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BESSIE SURTEES HOUSE, SANDHILL, NEWCASTLE UPON TYNE
DENDROCHRONOLOGICAL ANALYSIS OF OAK TIMBERS

SCIENTIFIC DATING REPORT

Ian Tyers

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SUMMARY

A tree-ring dating programme was commissioned on timbers from Bessie Surtees House. This building is a twentieth-century amalgamation of two merchants' houses with a complex history of extension and addition. The results identified that timbers from various levels within the buildings were datable by tree-ring dating techniques, with both buildings containing timbers from the sixteenth and seventeenth centuries. This dating programme was commissioned on this complex building to inform management and interpretation of this guardianship property, and to comply with planning permission relating to recent modifications. This report archives the dendrochronological results.

CONTRIBUTORS

Ian Tyers

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The sampling and analysis of timbers at Bessie Surtees House was funded by English Heritage (EH). Practical help and valuable discussions were provided by Martin Roberts, Historic Buildings Inspector, North East Region (EH), and Jane Sidell, then of Scientific Dating team (EH). Numerous English Heritage staff throughout the building were cheerfully tolerant of the disruption whilst I drilled timbers in their offices, doorways and stairwells.

ARCHIVE LOCATION

Sites and Monuments Record
City of Newcastle Planning Division
Civic Centre
Barras Bridge
Newcastle NE1 8PH

DATE OF INVESTIGATION

2008

CONTACT DETAILS

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INTRODUCTION

This document is a technical archive report on the tree-ring analysis of oak timbers from Bessie Surtees House, 41–44 Sandhill, Newcastle. It is beyond the dendrochronological brief to describe the building in detail or to undertake the production of detailed drawings. Elements of this report may be combined with detailed descriptions, drawings, and other technical reports at some point in the future to form either a comprehensive publication or an archive deposition on the building.

Bessie Surtees House stands on the north side of Sandhill (NGR NZ 2516 6385), which lies near both the Newcastle waterfront and on the slopes of the medieval castle. This area became an important administrative and commercial centre of Newcastle (Fig 1). The present building is a twentieth-century amalgamation by Viscount Gort of two merchants' houses fronting onto Sandhill, known as Surtees House and Milbank House, along with a derelict warehouse at the back, now known as Maddison House. Extensive renovations for Gort between 1931 and *c* 1937 included the insertion of period fittings such as chimney pieces, doors, etc and potentially also included reconstruction using timber framing obtained from elsewhere. The staircase of Milbank House was removed and the staircase in the rear section of Surtees House was utilised as a linking block between the three buildings. Further urgent repairs occurred from 1979 onwards, including further modifications to roof timbers and access. This report follows the building names (Fig 2), floor levels (Fig 3) and room numberings (Figs 4–9) used in the detailed record and interpretation of the building by Heslop *et al* (1994). Figures 10 and 11 are sections through Milbank House and Surtees House, and show the jettied frontage of Surtees House and later vertical brick frontage and the modification of the roof trusses in Milbank House. The Grade-I-listed building is in the guardianship of English Heritage and is currently their North East Regional Office.

METHODOLOGY

Tree-ring dating employs the patterns of tree-growth to determine the calendar dates for the period during which the sampled trees were alive. The amount of wood laid down in any one year by most trees is determined by the climate and other environmental factors. Trees over relatively wide geographical areas can exhibit similar patterns of growth, and this enables dendrochronologists to assign dates to some samples by matching the growth pattern with other ring-sequences that have already been linked together to form reference chronologies.

The building was visited by the author in December 2007 in company with Martin Roberts and Jane Sidell. An assessment of the dendrochronological potential of timbers in several areas of the structure had been requested by Martin Roberts. This assessment aimed to identify whether oak timbers with sufficient numbers of rings for analysis existed in any part of the complex. This assessment concluded that timbers in the roofs along with various timbers of the exposed internal framing contained suitable material. The

panelling and plasterwork severely restricted access to the structural elements lower down the buildings, particularly in Surtees House. Many elements of the decorative woodwork are thought to be later insertions to the building and were thus considered unsuitable for sampling and analysis. The structural framing of Maddison House is thought to date from the 1930s reconstruction, utilising timber framing brought in from elsewhere; this material was specifically excluded from the assessment request.

The sampling took place during March 2008. The selected timbers were sampled using a 15mm diameter corer attached to an electric drill. The cores were taken as closely as possible along the radius of the timbers so that the maximum number of rings could be obtained for subsequent analysis. The ring sequences in the cores were revealed by sanding.

This preparation revealed the width of each successive annual tree ring. Each prepared sample could then be accurately assessed for the number of rings it contained, and at this stage it was also possible to determine whether the sequence of ring widths within it could be reliably resolved. Dendrochronological samples need to be free of aberrant anatomical features, such as those caused by physical damage to the tree, which may prevent or significantly reduce the chances of successful dating.

Standard dendrochronological analysis methods (see eg English Heritage 1998) were applied to each suitable sample. The complete sequences of the annual growth rings in the suitable samples were measured to an accuracy of 0.01mm using a micro-computer based travelling stage. The sequences of ring widths were then plotted onto semi-log graph paper to enable visual comparisons to be made between sequences. In addition, cross-correlation algorithms (eg Baillie and Pilcher 1973) were employed to search for positions where the ring sequences were highly correlated. Highly correlated positions were checked using the graphs and, if any of these were satisfactory, new composite sequences were constructed from the synchronised sequences. Any *t*-values reported below were derived from the original CROS algorithm (Baillie and Pilcher 1973). A *t*-value of 3.5 or over is usually indicative of a good match, although this is with the proviso that high *t*-values at the same relative or absolute position need to have been obtained from a range of independent sequences, and that these positions were supported by satisfactory visual matching.

Not every tree can be correlated by the statistical tools or the visual examination of the graphs. There are thought to be a number of reasons for this: genetic variations; site-specific issues (for example, a tree growing in a stream bed will be less responsive to rainfall); or some traumatic experience in the tree's lifetime, such as injury by pollarding, defoliation events by caterpillars, or similar. These could each produce a sequence dominated by a non-climatic signal. Experimental work with modern trees shows that 5–20% of all oak trees cannot be reliably cross-matched, even when enough rings are obtained.

Converting the date obtained for a tree-ring sequence into a useful date requires a record of the nature of the outermost rings of the sample. If bark or bark-edge survives, a felling date precise to the year or season can be obtained. If no sapwood survives, the date obtained from the sample gives a *terminus post quem* for its use. If some sapwood survives, an estimate for the number of missing rings can be applied to the end-date of the heartwood. This estimate is quite broad and varies by region. This report uses a minimum of 10 rings and a maximum of 46 rings as a sapwood estimate (see eg English Heritage 1998, 10–11).

Where bark-edge or bark survives, the season of felling can be determined by examining the completeness or otherwise of the terminal ring lying directly under the bark. Complete material can be divided into three major categories:

- 'early spring', where only the initial cells of the new growth have begun – this is equivalent to a period in March/April, when the oaks begin leaf-bud formation;
- 'later spring/summer' where the early wood is evidently complete but the late wood is evidently incomplete, which is equivalent to May-through-September of a normal year, and
- 'winter' where the latewood is evidently complete and this is roughly equivalent to September-to-March (of the following year) since the tree is dormant throughout this period and there is no additional growth put on the trunk.

These categories can overlap as, for example, not all oaks simultaneously initiate leaf-bud formation. It should also be noted that slow-growing or compressed material cannot always be safely categorised.

Timber technology studies demonstrate that many of the tool marks recorded on ancient timbers can only have been done on green timber. There is little evidence for long-term storage of timber or of widespread use of seasoned, rather than green, timber in the medieval period (see eg English Heritage 1998, 11–12).

Reused timbers can only provide tree-ring dates for the original usage date, not their reuse. Identifying reused timbers requires careful timber recording which notes the presence of features which are not functional in the structure. It is always possible that some timbers exhibit no evidence of earlier usage, and are thus 'hidden reused' timbers. The dendrochronological impact of this problem is particularly acute where only single timbers have been dated from a structure.

The analysis may highlight potential same-tree identifications if two or more tree-ring sequences are obtained that are exceptionally highly correlated. Such pairs, or sometimes more, are then used as a same-tree group and each can be given the interpreted date of the most complete of the samples. They are most useful where several timbers date but only one has any sapwood or where same-tree identifications yield linkages between different areas.

RESULTS

In March 2008 53 timbers from across the building were cored; these cores were labelled 1–53 inclusive. Subsequently a slice was made available from a ground-floor ceiling beam of Maddison House that had been removed during recent refurbishment works. It was a requirement of the Listed Building Consent for these works that this timber was assessed and if possible tree-ring dated. An assessment identified this timber as potentially suitable and the analysis of this timber was added to the overall project, with this sample labelled as number 54. Figures 4–9 show the distribution of the samples through the 6 levels of Milbank House, and the 5 levels of Surtees House. In total, 21 samples were obtained from Surtees House: 8 samples from the main roof, 4 from the roof of the rear range, and 9 from the stairwell around levels 1 and 2. The remaining 32 samples were obtained from Milbank House: 13 from the main roof, comprising 12 from level 6, and a single roof timber exposed in level 5; 2 samples are from the level 6 rear-range roof, and the rest of the samples are from exposed timberwork in both the main and rear blocks (5 samples from level 2, 6 from level 3, and 6 from level 4).

Each sample was assessed for the wood type, the number of rings it contained, and whether the sequence of ring widths could be reliably resolved. This assessment confirmed that all the sampled timbers were oak (*Quercus* spp.) and that 42 were suitable for dendrochronological analysis. The 12 exceptions either had too few rings for analysis or had fragmented badly during sampling. These comprised six samples from Surtees House and six from Milbank House. There was good survival of sapwood in all of the targeted areas and bark-edge survival was also reasonably good. The details of these samples are provided in Tables 1–3.

The 42 suitable samples were prepared for analysis, measured, and the resultant ring series were initially compared with other material from the same building and level. Further comparisons were then made between levels, and between buildings. Various interim composite groupings of sequences were made during this process. Finally the interim composites and the individual sample series were individually compared with reference series of medieval and later tree-ring data from throughout Britain. These results were reviewed and three final composite series were constructed: Milbank 1 from five samples from the second and third levels of Milbank House (Tables 4 and 5), Milbank 2 from 12 samples from levels 4–6 from Milbank House (Table 6 and 7), and Surtees 2 from four samples from levels 1 and 5 at Surtees House (Table 8 and 9). In each case these are groups formed by cross-matched tree-ring data, supported by good external cross-matching. In addition, two individual samples from levels 1 and 2 from Surtees House (Table 10) and the sample from level 1 of Maddison House (Table 11) were found to exhibit good external cross-matching with reference data. These latter three series and the Milbank 1 sequence form an internally consistent group (Table 12), and the final 164-year site composite sequence constructed from these, Bessie 1, matches with reference data (Table 13) at AD 1364 to AD 1527 inclusive. Sequences Milbank 2 and Surtees 2 cross-match (*t*-value 5.52), and a final 180-year composite was constructed

from these, named Bessie 2, which matches with reference data (Table 14) at AD 1471 to AD 1650 inclusive. A summary of the results for the component samples of these chronologies are provided in Tables 1–3 and Figures 12–14.

Four of the remaining 18 individual series from the building, all from the front-range roof of Surtees House were also found to form a consistent group (Fig 15, Table 15), and a short composite sequence of 75 years, Surtees 3, was constructed from these. Neither this nor its component individual series, nor any of the remaining individual series, provided any consistent dating evidence when compared with English, European, and other reference data, as well as the other undated sequences, and these samples thus remain undated.

