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THE BELLFRAME
CHURCH OF HOLY TRINITY
RATCLIFFE-ON-SOAR
NOTTINGHAMSHIRE

SURVEY, RECORDING AND
TREE-RING ANALYSIS OF TIMBERS

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NGR: SK 49476 28911
SEPTEMBER 2015

THE CHURCH OF ENGLAND
Diocese of Southwell & Nottingham

heritage lottery fund
LOTTERY FUNDED

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SURVEY, RECORDING, AND TREE-RING ANALYSIS OF TIMBERS FROM THE BELLFRAME OF THE CHURCH OF HOLY TRINITY, RATCLIFFE-ON-SOAR, NOTTINGHAMSHIRE

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SUMMARY

Dendrochronological analysis undertaken on samples taken from timbers of the bellframe at this church resulted in the construction of a single site sequence.

Site sequence NBFHSQ01, contains ten samples and spans the period AD 1357–1477.

Interpretation of the sapwood suggests felling of all samples occurred in AD 1478–1501.

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INTRODUCTION

The Church of Holy Trinity is located in the village of Ratcliffe-on-Soar, Nottinghamshire (Figs 1 & 2). There has been a church at Ratcliffe since at least AD 1086 when one is mentioned in Domesday. However, the present church is thought to date from the late-twelfth century with the chancel dating to *c* AD 1160. The tower and nave were added *c* AD 1220 with the nave aisles and spire *c* AD 1290. The south aisle was rebuilt and the porch added *c* AD 1320 with the north aisle altered later in the fourteenth century. In the first half of the nineteenth century the church, originally dedicated to St Mary, was re-dedicated to The Holy Trinity. Major restoration work was undertaken by AD 1886 (http://southwellchurches.nottingham.ac.uk/ratcliffe/hintro.php).

The Bell frame

This was originally a short headed frame with queen posts for three bells, (Pickford Group 3.E) and transoms. At a later date the two heads of the centre pit trusses were removed and long heads substituted which extend into the tower walls (Figs 3 & 4). This seems to have been an attempt to stabilise the frame and was possibly done when the treble bell was recast in AD 1788.

The frame shows the usual characteristics of a short headed frame, has stabilising transoms part of the way up the braces on each truss, and there is evidence, in the form of cut-outs on the braces, of transom braces.

The Bells

1(i). * G.HEDDERLY FECIT NOTTM * IOHN CHAMBERLAIN C WARDEN

(ii). :TO HONOUR OF BOTH GOD & KING:OUR VOICES SHAL IN CONSORT RING

(iii). [46]

(iv). 1788

2(i). [+43] LAVD [+133] AND [+133] PRAYS [+133] TO [+133]GOD [+133] I [+133] SYNG [+133] AND [+133] SEND [+133] THEME [+133] HEVEN [+133] THAT [+133] HERYTH [+133] ME [+133] RENG [+133] MHSC

(ii). Line of 134 [40]

3. IHS [134] BE [134] MI [134] SPED [134] MHS [40] [134]

Badge numbers are taken from the Church Bells of Nottinghamshire.

The bells are now hung dead; this was undertaken by Taylors in 1939 at a cost of £79. All bells now hang in the centre pit of the old wooden frame, whereas formerly each bell hung in a separate pit.

The treble, as it indicates, is the work of George Hedderly of Nottingham. The second and tenor both have the badge used by Henry 1 Oldfield and the lettering is the small Gothic capitals set but the lion word stop is that seen on bells cast at Leicester. Thus these bells could possibly be a joint production by Henry Oldfield and William or Francis Watts in the 1580's. The inscription on the second would appear to be unique. The meaning of the letters MHSC on the second and MHS on the tenor is not known.

Physical data:

	Diameter	Weight (Cwt.Qr.Lb)	Note
Treble.	25.5"	3.3.5	Eb+36 cents 1271 Hz
2.	29"	4.1.0	C+44 cents 1074 Hz
Tenor.	30"	4.3.4	B+42 cents 1012 Hz

The bells are not well in tune with each other, approximating to the front three of a ring of five bells in a major key, with the treble a whole semi-tone sharp.

