as it may have appeared in the late thirteenth century (English Heritage)

Figure 1: Location plan of Buildwas Abbey

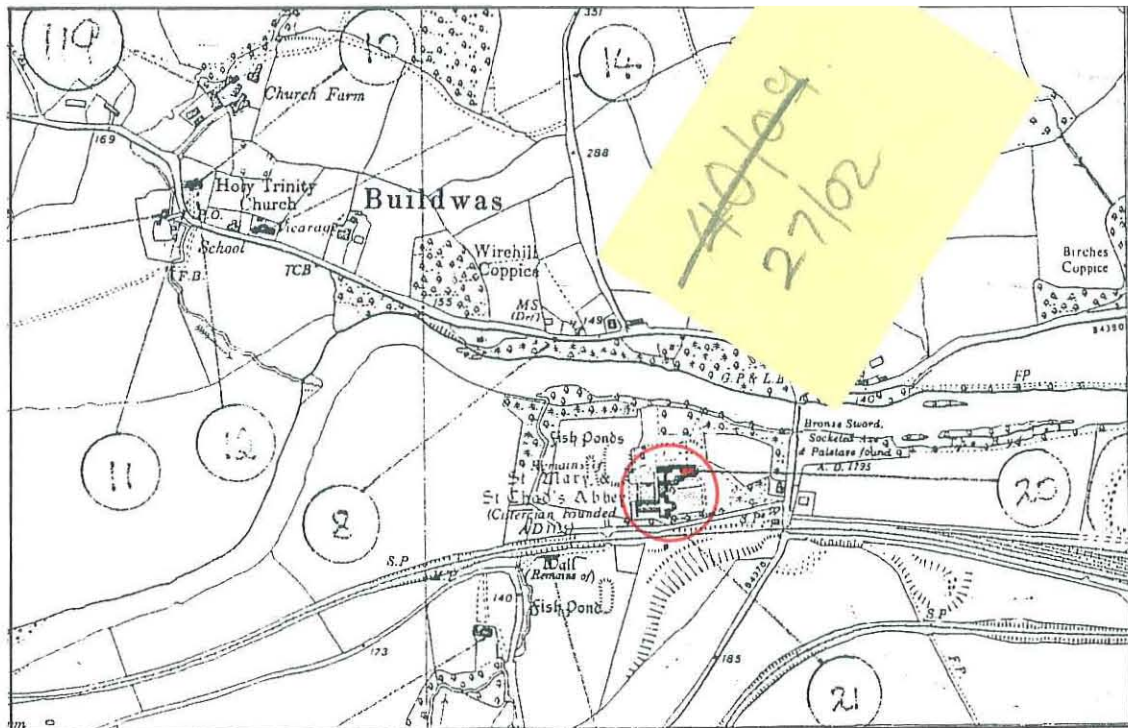