The measurement data for all the measured samples are listed in Appendix 1.

DISCUSSION

The dated samples are derived from different areas of the three component buildings. These areas are discussed firstly from Milbank House, from bottom to top, then Surtees House also primarily from bottom to top, and then the sample from Maddison House. All the datable material matches strongly with other local reference data and it is likely that all these timbers were derived from the general vicinity of Newcastle.

Milbank House

This six-storey building was faced in brick *c* 1741 (Heslop *et al* 1994, 5); the timber framing on the south elevation is thus absent. The current façade hides a timber-framed structure that was presumably jettied on the street frontage until that point. Gort's 1930s interventions included the insertion of a decorative overmantel in Level 3, and presumably some of the linking access routes between Milbank House and the Surtees House stairwell.

The 32 samples obtained from timbers within Milbank House yielded 17 datable tree-ring sequences. These fall into two clusters of dates: five samples are broadly early sixteenth-century, and were derived from levels 2 and 3, and 12 samples are broadly early seventeenth-century, and were derived from levels 4 and 6 (Fig 12).

Levels 2 and 3 ceiling joists

Eleven samples were obtained from these two levels. Five of these are from the massive east-west ceiling joists, three of *c* 8m length in public room 203 on level 2, and the slightly shorter pair in room 307 on level 3. As noted by Heslop *et al* (1994, 7–8), the level 2 beams are nicely moulded but the level 3 beams have been crudely cut back; presumably they were boxed in by plasterwork at some stage. The other timbers that were sampled

in these levels include ceiling joists in the rear block, and door posts and wall framing from the linking areas.

Two of the samples were unsuitable for analysis but five of the suitable nine samples were found to cross-match. The composite sequence was found to date and thus there are tree-ring dates for five of these structural elements. The 153-year Milbank I composite sequence was found to match composite sequences obtained from the neighbouring areas at AD 1374 to AD 1527 inclusive. This material comprised reasonably slow-growing and long-lived oaks.

The tree-ring analysis dates the rings present in the cores. The correct interpretation of those dates relies upon the characteristics of the final rings in them. Bark-edge survived on one of these timbers, some sapwood on another two, and no sapwood was present on the remaining two. Making allowances for minimum and maximum likely amounts of missing sapwood provides individual felling dates, or felling date ranges, or *terminus post quem* dates for each of the datable timbers. Figure 12 and Table 1 includes the felling date or interpreted felling date ranges for each of the datable samples.

The interpretation of three of these dated samples is straightforward. Samples 28, 33, and 34 all have some sapwood, and sample 28 is complete to bark edge. This latter retains a complete ring for AD 1510, and the onset of growth for the following year. This timber was therefore felled in the spring of AD 1511. The calculated felling date ranges for the two other samples indicates this group of timbers were either precisely or broadly contemporaneous. These three timbers comprise a ceiling joist in the level 3 back range, one of the two large ceiling joists from room 307 and one from room 203. Sample 32, another of the room 307 ceiling joists, had no sapwood, and whilst it may be contemporaneous with this material, it does have later heartwood than the others. These results in combination suggest that Milbank House, up to the level 3 ceiling height, contains an early sixteenth-century structure. The level 3 ceiling in the back range is likely to date from AD 1511, and the level 2 and 3 ceiling joists in the front range date from between AD 1509 and AD 1522, assuming these latter were all used for a single campaign of construction. These results suggest that the Milbank House levels 2 and 3 structure is likely to predate the earliest documentary evidence for the property, *c* 1565 (Heslop *et al* 1994 5).

It is noteworthy that the long ceiling joists from room 203 with decorative mouldings were made out of trees *c* 8m long that were not particularly long-lived, and which were only just large enough for purpose. Most retained some evidence for sapwood, despite the deep mouldings on the level 2 timbers, and some evidence for their later defrassing. Some sapwood even survived the deliberate removal of the mouldings on the level 3 timbers.

The fifth datable sample in this group from Milbank House is clearly from a different date, although it is still from the sixteenth century. This sample, from the eastern door post from the lobby area into room 307 on level 3, only retains heartwood, and has a latest

ring of AD 1527. This timber therefore cannot be earlier than *c* AD 1537. The sampling notes indicate that this timber retained sapwood, although none survived on the sample, but this record makes it likely this timber was felled a decade or two either side of *c* 1550. This timber may not of course be original to the property, since access routes, and thus door posts, were potentially changed so comprehensively by Gort. This timber could thus be either reused or secondary, or may indicate a later sixteenth-century phase of construction work in Milbank House. No other material that appeared to be contemporaneous with this sample was identified during this analysis.

Levels 4 and 6

A further 21 samples were from timbers above level 3 in Milbank House. Six of these are from storey posts, various joists, and a door post on level 4. A further 15 samples are from roof timbers, 2 from the rear-range roof, and 13 from the front-range roof. The latter was sampled fairly extensively because the common rafters show some evidence for reuse. Heslop *et al* (1994, 12–13) note that the two-storey-high cruck blades, surviving on the north side of this roof, were truncated on the south side by the insertion of the façade to create the present principal rafters (the present form of the roof can be seen in Fig 10). They also note that many of the purlins and rafters were replaced, and they highlight the change in timber sizes between the larger ceiling beams from the lower levels to the markedly smaller timbers utilised in levels 4 and above in Milbank House.

All 6 of the level 4 timbers were suitable for analysis, and 11 of the 15 roof timbers. Twelve of the 17 suitable samples were found to cross-match, the composite sequence was found to date, and thus there are tree-ring dates for 12 of these structural elements. The 146-year Milbank 2 composite sequence was found to match composite sequences obtained from the surrounding regions at AD 1471 to AD 1617 inclusive. This material generally comprised faster-growing and shorter-lived oaks than those used in the lower levels of the building.

The correct interpretation of these results relies upon the characteristics of the final rings in the samples. Bark-edge survived on five of these timbers, some sapwood on another four, and the onset of sapwood was present on the remaining three. Making allowances for minimum and maximum likely amounts of missing sapwood provides individual felling dates, or felling date ranges, for each of the datable timbers. Figure 12 and Table 1 includes the felling date or interpreted felling date ranges for each of the datable samples.

The interpretation of the roof levels is straightforward. From the front-range roof, all five dated timbers retain sapwood, and two are complete to bark edge. These latter both retain a ring for AD 1615. In one case it has a complete ring, indicating this timber was felled in the winter of 1615 or early spring of AD 1616. The other is too slow-growing to identify which season it was felled in. The calculated felling date ranges for the remaining three samples indicates this material was either precisely or broadly contemporaneous. These five timbers comprise two yokes, one principal rafter (this is probably a truncated

cruck), and two common rafters. A single datable timber from the rear-range roof, sample 23 derived from a king post, also retains some sapwood and this timber appears to be broadly contemporaneous with the dated timbers in the front-range roof. This sample has a calculated felling date range of AD 1609 to AD 1645. These results indicate that the Milbank House level 6 roof structures are therefore likely to date from *c* 1615. The property was sold in 1605 to William Hall, merchant (Heslop *et al* 1994, 5).

The level 4 timbers are slightly more complicated to interpret. All six samples from this area were suitable for analysis, and all six were found to be datable. Three of these were complete to bark edge, the rest have some sapwood, or the onset of sapwood. The dated timbers which retain bark-edge are a storey post, with jowls top and bottom, felled in winter AD 1613 or spring AD 1614, a joist or tie on top of another jowled storey post felled in spring AD 1615, and a mid rail in a piece of internal framing, felled in late spring or summer AD 1617. The other three dated timbers without bark-edge could be any of these dates, or from other dates broadly contemporary with them; in combination, the felling date ranges calculated for them indicate they were felled between AD 1602 and AD 1627. These timbers therefore, whilst being broadly the same date as those of the roof above, vary slightly in their details. This variation is slightly unusual to find within what is a relatively small building. This may indicate stockpiling of construction timber, or perhaps more likely that there was a somewhat extended construction and fitting out programme in the upper floors of Milbank House, perhaps involving minor changes of plan, or piecemeal alterations whilst parts of the building remained in commercial or domestic use. This phase or these phases, if there were multiple separate campaigns of extension, would date to the period shortly after the purchase of the property in 1605 mentioned above.

Surtees House

This five-storey building is a bay wider than Milbank House (Fig 3). The timber-framed structure is jettied at every level (Fig 11), and is one floor lower than Milbank House. The attic had a secondary remodelling to form the garret on the front elevation. The building only came into the same ownership as Milbank House from 1931, so it might be expected to have different construction events, though these are likely to be within a general chronological framework of the same economic and social pressures to extend and aggrandise.

The 21 samples obtained from timbers within Surtees House yielded 6 datable tree-ring sequences. These fall into two clusters of dates, two samples are broadly early sixteenth-century, and were derived from the a storey post and a doorway at levels 1 and 2, and four are broadly mid-seventeenth-century (Fig 13). One of these was derived from the level 1 stairwell and the rest from the level 5 rear-range roof. A further group of four samples from the level 5 front-range roof are cross-matched but undated. The markedly different rates of success evident between the two buildings for obtaining dates from samples presumably reflects a combination of factors.

Level 1 main structure, and a level 2 doorway timber

Nine samples were obtained from timbers in these two levels. One is from the jowled storey post that acts as the corner post of the stairwell. Four others were from various horizontal elements of the level 1 stairwell south wall, which is also the rear wall of room 106, and partially the rear of room 202. In addition, four samples were obtained from timbers around the doorway leading from the level 2 stairwell into room 202.

Three of these samples were unsuitable for analysis, but three of the six suitable samples were found to cross-match, two (separately) to reference data giving early sixteenth-century dates. A third sample from this area, of seventeenth-century date, will be discussed in the next section. The two samples of interest here were both derived from reasonably slow-growing and long-lived oaks.

The correct interpretation of these results relies upon the characteristics of the final rings in the samples. Sapwood and bark-edge survived on neither of these timbers. Making allowance for minimum likely amounts of missing sapwood provides *terminus post quem* dates for these datable timbers. Figure 13 and Table 2 includes the *tpq* dates calculated for both.

One of the datable samples was obtained from the major storey post, and one from a level 2 doorway post. The former retains heartwood to AD 1497, the latter to AD 1448. The sampling notes indicate the presence of sapwood at an inaccessible location on the door post. These timbers were therefore felled after *c* AD 1507 and after *c* AD 1458 respectively, with the latter probably predating *c* AD 1500. These two timbers thus appear to represent two different building phases, although the storey post from Surtees House could be of similar date to the Milbank House lower levels (AD 1511) or perhaps slightly later. The doorway post appears to be somewhat earlier, but like those in Milbank House, this timber should be treated somewhat cautiously, due to the possible introduction of material from elsewhere by Gort. These results indicate that the major structural elements of Surtees Milbank House level 1 include at least one timber of earlier sixteenth-century date, placing this part of the building into a relatively undocumented period for the property (Heslop *et al* 1994, 14).

Level 1 stairwell area, and the level 5 rear roof

Four samples were obtained from the rear roof of Surtees House, from the two accessible trusses in room 502. This roof uses a simple A-frame truss type (like the one on the main range, see Fig 11).

All four of the rear-roof samples were suitable for analysis, and three were found to cross-match, along with one of the level 1 stairwell timbers, and the composite sequence was found to date. There are therefore tree-ring dates for three of the roof timbers, and one of the stairwell timbers. The 147-year Surtees 2 composite sequence was found to

match composite sequences obtained from the surrounding regions at AD 1504 to AD 1650 inclusive.