Figure 2: Site plan of Buildwas Abbey

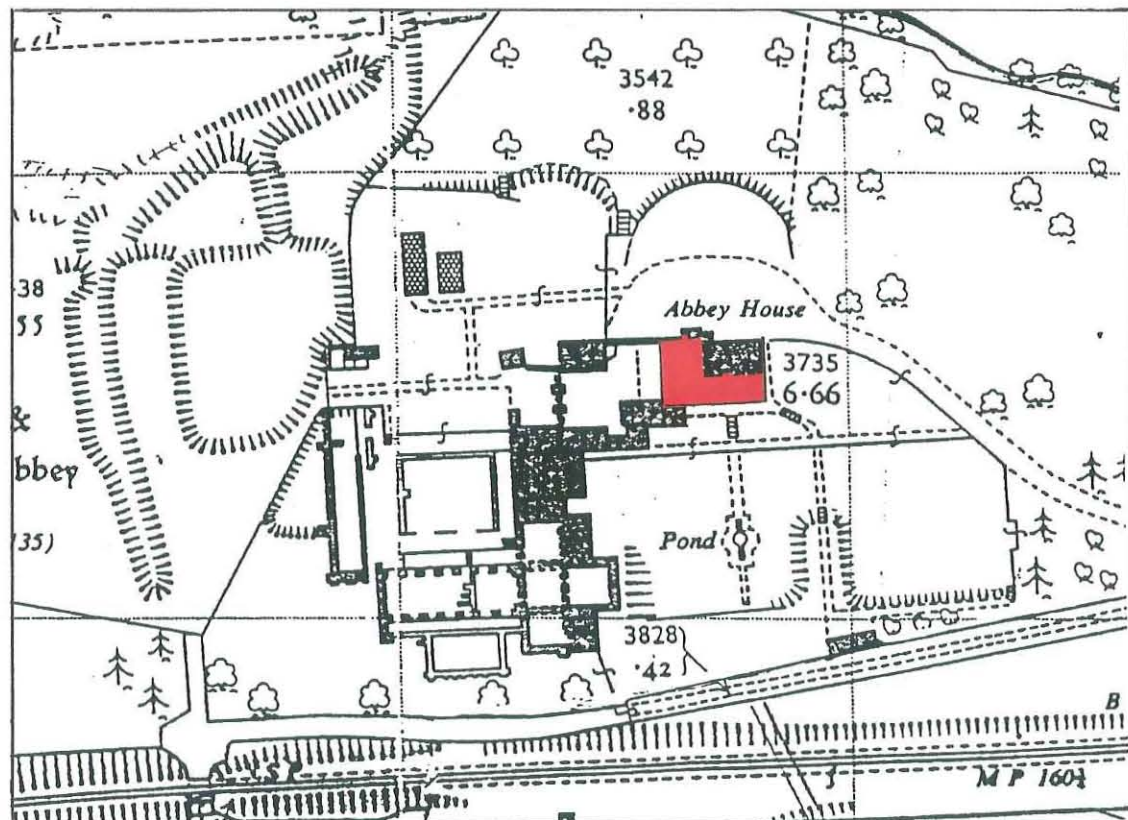
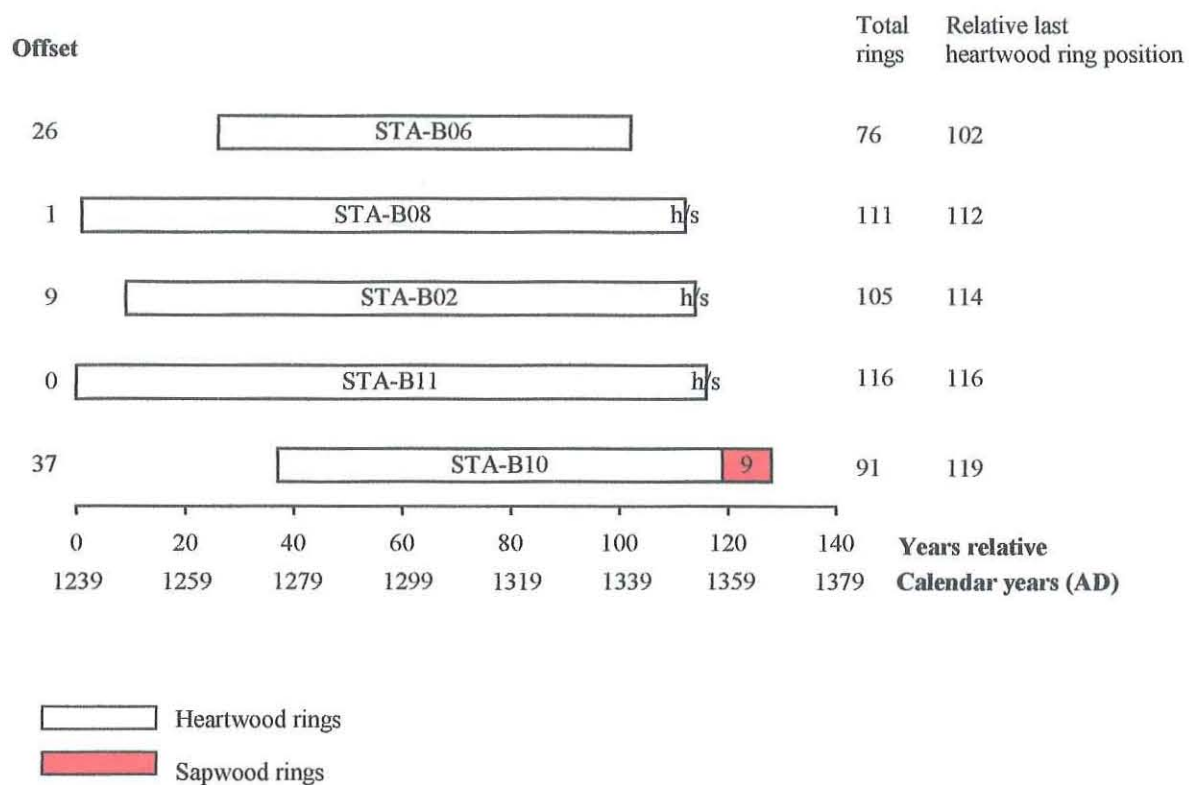


Figure 4: Bar diagram of samples in site sequence STABSQ01



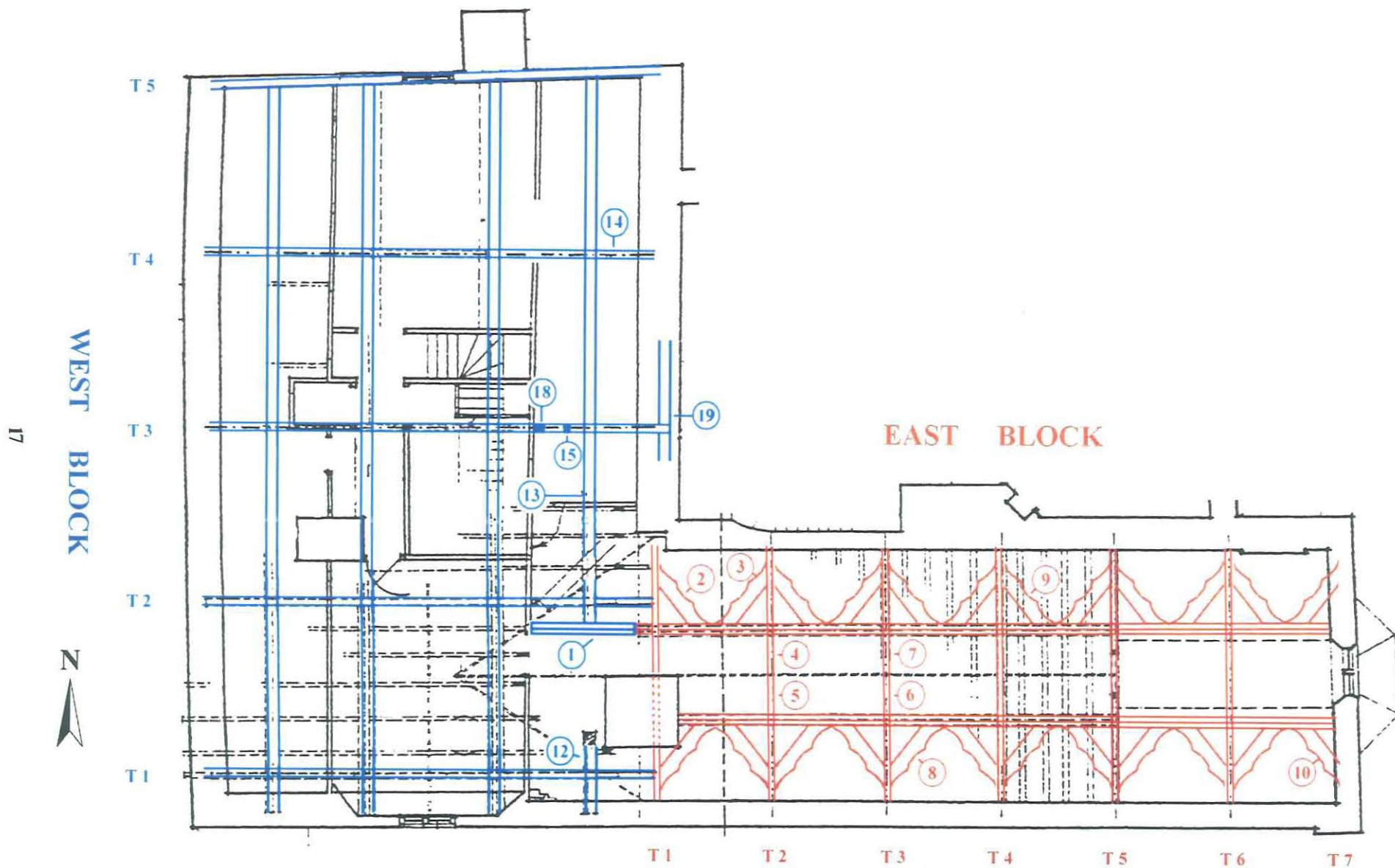


Figure 6: Roof plan of Abbot's Residence showing position of timbers sampled

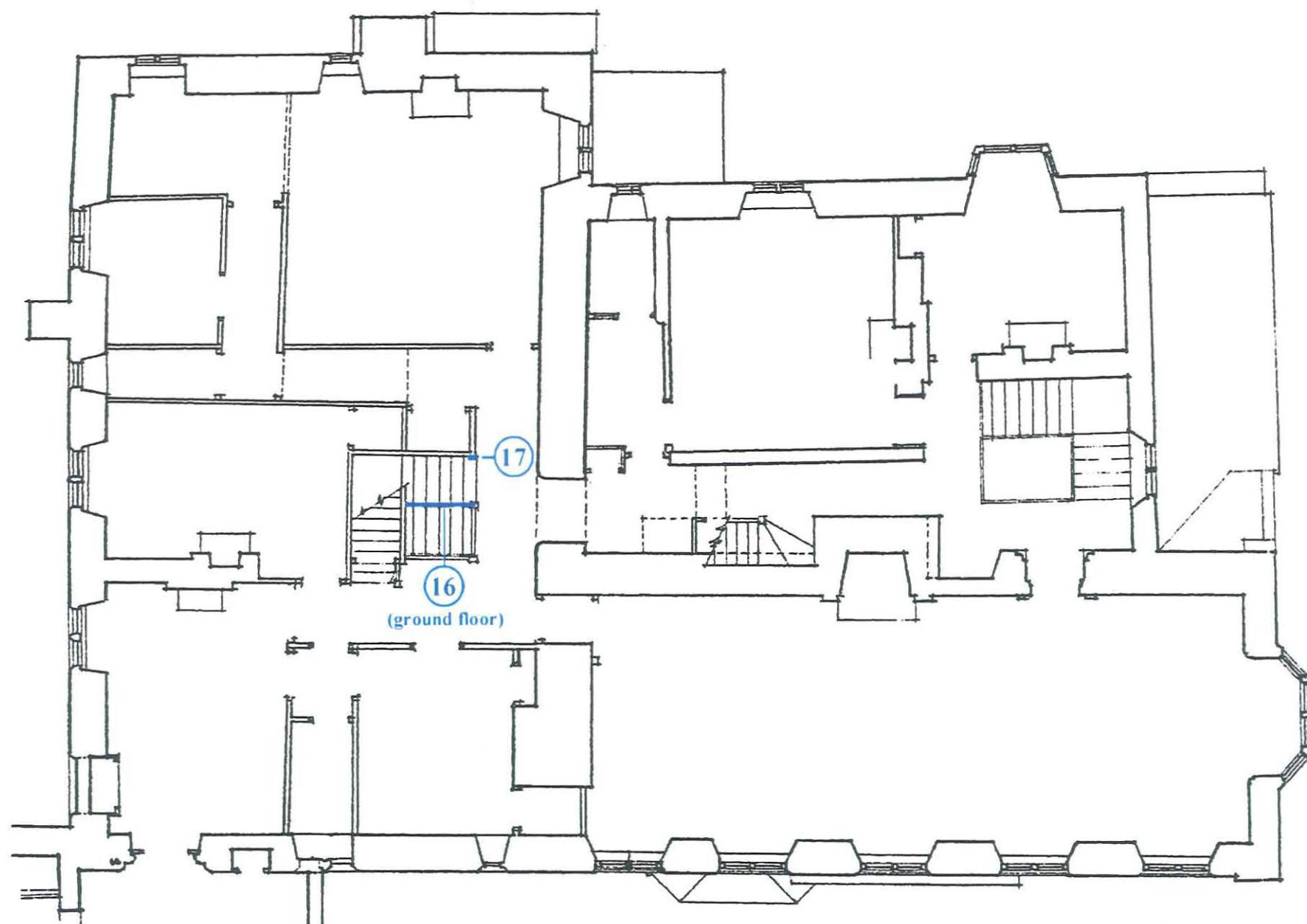


Figure 7: First floor plan of Abbot's Residence showing position of timbers sampled

Figure 8: Photograph of re-used section of cornice beneath staircase (M J Worthington)



Figure 10: Sections of timbers sampled (scale 1:8)