The correct interpretation of these results relies upon the characteristics of the final rings in the samples. Bark-edge survived on one of these timbers, some sapwood on another one and the onset of sapwood was present on the remaining two. Making allowances for minimum and maximum likely amounts of missing sapwood provides individual felling dates, or felling date ranges, for each of the datable timbers, these are given in Figure 13 and Table 2 for each of these datable samples.

The interpretation of these dated samples is straightforward. The sample complete to bark edge retains a complete ring for AD 1650, and the onset of growth for the following year. This timber was therefore felled in the spring of AD 1651. The calculated felling date ranges for the remaining three samples indicates this material was either precisely or broadly contemporaneous. These four timbers comprise three of the principal rafters from the rear roof, room 502, and an upper wall plate from the level 1 stairwell. These results in combination suggest that the Surtees House rear roof, and some elements of the timbers associated with the stairwell as far down as level 1, date from *c* AD 1651. These results indicate that the Surtees House rear range is therefore likely to date from around the period when the house was in the hands of the Cock and Davison families (Heslop *et al* 1994, 14).

Level 5 front roof

The front-range roof contains four simple A trusses (see Fig 11). Heslop *et al* (1994, 20) note that the Surtees House front-range roof purlins are embedded in the Milbank House eastern wall, so as to indicate that Milbank House existed to this height by the time Surtees House was raised to this level. This tree-ring analysis indicates that the Milbank House roof dates from *c* AD 1615. Three of the eight samples from this roof were unsuitable for analysis, but four of the suitable five samples from this roof were found to cross-match. However, each is derived from young and fast-grown trees, and the composite sequence amounts to only 75 years. No conclusive dating information was obtained for this sequence.

Maddison House

The single Maddison House sample was derived from building works strengthening this floor to take the EH regional archive. The 106-year sequence from it was found to strongly match the other sequences from Milbank House and Surtees House as well as other sequences obtained from the region.

No sapwood or bark-edge survived on this timber. Making an allowance for minimum likely amounts of missing sapwood provides a *terminus post quem* date for this sample, given in Figure 14 and Table 3.

The interpretation of this sample is straightforward. The sample retains an outermost heartwood ring for AD 1510, with no evidence for sapwood. This suggests this timber was felled after *c* AD 1520.

This timber is essentially indistinguishable in timber character and likely source zone from those utilised in the sixteenth-century phases of Milbank and Surtees Houses, even though it is of a different date. There is thus no tree-ring evidence from this single sample to support the idea that the level 1 part of Maddison House is derived from a building from Staffordshire, which appears to be the case for the timbers in the upper levels (pers comm Martin Roberts). Heslop *et al* (1994, 1, 22) suggest the previous warehouses were dismantled to the ground and reconstructed with other material. The date and likely provenance of this ceiling joist suggests either that some of an earlier local building survived, or alternatively that the timbers used in the 1930s recycled some from this or another local building.

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Figure 1. Location of Bessie Surtees House (circled) in central Newcastle upon Tyne.

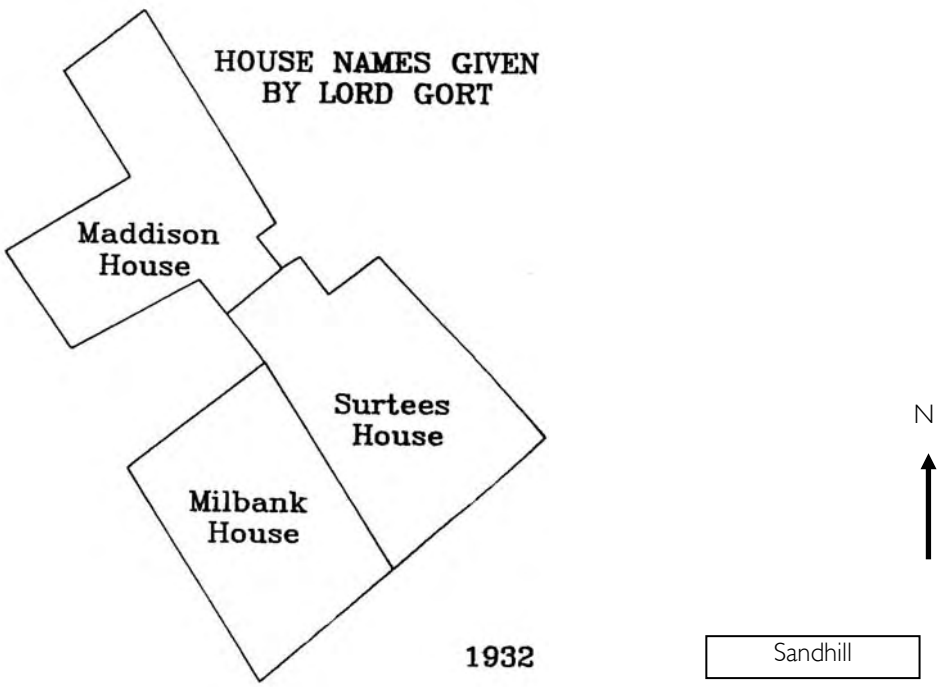

Figure 2. Plan of Bessie Surtees House showing the original division as two separate Merchants Houses fronting onto Sandhill. These have been known since 1932 as Milbank House and Surtees House, with the later block at the back of the property, originally a warehouse, known as Maddison House. Based on Figure 1c of Heslop et al (1994)

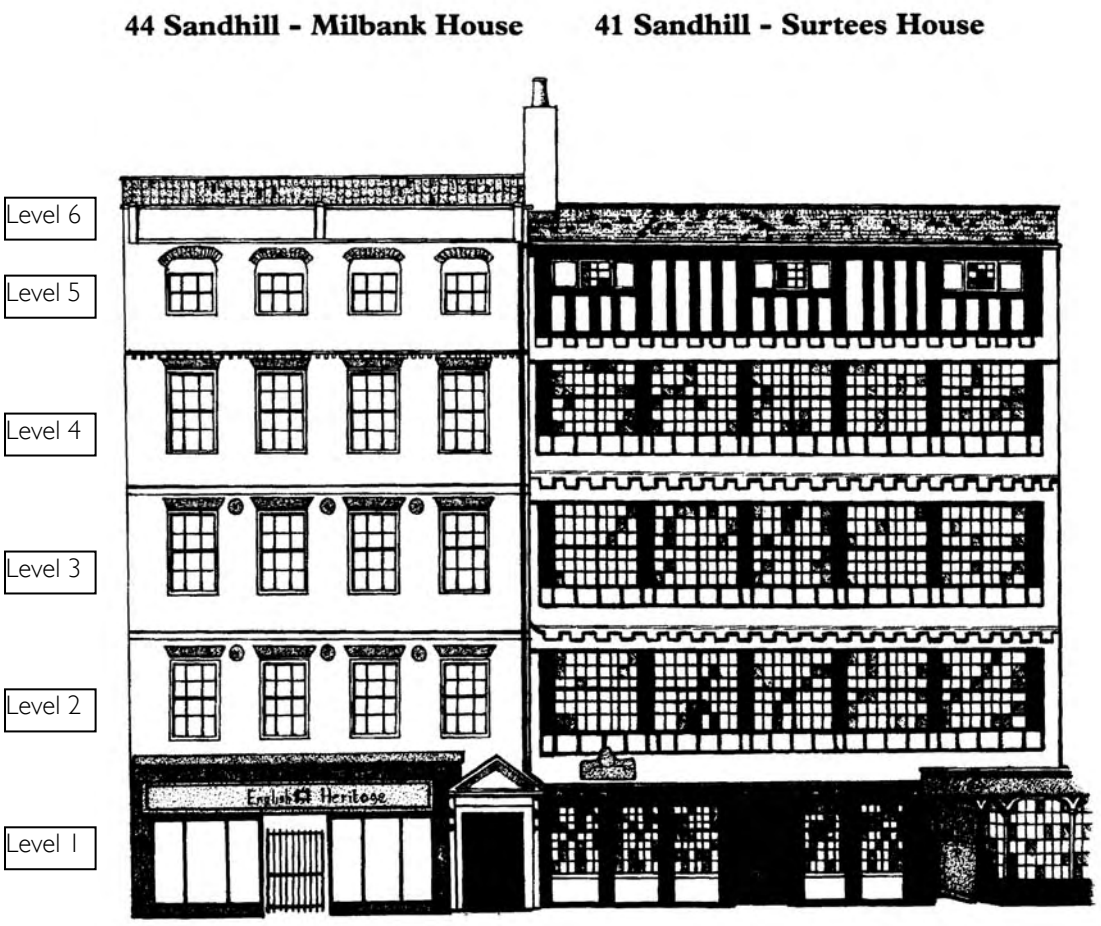

Figure 3. Street frontage of Bessie Surtees House showing the contrasting frontages of Milbank House and Surtees House and also showing Levels 1–6 following the convention of Heslop et al (1994). Based on a figure from English Heritage leaflet 'Bessie Surtees House, Information for Teachers', English Heritage 2000

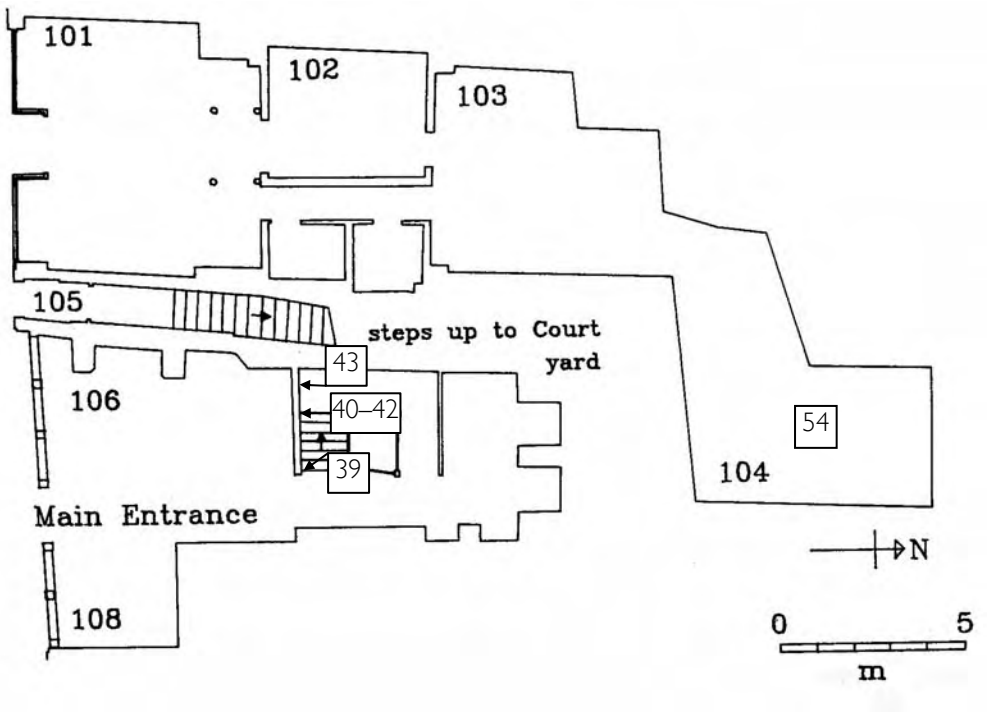

Figure 4. Plan of Level 1 of Bessie Surtees House showing the location of the stairwell, and the approximate location and direction of samples 39–43. The ceiling of room 104 is the origin of the beam removed during strengthening works for the EH regional archive (room 209) referred to as sample 54 in this report. Based on Figure 3 of Heslop et al (1994)

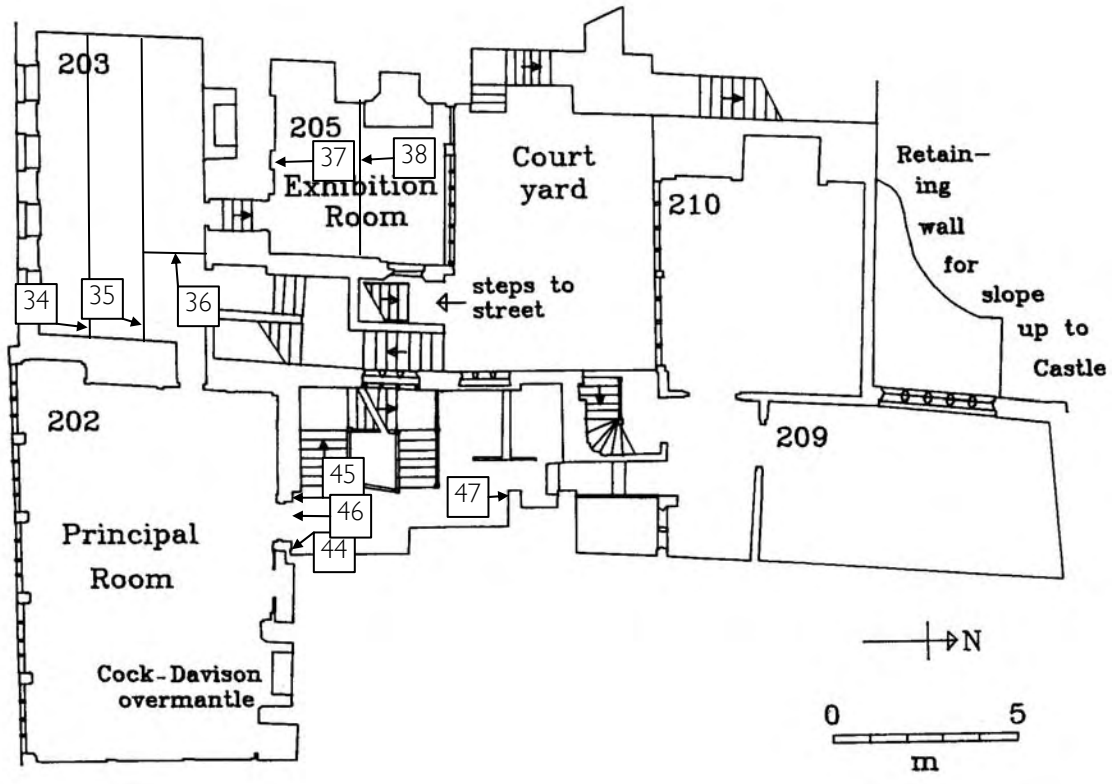

Figure 5. Plan of Level 2 of Bessie Surtees House showing the location of rooms 203, 205 and the lobby in the stairwell, and the approximate location and direction of samples 34–38, and 44–47. Based on Figure 4 of Heslop et al (1994)

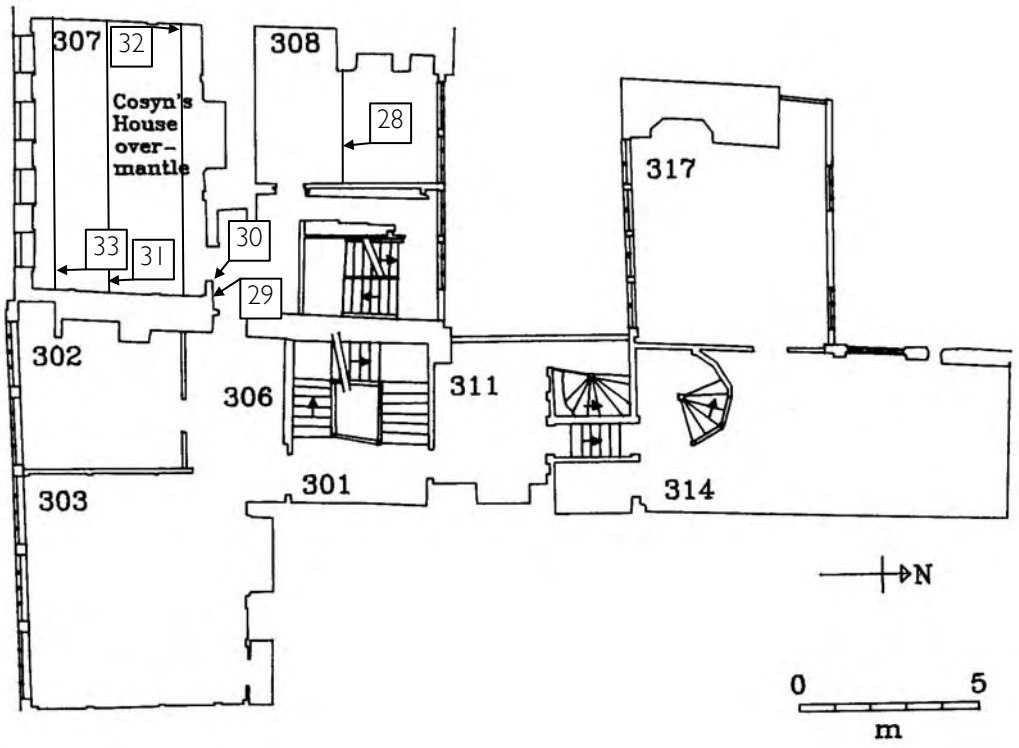

Figure 6. Plan of Level 3 of Bessie Surtees House showing the location of rooms 307, 308, and the unnumbered lobby between them, and the approximate location and direction of samples 28–33. Based on Figure 5 of Heslop et al (1994)

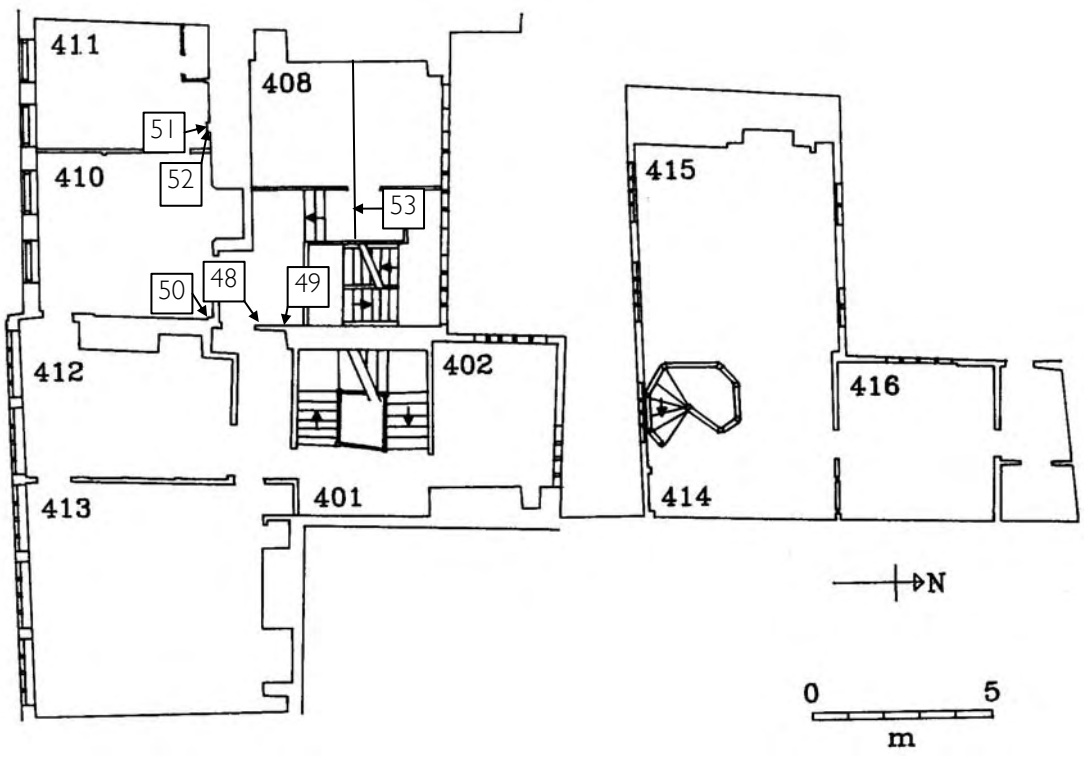

Figure 7. Plan of Level 4 of Bessie Surtees House showing the location of rooms 410, 411 and the unnumbered lobby between 408 and 410, and the approximate location and direction of samples 48–53. Based on Figure 6 of Heslop et al (1994)

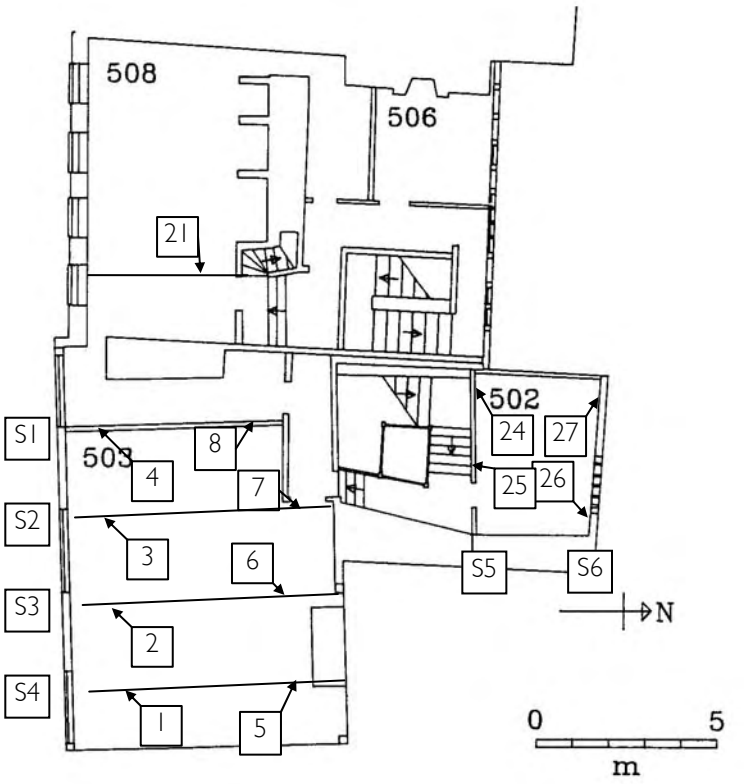

Figure 8. Plan of Level 5 of Bessie Surtees House showing the location of rooms 502, 503, and 508, the truss numbering scheme assigned to the Surtees House roof trusses S1–S6, and the approximate location and direction of samples 1–8, 21, and 24–27. Based on Figure 8 of Heslop et al (1994)

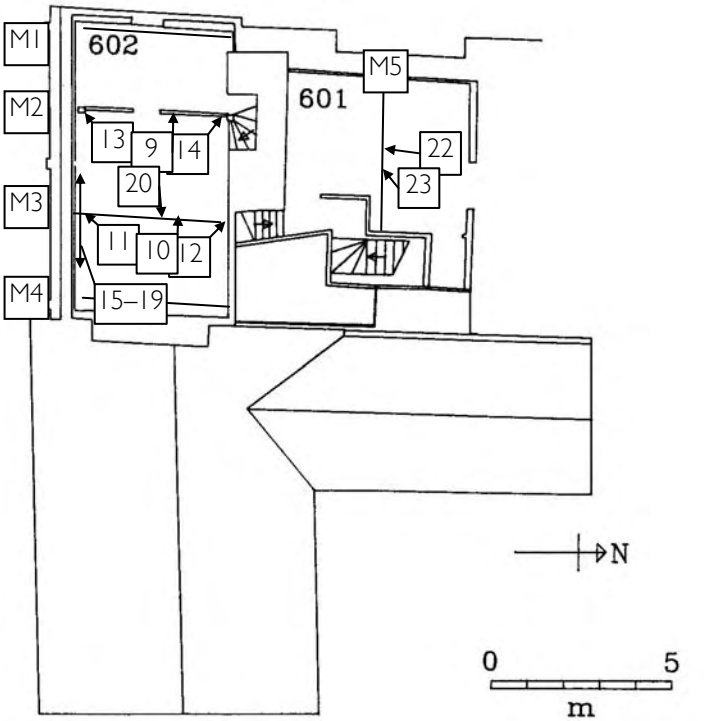

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Figure 9. Plan of Level 6 of Bessie Surtees House showing the location of rooms 601, and 602, the truss numbering scheme assigned to the Milbank House roof trusses M1–M5, and the approximate location and direction of samples 9–20, and 22–23. Based on Figure 9 of Heslop et al (1994)

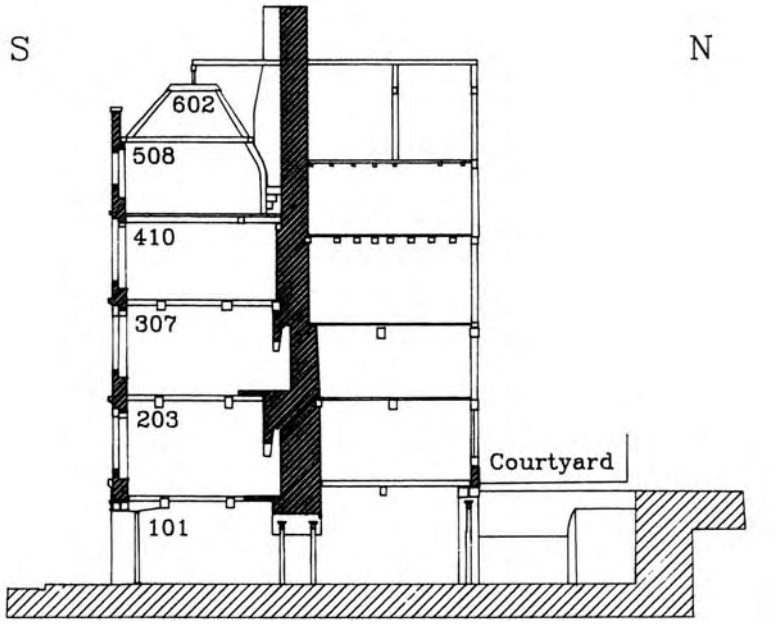

Figure 10. Section of Milbank House at Bessie Surtees House. Based on Figure 10 of Heslop et al (1994)

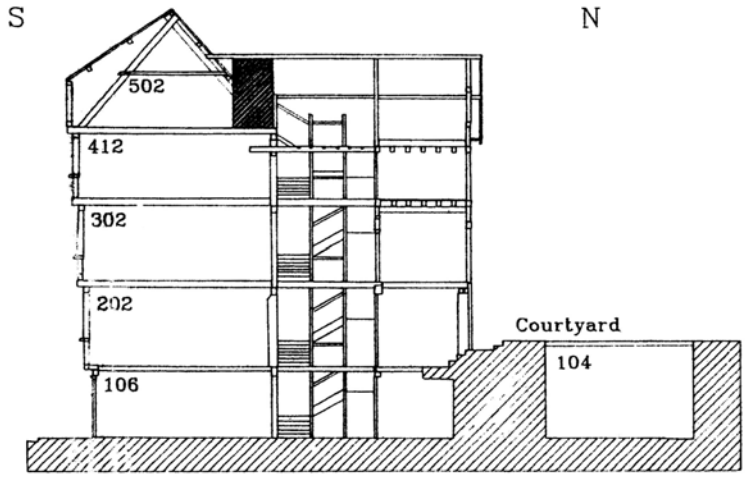

Figure 11. Section of Surtees House at Bessie Surtees House. Based on Figure 12 of Heslop et al (1994)

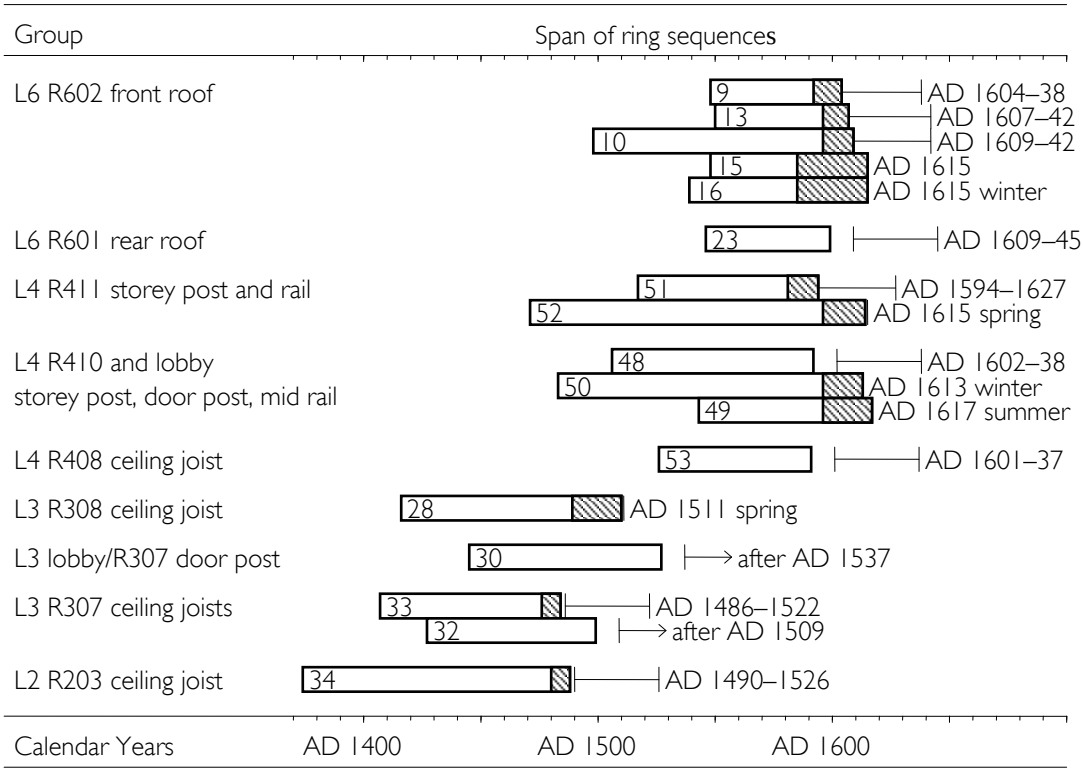

Figure 12. Bar diagram showing the absolute dating positions of the 17 dated tree-ring sequences for samples from Milbank House, Bessie Surtees House. The interpreted felling dates are also shown for each sample

KEY L1–L6 building levels, eg R203, R602 room numbers, following Heslop *et al* (1994), see also Figures 4–9. Horizontal scale the same as for Figures 13 and 14. White bars are oak heartwood, hatched bars are sapwood

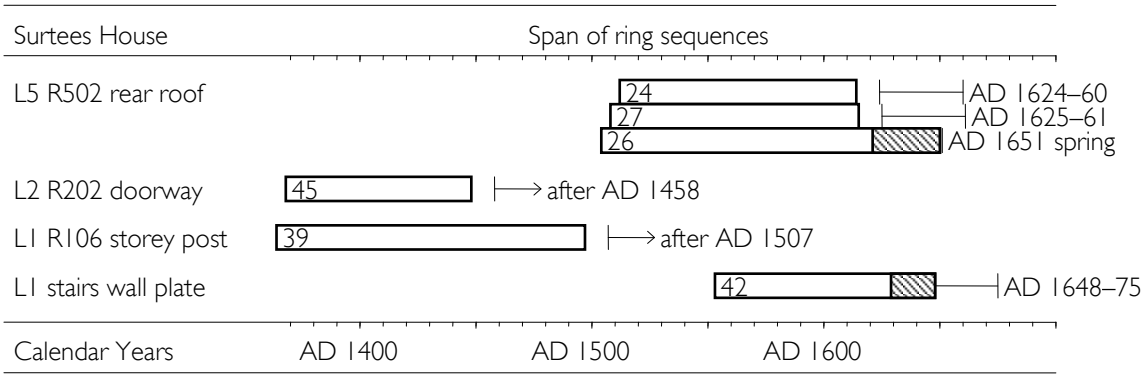

Figure 13. Bar diagram showing the absolute dating positions of the 6 dated tree-ring sequences for samples from Surtees House, Bessie Surtees House. The interpreted felling dates are also shown for each sample

KEY L1–L5 building levels, R202, R502 room numbers, following Heslop *et al* (1994), see also Figures 4–9. Horizontal scale the same as for Figures 12 and 14. White bars are oak heartwood, hatched bars are sapwood

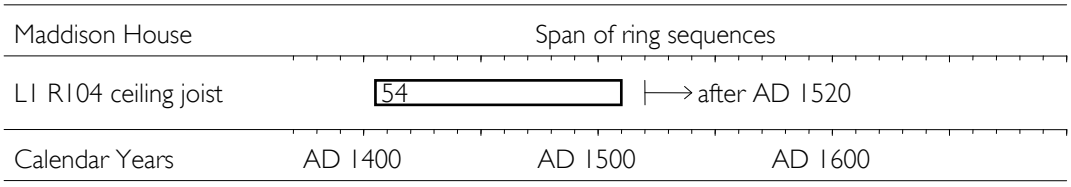

Figure 14. Bar diagram showing the absolute dating position of the dated tree-ring sequence from the single sample from Maddison House, Bessie Surtees House. The interpreted felling date is also shown for the sample

KEY L1 building level, R104 room number, following Heslop *et al* (1994), see also Figure 4. Horizontal scale the same as for Figures 12 and 13. White bar is oak heartwood

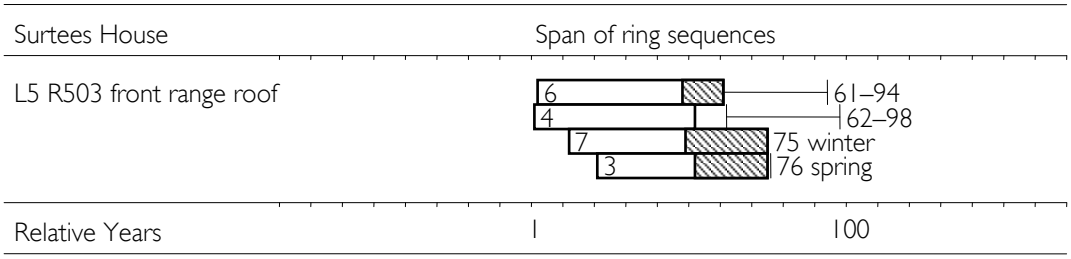

Figure 15. Bar diagram showing the relative dating positions of the 4 matched but undated tree-ring sequences from Surtees House, Bessie Surtees House. A relative interpreted felling date is also shown for each sample, although this assumes a British sapwood estimate is appropriate

KEY L5 building level, R503 room number, following Heslop *et al* (1994), see also Figure 8. White bars are oak heartwood, hatched bars are sapwood, the horizontal scale is arbitrary relative years

Table 1. Details of the 32 samples from timbers from Milbank House.

Sample	Location	Rings	Sap	Date of measured sequence	Interpreted result
9	L6 R602 M2 yoke	57	12	AD 1548–AD 1604	AD 1604–38
10	L6 R602 M3 yoke	112	13	AD 1498–AD 1609	AD 1609–42
11	L6 R602 M3 S principal	51	18	not dated	-
12	L6 R602 M3 N principal	58	18+Bs	not dated	-
13	L6 R602 M2 S principal	58	11	AD 1550–AD 1607	AD 1607–42
14	L6 R602 M2 N principal	-	-	not measured	-
15	L6 R602 M3–4 S rafter	68	30+B	AD 1548–AD 1615	AD 1615
16	L6 R602 M3–4 S rafter	77	30+Bw	AD 1539–AD 1615	AD 1615 winter
17	L6 R602 M2–3 S rafter	58	23+Bw	not dated	-
18	L6 R602 M2–3 S rafter	-	-	not measured	-
19	L6 R602 M2–3 S rafter	58	28+Bs	not dated	-
20	L6 R602 M3 king post	-	-	not measured	-
21	L5 R508 M3 tiebeam	70	3	not dated	-
22	L6 R601 M5 yoke	-	-	not measured	-
23	L6 R601 king post	54	H/S	AD 1546–AD 1599	AD 1609–45
28	L3 R308 ceiling beam	95	21+Bs	AD 1416–AD 1510	AD 1511 spring
29	L3 lobby corner post	-	-	not measured	-
30	L3 lobby door post	83	-	AD 1445–AD 1527	after AD 1537
31	L3 R307 C ceiling joist	-	-	not measured	-
32	L3 R307 N ceiling joist	73	-	AD 1427–AD 1499	after AD 1509
33	L3 R307 S ceiling joist	78	8	AD 1407–AD 1484	AD 1486–1522
34	L2 R203 S ceiling joist	115	8	AD 1374–AD 1488	AD 1490–1526
35	L2 R203 N ceiling joist	79	H/S	not dated	-
36	L2 R203 N trimmer	64	10	not dated	-
37	L2 R205 C ceiling joist	75	14+Bw	not dated	-
38	L2 R205 S ceiling joist	54	14	not dated	-
48	L4 lobby door post	87	H/S	AD 1506–AD 1592	AD 1602–38
49	L4 lobby mid rail	75	21+Bs	AD 1543–AD 1617	AD 1617 summer
50	L4 R410 NE storey post	131	17+Bw	AD 1483–AD 1613	AD 1613 winter
51	L4 R411 NE storey post	78	13	AD 1517–AD 1594	AD 1594–1627
52	L4 R411 NE rail/joist	144	18+Bs	AD 1471–AD 1614	AD 1615 spring
53	L4 R408 ceiling joist	66	H/S	AD 1526–AD 1591	AD 1601–37

KEY For locations see Figures 4–9. Levels L1–6 and room numbers eg R602 follow Heslop *et al* (1994). Truss numbers M1–M5 see Figure 9. N north, S south, E east, W west, C central, H/S is heartwood/sapwood edge, B bark season indistinguishable, Bw bark after complete ring, Bs bark after incomplete additional annual ring.

Table 2. Details of the 21 samples from timbers from Surtees House.

Sample	Location	Rings	Sap	Date of measured sequence	Interpreted result
1	L5 R503 S4 S principal	-	-	not measured	-
2	L5 R503 S3 S principal	-	-	not measured	-
3	L5 R503 S2 S principal	55	23+Bs	not dated*	-
4	L5 R503 S1 S principal	52	H/S	not dated*	-
5	L5 R503 S4 N principal	-	-	not measured	-
6	L5 R503 S3 N principal	60	13	not dated*	-
7	L5 R503 S2 N principal	64	26+Bw	not dated*	-
8	L5 R503 S1 N principal	58	H/S	not dated	-
24	L5 R502 S5 W principal	103	H/S	AD 1512–AD 1614	AD 1624–60
25	L5 R502 S5 collar	61	H/S	not dated	-
26	L5 R502 S6 E principal	147	29+Bs	AD 1504–AD 1650	AD 1651 spring
27	L5 R502 S6 W principal	108	H/S	AD 1508–AD 1615	AD 1625–61
39	L1 R106 storey post	134	-	AD 1364–AD 1497	after AD 1507
40	L1 stairs upper mid rail	98	-	not dated	-
41	L1 stairs upper mid rail	59	8	not dated	-
42	L1 stairs wall plate	96	19	AD 1553–AD 1648	AD 1648–75
43	L1 stairs corner joist	129	11	not dated	-
44	L2 doorway 202 E post	-	-	not measured	-
45	L2 doorway 202 W post	81	-	AD 1368–AD 1448	after AD 1458
46	L2 doorway 202 joist	-	-	not measured	-
47	L2 doorway 209 joist	-	-	not measured	-

KEY For locations see Figures 4–8. Levels L1–5, and room numbers eg R503 follow Heslop *et al* (1994). Truss numbers S1–S6 see Figure 8. N north, S south, E east, W west, H/S is heartwood/sapwood edge, Bw bark after complete ring, Bs bark after incomplete additional annual ring. * these sequences cross-match each other, see Table 15, but are undated.

Table 3. Details of the sample from a timber from Maddison House.

Sample	Location	Rings	Sap	Date of measured sequence	Interpreted result
54	L1 R104 Ceiling joist	106	-	AD 1405–AD 1510	after AD 1520

KEY Level L1, and room number R104 follow Heslop *et al* (1994). For approximate location see Figure 4.

Table 4. The t-values (Baillie and Pilcher 1973) between 5 sampled timbers from Milbank House, Bessie Surtees House. - t-value less than 3.0. See also Tables 5 and 12. These series were combined with material from Surtees House and Maddison House to form the composite sequence Bessie 1 used in Table 13.

	30	32	33	34
28	3.61	4.77	3.93	4.27
30		3.07	-	-
32			-	-
33				5.94

Table 5. Showing example t-values (Baillie and Pilcher 1973) between 5 sampled timbers from Milbank House, Bessie Surtees House. See also Tables 4 and 12. These series were combined with material from Surtees House and Maddison House to form the composite sequence Bessie 1 used in Table 13.

Reference chronology	28	30	32	33	34
Co Durham, Hallgarth Manor Cottages Pittington (Howard *et al* 2001a)	6.64	4.07	5.35	6.21	6.77
Co Durham, Low Harperley Wolsingham (Arnold *et al* 2006)	6.10	5.98	4.78	6.21	7.23
Co Durham, Rock Farm Wheatley Hill (Arnold *et al* 2004d)	6.93	4.19	4.42	5.89	5.68
Gtr Manchester, Salford Ordsall Hall (Arnold *et al* 2004c)	3.93	4.11	3.43	4.40	5.59
Northumberland, Halton Castle near Corbridge (Howard *et al* 2001b)	5.93	4.75	4.54	5.84	7.50
Nottinghamshire etc, regional sequence (Laxton and Litton 1988)	5.03	3.36	3.45	3.86	4.93
Tyne and Wear, Newcastle Rigging Loft (Howard *et al* 2002a)	6.40	5.08	3.96	5.69	5.72
Tyne and Wear, Newcastle White Hart Yard (Arnold *et al* 2005)	6.24	3.20	3.71	6.32	5.79

Table 6. The t-values (Baillie and Pilcher 1973) between 12 sampled timbers from Milbank House, Bessie Surtees House. - t-value less than 3.0. See also Table 7. These series were combined with material from Surtees House to form the composite sequence Bessie 2 used in Table 14.

	10	13	15	16	23	48	49	50	51	52	53
9	3.26	4.11	5.89	5.09	3.56	4.31	3.57	4.68	-	-	6.10
10		3.33	3.56	4.67	5.62	8.12	-	9.39	3.19	-	-
13			4.90	4.83	5.10	5.85	5.07	4.45	5.18	-	3.54
15				7.43	4.36	4.52	6.31	4.95	-	-	-
16					5.19	4.06	-	3.97	3.04	-	-
23						5.03	4.56	4.33	4.98	3.54	5.52
48							3.80	9.33	3.45	-	3.13
49								4.49	3.09	4.07	3.19
50									3.43	3.48	-
51										-	3.52
52											-

Table 7. Showing example t-values (Baillie and Pilcher 1973) between 12 sequences from Milbank House, Bessie Surtees House, and oak reference data. See also Table 6. These series were combined with material from Surtees House to form the composite sequence Bessie 2 used in Table 14.

Reference chronology	9	10	13	15	16	23	48	49	50	51	52	53
Bull Hole Byre Bearpark	-	3.37	4.11	-	3.43	3.85	4.41	4.00	5.65	3.05	5.19	3.60
Fell Close Healyfield	4.44	-	3.27	3.10	3.58	-	3.59	-	4.15	3.76	-	4.88
Finchale Priory Barn	-	4.59	4.78	3.02	-	-	3.63	4.56	5.46	3.94	5.03	-
Hallgarth Manor Pittington	4.82	4.04	6.39	3.84	5.04	5.06	5.66	3.68	5.54	6.90	5.37	5.02
Stockport Market Place	3.49	3.28	-	-	-	-	3.79	-	4.24	-	3.56	3.79
Dilston Castle Corbridge	4.19	3.30	3.91	-	4.40	3.28	5.26	3.38	5.66	5.99	4.77	4.22
East Midlands region	-	3.98	-	-	-	3.24	3.32	-	3.31	3.21	3.35	3.06
Surtees House Newcastle	4.36	3.95	3.15	3.06	3.38	-	5.74	3.62	5.74	-	-	-

Chronology references
Co Durham, Bull Hole Byre Bearpark (Arnold *et al* 2002a)
Co Durham, Fell Close Healyfield (Arnold *et al* 2004a)
Co Durham, Finchale Priory Barn (Arnold *et al* 2002b)
Co Durham, Hallgarth Manor Pittington (Howard *et al* 2001a)
Gtr Manchester, Market Place Stockport (Tyers 1999b)
Northumberland, Dilston Castle Corbridge (Arnold *et al* 2003)
Nottinghamshire etc, regional sequence (Laxton and Litton 1988)
Tyne and Wear, Newcastle Surtees House 2 (this report)

Table 8. The t-values (Baillie and Pilcher 1973) between 4 sampled timbers from Surtees House, Bessie Surtees House. - t-value less than 3.0. See also Table 9. These series were combined with material from Milbank House to form the composite sequence Bessie 2 used in Table 14.

	26	27	42
24	6.71	7.29	4.34
26		7.22	-
27			4.65

Table 9. Showing example t-values (Baillie and Pilcher 1973) between 4 sequences from Surtees House, Bessie Surtees House and oak reference data. See also Table 8. These series were combined with material from Milbank House to form the composite sequence Bessie 2 used in Table 14.

Reference chronology	24	26	27	42
Co Durham, Bull Hole Byre Bearpark (Arnold *et al* 2002a)	4.52	3.23	4.26	3.74
Co Durham, Fell Close Healyfield (Arnold *et al* 2004a)	8.26	3.28	7.82	6.36
Co Durham, Finchale Priory Barn (Arnold *et al* 2002b)	5.33	3.93	5.37	3.70
Co Durham, Hallgarth Manor Pittington (Howard *et al* 2001a)	5.30	3.78	5.11	3.69
Co Durham, Low Harperley Wolsingham (Arnold *et al* 2006)	4.04	4.05	3.81	3.56
Northumberland, Dilston Castle Corbridge (Arnold *et al* 2003)	7.69	4.12	5.57	3.76
Tyne and Wear, Newcastle Milbank House 2 (this report)	5.05	3.88	3.82	3.29
Yorkshire, Finthorpe Barn Huddersfield (Boswijk 1997)	4.91	3.60	3.87	3.04

Table 10. Showing example t-values (Baillie and Pilcher 1973) between the sequences obtained from Surtees House samples 39 and 45 from Bessie Surtees House and oak reference data. See also Table 12. These series were combined with material from Milbank House and Maddison House to form the composite sequence Bessie 1 used in Table 13.

Reference chronology	Surtees House 39	Surtees House 45
Cleveland, Hartlepool Tunstall Hall Farm (Howard *et al* 2002b)	6.41	5.24
Co Durham, Low Harperley Wolsingham (Arnold *et al* 2006)	6.95	4.76
Northumberland, Halton Castle near Corbridge (Howard *et al* 2001b)	5.21	5.33
Northumberland, Moot Hall Market Place Hexham (Arnold *et al* 2004e)	5.76	4.72
Northumberland, Prudhoe Castle Gates Prudhoe (Arnold *et al* 2002d)	5.22	5.68
Nottinghamshire etc, regional sequence (Laxton and Litton 1988)	4.86	6.20
Tyne and Wear, Newcastle Milbank House 1 (this report)	4.80	7.69
Yorkshire, Old Chapel Sinnington (Tyers 2001b)	5.52	5.32

Table 11. Showing example t-values (Baillie and Pilcher 1973) between the sequence from Maddison House sample 54, Bessie Surtees House and oak reference data.

Reference chronology	Maddison House 54
Co Durham, Rock Farm Wheatley Hill (Arnold *et al* 2004d)	6.99
Northumberland Moot Hall Market Place Hexham (Arnold *et al* 2004e)	7.39
Nottinghamshire etc, regional sequence (Laxton and Litton 1988)	7.27
Staffordshire, Black Ladies nr Brewood T32 (Tyers 1999a)	7.80
Tyne and Wear, Newcastle Milbank House 1 (this report)	6.38
Tyne and Wear, Newcastle Rigging Loft (Howard *et al* 2002a)	7.40
Tyne and Wear, Newcastle Surtees House #45 (this report)	7.15
Yorkshire, Sheffield Bishops House (Morgan 1980)	7.14

Table 12. The t-values (Baillie and Pilcher 1973) between the Milbank 1 composite sequence and three individual series from Surtees House and Maddison House, Bessie Surtees House. These were combined to form the composite sequence Bessie 1 used in Table 13.

	39	45	54
Milbank 1	4.80	7.69	6.38
39		4.77	5.59
45			7.15

Table 13. Showing example t-values (Baillie and Pilcher 1973) between the composite sequence Bessie 1 constructed from timbers in Bessie Surtees House and oak reference data.

Reference chronology	Bessie 1 AD 1364–1527
Co Durham, Hunwick Hall Farm Hunwick (Arnold *et al* 2004b)	8.16
Co Durham, Low Harperley Wolsingham (Arnold *et al* 2006)	8.78
Co Durham, Rock Farm Wheatley Hill (Arnold *et al* 2004d)	8.08
Northumberland, Aydon Castle Corbridge (Hillam and Groves 1991)	8.44
Northumberland, Aydon Castle latrine Corbridge (Arnold *et al* 2002e)	7.92
Northumberland, Halton Castle near Corbridge (Howard *et al* 2001b)	8.68
Tyne and Wear, Gateshead Gibside Hall (Arnold *et al* 2002c)	7.97
Tyne and Wear, Newcastle White Hart Yard (Arnold *et al* 2005)	7.77

Table 14. Showing example t-values (Baillie and Pilcher 1973) between the composite sequence Bessie 2 constructed from timbers in Bessie Surtees House and oak reference data.

Reference chronology	Bessie 2 AD 1471–1650
Co Durham, Bull Hole Byre Bearpark (Arnold *et al* 2002a)	8.03
Co Durham, Fell Close Healyfield (Arnold *et al* 2004a)	6.63
Co Durham, Finchale Priory Barn (Arnold *et al* 2002b)	7.15
Co Durham, Hallgarth Manor Cottages Pittington (Howard *et al* 2001a)	8.91
Co Durham, Low Harperley Wolsingham (Arnold *et al* 2006)	7.29
Derbyshire, Kent House Ridgeway (Groves and Hillam 1990)	6.33
Northumberland, Dilston Castle Corbridge (Arnold *et al* 2003)	9.60
Yorkshire, Bradford Headley Hall Barns (Tyers 2001a)	6.80

Table 15. The t-values (Baillie and Pilcher 1973) between 4 sampled timbers from Surtees House, Bessie Surtees House. These were combined to form the undated composite sequence Surtees 3, see also Figure 15.

	4	6	7
3	3.24	3.55	9.37
4		5.98	3.66
6			4.95

APPENDIX 1

bsh3

310	278	423	504	410	428	422	433	441	448
335	275	399	385	383	170	187	219	257	248
207	269	276	240	147	139	212	192	263	193
189	218	154	173	146	118	183	259	181	228
189	186	110	98	83	153	185	178	247	216
189	143	167	228	237					

bsh4

385	275	340	417	383	387	364	423	442	405
356	316	281	379	273	268	253	301	269	273
240	132	174	134	140	210	253	275	350	373
419	409	297	301	253	66	46	45	48	59
66	69	68	94	66	76	101	76	106	113
104	123								

bsh6

343	371	392	324	402	456	361	368	381	295
345	356	337	357	282	290	252	324	280	258
220	281	256	186	297	390	348	325	332	289
377	302	314	391	110	61	65	76	88	58
84	106	119	105	168	115	115	154	128	113
67	60	51	46	67	132	166	103	131	164

bsh7

368	445	381	353	305	258	223	214	289	238
248	289	366	337	366	325	329	280	262	191
213	222	247	291	143	180	227	223	193	148
149	176	176	106	131	141	135	189	156	159
157	145	140	138	141	163	193	137	183	194
168	105	78	77	105	178	177	200	175	139
113	110	129	133						

bsh8

261	203	259	269	228	275	239	289	271	244
242	237	282	273	235	232	235	329	266	300
255	186	204	197	178	215	211	228	237	178
182	168	198	242	242	141	145	99	138	156
222	193	178	215	177	142	122	108	168	136
108	130	112	170	98	122	107	83		

bsh9

284	232	257	305	252	249	211	267	221	273
238	226	186	268	369	329	353	227	330	215
194	282	323	359	247	427	292	296	338	236
206	272	341	220	255	233	284	225	312	231
183	197	183	155	161	283	194	194	153	188
201	203	198	204	178	161	158			

bsh10

157	130	171	102	90	109	173	178	131	167
156	140	121	123	100	103	113	105	113	74
119	99	96	129	135	102	115	98	114	109
99	108	81	103	108	123	71	122	123	120
93	123	142	132	129	103	124	114	106	77
125	124	101	111	91	81	110	143	104	95
109	89	82	87	121	123	113	109	134	106
51	47	60	57	63	88	102	122	102	92
86	104	125	139	105	115	100	136	139	126
132	125	119	93	98	115	150	134	127	168
184	151	145	122	132	153	166	133	227	188
172	141								

bsh11

484	374	422	453	490	465	451	469	452	420
390	264	267	221	246	198	207	234	223	161
193	214	145	222	136	136	149	146	188	167
174	163	143	130	106	97	94	99	91	107
92	98	96	91	121	128	96	102	98	117
112									

bsh12

573	514	643	506	532	488	429	353	254	301
341	422	420	310	336	319	389	284	286	303
217	283	279	199	219	228	194	244	208	148
144	129	123	122	119	137	147	115	130	151
132	143	130	120	173	132	167	119	132	130
124	127	135	130	141	137	138	150		

bsh13

362	481	332	332	384	463	599	471	351	459
362	475	477	363	480	360	418	216	133	146
215	272	229	288	243	254	235	200	193	222
295	249	187	236	190	230	346	319	237	256
209	164	142	159	167	197	199	256	248	249
251	177	102	85	99	134	170	166		

bsh15

182	216	186	188	153	141	117	148	166	187
164	165	155	150	161	150	146	115	161	105
65	97	150	135	128	145	117	121	127	126
128	128	120	100	91	144	135	121	138	116
109	137	131	96	96	130	124	118	105	102
130	136	129	117	115	84	74	84	112	134
137	127	177	103	110	126	73	90		

bsh16

184	207	150	122	126	129	133	139	107	136
151	142	153	140	118	100	109	124	137	161
144	109	152	127	145	112	103	126	82	37
87	106	101	97	100	122	116	120	107	107
111	129	100	88	97	114	100	132	125	106
98	91	61	83	92	101	101	65	96	73
105	103	100	71	77	68	77	98	93	103
111	127	108	117	139	90	96			

bsh17

327	331	277	321	377	388	351	299	175	331
265	258	238	254	283	209	142	127	243	302
247	252	281	225	164	133	189	273	258	209
172	239	272	261	256	205	105	117	147	129
145	204	204	194	134	135	118	136	127	135
96	78	63	44	68	68	110	82		

bsh19

169	231	196	253	254	204	255	293	249	243
251	224	247	226	280	308	194	200	208	202
161	138	173	187	202	185	175	185	173	162
148	162	135	150	189	157	142	183	135	141
94	99	121	163	115	145	162	134	141	114
128	115	179	203	160	186	161	161		

bsh21

173	122	128	110	178	151	140	135	158	146
167	193	178	194	240	197	197	177	201	232
194	204	214	179	194	224	200	165	184	204
194	180	185	210	211	199	198	192	192	154
215	156	120	126	144	166	118	190	154	153
155	177	86	137	176	146	152	152	150	158
196	233	182	135	101	104	127	128	156	142

bsh23

249	257	301	349	350	356	225	202	235	196
166	131	177	241	239	382	359	292	269	233
234	223	115	141	232	249	201	230	231	192
183	178	152	156	192	158	141	177	201	210
224	194	173	163	185	130	124	167	171	197
138	172	165	146						

bsh24

168	181	187	208	166	150	170	148	128	138
158	107	150	147	201	157	138	141	111	117
66	108	74	135	152	164	101	161	157	141
151	133	160	142	124	74	120	104	138	176
147	142	109	166	169	154	119	149	134	149
169	141	154	103	89	37	74	84	112	124
96	122	127	100	97	65	76	116	89	93
79	85	89	79	115	97	83	71	46	42
40	63	71	71	55	53	47	55	41	55
44	55	75	61	77	85	93	71	70	70
66	64	69							

bsh25

81	55	103	111	105	93	67	92	83	86
86	74	69	71	92	95	82	75	150	146
140	139	118	87	115	191	172	146	121	68
113	118	150	201	228	140	158	251	215	162
130	89	149	109	109	140	166	144	120	100
109	144	155	141	122	124	109	100	157	115
94									

bsh26

178	156	169	220	181	173	150	143	113	133
145	149	136	109	126	91	87	103	100	88
85	105	113	107	89	109	78	95	66	78
51	112	88	89	85	92	81	97	83	85
83	76	77	48	68	69	100	99	95	84
77	97	101	105	79	101	99	93	101	88
94	82	59	49	47	54	71	62	66	71
58	59	39	36	31	49	41	45	37	39
47	39	49	36	34	36	34	31	28	30
30	37	30	29	24	23	25	29	27	23
27	33	38	36	42	40	46	34	37	40
41	40	34	28	25	27	36	37	35	38
25	24	17	15	23	29	34	39	36	33
23	23	27	34	44	43	44	46	49	50
41	37	53	58	49	55	56			

bsh27

292	270	228	168	165	151	154	162	128	120
148	167	138	117	119	92	104	119	127	127
121	142	101	119	70	73	77	112	114	119
97	127	130	142	116	123	126	103	104	73
97	116	111	206	124	142	103	121	148	161
94	119	118	145	144	122	125	123	74	59
78	103	129	96	97	109	82	87	65	57
65	69	76	60	51	65	75	62	81	64
66	70	57	42	42	41	54	58	40	52
49	42	51	47	45	54	65	67	62	64
83	65	77	49	63	69	64	73		

bsh28

299	349	364	252	210	223	178	266	256	232
209	205	201	286	196	167	248	246	266	260
214	274	202	247	285	284	235	168	234	204
145	207	194	214	180	210	229	184	180	128
187	263	139	127	170	144	153	151	154	175
185	186	252	201	240	235	212	189	145	248
312	248	200	193	143	191	170	196	167	150
221	270	212	187	208	121	136	110	123	146
168	178	110	144	134	96	144	117	109	148
119	101	131	125	143					

bsh30

275	212	244	316	319	265	355	360	250	388
257	311	254	167	191	191	184	203	129	131
94	112	115	111	72	113	126	86	109	45
102	105	111	117	89	119	64	44	92	106
85	84	119	79	124	102	53	51	44	65
101	79	74	42	71	66	40	52	68	117
118	88	103	93	94	106	108	75	73	80
78	80	42	71	76	75	90	86	75	71
89	89	107							

bsh32

140	131	124	103	109	103	125	156	171	154
170	198	197	253	263	236	276	284	294	241
276	298	274	292	328	320	391	411	344	416
441	352	286	264	260	290	272	246	258	310
231	304	219	270	272	197	208	196	196	218
188	183	184	152	156	123	166	126	120	132
188	117	125	110	75	95	93	85	89	100
81	100	97							

bsh33

206	191	252	177	187	176	160	152	171	169
166	174	135	171	133	131	138	143	155	160
182	218	307	172	201	217	153	214	179	168
143	173	128	167	171	115	149	129	117	93
119	110	119	111	120	108	135	116	124	183
153	117	123	143	144	125	119	122	123	104
150	149	114	114	136	79	106	85	145	151
186	126	142	100	85	141	126	137		

bsh34

263	171	270	248	250	236	237	244	279	309
300	220	260	316	296	262	246	319	242	288
249	267	305	277	291	257	263	240	275	331
300	272	295	266	287	235	265	274	226	221
244	244	223	255	242	191	273	241	255	249
226	266	220	233	302	322	216	215	251	197
240	182	184	165	163	116	132	185	152	207
216	172	144	154	159	163	181	166	182	173
137	117	151	145	117	110	113	114	114	118
104	103	99	130	119	92	110	112	93	92
79	98	114	107	110	100	103	136	123	109
109	96	102	128	131					

bsh35

202	195	251	309	347	423	415	533	462	390
299	389	382	329	370	288	313	250	273	263
268	214	287	311	280	285	299	328	242	186
162	191	259	215	314	331	278	229	305	303
291	237	265	387	264	316	281	325	267	260
276	253	203	269	252	199	214	282	390	307
289	338	251	242	238	244	353	311	458	341
327	306	347	329	281	278	245	341	397	

bsh36

214	230	125	141	120	131	114	99	113	85
99	126	84	94	89	99	87	95	109	123
115	170	161	141	143	102	139	166	107	103
109	120	144	137	169	135	112	153	99	63
56	93	95	102	117	155	122	133	118	142
167	163	132	99	135	118	118	160	187	116
131	107	71	88						

bsh37

358	254	246	254	303	255	201	230	226	183
227	234	237	192	176	162	181	184	161	166
161	174	162	140	153	153	117	153	167	177
211	244	194	193	199	195	244	293	291	289
304	244	284	283	302	297	325	289	278	316
327	297	274	278	250	242	185	222	250	322
272	227	259	231	223	138	116	210	200	221
193	249	254	233	197					

bsh38

214	198	291	252	188	213	220	201	195	264
209	237	238	180	171	221	208	225	217	198
161	182	329	252	196	219	234	179	217	155
210	223	167	240	243	266	219	261	243	286
209	192	307	235	237	184	173	165	164	166
249	195	205	231						

bsh39

174	191	112	110	74	68	57	108	151	204
199	133	64	80	83	89	79	77	106	104
121	65	99	121	98	70	104	84	104	130
116	71	116	84	84	99	115	77	72	91
77	78	69	85	91	91	81	63	67	72
77	73	49	67	67	49	79	92	70	87
89	74	65	39	63	87	54	75	65	68
69	88	75	68	77	66	74	96	77	82
107	68	54	40	58	78	78	97	135	94
101	93	80	101	85	95	83	79	75	78
109	94	82	102	112	77	91	120	64	55
64	62	77	49	34	37	37	34	29	25
33	41	49	62	53	41	49	37	39	36
50	49	53	68						

bsh40

270	387	409	266	208	161	275	204	175	219
184	186	278	52	44	60	70	82	72	67
79	65	107	106	109	121	128	127	136	130
134	140	144	114	131	152	119	121	130	98
103	105	140	89	78	84	97	95	74	95
66	64	55	50	54	60	40	38	47	52
58	53	47	39	51	41	40	49	68	53
65	57	60	51	48	41	57	46	50	44
41	26	46	50	64	57	68	62	76	61
64	79	70	78	69	86	100	90		

bsh41

182	166	185	156	138	202	200	196	225	167
181	171	189	251	339	290	316	258	283	263
242	221	168	235	160	138	142	182	196	175
172	186	178	138	107	108	155	145	120	111
138	164	139	187	177	118	146	142	114	116
194	172	155	134	176	170	146	170	195	

bsh42

286	192	265	284	223	206	253	209	233	202
243	202	118	105	96	111	157	212	147	129
172	82	46	40	40	61	101	103	91	65
85	119	104	125	118	78	103	84	54	74
107	124	119	58	106	99	76	60	85	67
110	122	87	91	116	116	109	104	86	109
92	112	135	128	114	176	139	134	110	117
121	120	75	79	105	114	168	142	109	115
112	89	49	42	53	75	67	100	109	109
104	80	112	134	107	98				

bsh43

169	345	211	213	147	118	162	187	126	75
87	79	64	116	134	102	94	57	52	78
89	152	69	70	112	73	69	62	67	57
79	73	86	80	74	74	85	78	89	98
96	86	56	64	91	90	61	56	78	58
47	55	46	52	52	64	57	78	68	48
47	64	59	50	38	42	36	42	42	29
33	36	29	42	53	51	58	58	46	46
41	43	48	37	38	28	25	26	28	42
40	51	56	43	44	49	48	48	54	48
52	58	59	64	66	64	64	64	66	76
59	65	63	71	66	59	58	66	49	71
87	56	86	81	77	50	67	79	112	

bsh45

226	265	174	173	271	235	222	202	260	199
269	243	199	224	193	221	230	161	187	210
182	151	177	249	164	142	156	157	174	164
185	150	225	160	140	223	133	137	115	116
138	196	150	171	141	165	112	121	91	102
86	56	88	100	94	131	132	91	89	85
107	152	94	85	132	96	90	70	72	61
77	73	94	109	77	76	92	72	60	70
73									

bsh48

254	309	258	277	201	224	159	134	178	164
178	84	171	140	167	179	140	143	179	150
171	133	84	100	86	92	103	96	81	129
145	120	113	149	163	115	130	99	141	128
120	87	150	153	178	155	92	100	95	133
145	102	109	114	136	143	187	163	152	126
135	83	68	82	126	120	106	172	176	178
185	175	165	214	239	214	174	159	163	169
188	172	182	207	196	149	143			

bsh49

387	451	469	435	412	340	455	505	456	307
306	200	232	236	199	175	209	228	254	258
215	229	216	262	194	171	145	248	304	274
349	262	240	204	155	145	194	141	109	80
142	162	207	246	223	151	204	263	208	157
232	226	227	177	168	169	190	198	141	142
107	106	97	108	120	124	122	147	122	108
134	102	121	150	74					

bsh50

333	333	355	326	322	211	245	263	215	225
184	169	235	244	211	232	263	304	232	111
110	210	262	165	186	178	203	190	189	157
155	152	147	181	121	214	125	162	236	208
153	206	203	231	143	174	184	139	125	163
183	127	167	222	202	167	239	234	199	206
139	153	153	127	91	160	147	193	196	137
121	106	181	195	131	105	133	146	156	209
163	142	122	153	104	78	68	103	108	105
219	282	276	253	204	160	193	208	180	170
167	218	191	274	241	230	220	187	126	179
238	266	264	198	195	237	229	232	196	164
143	131	100	146	200	178	160	225	206	167
209									

bsh51

428	503	519	467	395	316	293	270	237	230
200	299	251	382	264	247	248	303	279	303
199	217	340	367	295	187	183	190	196	244
187	220	183	146	204	163	130	182	186	246
117	153	266	193	207	145	130	206	220	243
173	92	94	146	186	132	163	159	225	148
114	96	168	264	184	182	149	209	217	252
137	150	109	131	94	110	163	238		

bsh52

344	359	215	303	331	309	298	218	163	116
144	120	119	150	187	209	280	219	175	178
124	172	193	155	127	155	149	88	145	133
132	99	73	133	158	149	97	129	166	138
131	106	188	113	127	95	94	107	91	68
58	42	41	62	56	83	79	77	73	79
99	94	78	100	94	88	125	207	205	213
179	143	130	111	131	137	109	142	206	264
291	182	159	155	143	137	106	97	107	85
96	122	120	104	89	95	77	71	63	78
89	85	99	109	124	106	79	107	103	101
97	85	96	123	118	116	115	91	104	101
91	94	114	110	125	128	120	110	142	133
117	105	130	133	119	162	147	147	176	130
125	149	145	121						

bsh53

534	437	404	376	413	321	304	342	312	418
267	298	293	404	432	330	262	337	514	502
322	650	381	350	364	425	246	225	209	257
187	199	222	260	222	307	320	315	315	274
313	243	226	260	358	321	276	335	392	255
284	189	169	206	275	160	158	175	241	265
292	236	194	179	196	143				

bsh54

176	218	174	160	161	152	147	143	149	138
138	116	134	144	96	151	145	143	183	184
145	116	114	170	176	136	132	196	132	122
134	104	100	112	97	96	104	73	96	111
128	100	88	100	98	98	118	114	113	109
82	101	92	83	87	82	82	85	100	97
98	88	146	177	160	168	152	139	116	92
121	164	164	162	174	128	186	143	127	129
123	162	163	136	108	118	118	98	93	87
93	106	93	88	101	118	81	102	83	90
107	123	92	102	113	80				






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The Research Department provides English Heritage with this capacity in the fields of buildings history, archaeology, and landscape history. It brings together seven teams with complementary investigative and analytical skills to provide integrated research expertise across the range of the historic environment. These are:

* *Aerial Survey and Investigation*
* *Archaeological Projects (excavation)*
* *Archaeological Science*
* *Archaeological Survey and Investigation (landscape analysis)*
* *Architectural Investigation*
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* *Survey of London*

The Research Department undertakes a wide range of investigative and analytical projects, and provides quality assurance and management support for externally-commissioned research. We aim for innovative work of the highest quality which will set agendas and standards for the historic environment sector. In support of this, and to build capacity and promote best practice in the sector, we also publish guidance and provide advice and training. We support outreach and education activities and build these in to our projects and programmes wherever possible.

We make the results of our work available through the Research Department Report Series, and through journal publications and monographs. Our publication Research News, which appears three times a year, aims to keep our partners within and outside English Heritage up-to-date with our projects and activities. A full list of Research Department Reports, with abstracts and information on how to obtain copies, may be found on www.english-heritage.org.uk/researchreports

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