PRINCIPLES OF TREE-RING DATING

Tree-ring dating relies on a few simple, but fundamental, principles. Firstly, as is commonly known, trees (particularly oak trees) grow by adding one, and only one, growth-ring to their circumference each, and every, year. Each new annual growth-ring is added to the outside of the previous year's growth just below the bark. The width of this annual growth-ring is largely, though not exclusively, determined by the weather conditions during the growth period (roughly March to September). In general, good conditions produce

wider rings and poor conditions produce narrower rings. Thus, over the lifetime of a tree, the annual growth-rings display a climatically determined pattern. Furthermore, and importantly, all trees growing in the same area at the same time will be influenced by the same growing conditions and the annual growth-rings of all of them will respond in a similar, though not identical, way.

Secondly, because the weather over any number of consecutive years is unique, so too is the growth pattern of the tree. The pattern of a short period of growth, 20 or 30 consecutive years, might conceivably be repeated two or even three times in the last one thousand years. A short pattern might also be repeated at different time periods in different parts of the country because of differences in regional micro-climates. It is less likely, however, that such problems would occur with the pattern of a longer period of growth, that is, anything in excess of 60 years or so. In essence, a short period of growth, anything less than 50 rings, is not reliable, and the longer the period of time under comparison the better.

The third principal of tree-ring dating is that, until the early-to mid-nineteenth century, builders of timber-framed houses usually obtained all the wood needed for a given structure by felling the necessary trees in a single operation from one patch of woodland or from closely adjacent woods. Furthermore, and contrary to popular belief, the timber was used "green" and without seasoning, and there was very little long-term storage as in timber-yards of today. This fact has been well established from a number of studies where tree-ring dating has been undertaken in conjunction with documentary studies. Thus, establishing the felling date for a group of timbers gives a very precise indication of the date of their use in a building.

Tree-ring dating relies on obtaining the growth pattern of trees from sample timbers of unknown date by measuring the width of the annual growth-rings. This is done to a tolerance of 1/100 of a millimetre. The growth patterns of these samples of unknown date are then compared with a series of reference patterns or chronologies, the date of each ring of which is known. When a sample "cross-matches" repeatedly at the same date against a series of different relevant reference chronologies the sample can be said to be dated. The degree of cross-matching, that is the measure of similarity between sample and reference is denoted by a "t-value"; the higher the value the greater the similarity. The greater the similarity the greater is the probability that the patterns of the samples and references have been produced by growing under the same conditions at the same time. The statistically accepted fully reliable minimum t-value is 3.5.

However, rather than attempt to date each sample individually it is usual to first compare all the samples from a single building, or phases of a building, with one another, and attempt to cross-match each one with all the others from the same phase or building. When samples from the same phase do cross-match with each other they are combined at their matching positions to form what is known as a "site chronology". As with any set of data, this has the effect of reducing the anomalies of any one individual (brought about in the case of tree-rings by some non-climatic influence) and enhances the overall climatic signal. As stated above, it is the climate that gives the growth pattern its distinctive pattern. The greater the number of samples in a site chronology the greater is the climatic signal of the group and the weaker is the non-climatic input of any one individual.

Furthermore, combining samples in this way to make a site chronology usually has the effect of increasing the time-span that is under comparison. As also mentioned above, the longer the period of growth under consideration, the greater the certainty of the cross-match. Any site chronology with less than about 55 rings is generally too short for satisfactory analysis.

SAMPLING STRATEGY

A total of ten timbers were sampled with each sample being given the code NBF-H and numbered 01–10. The location of all samples was noted at the time of sampling and has been marked on Figures 5–8. Further details relating to the samples can be found in Table 1.

ANALYSIS & RESULTS

All ten samples were prepared by sanding and polishing and their growth ring widths measured. These measurements were then compared with each other by usual laboratory procedures where all ten samples matched each other.

All ten samples were then combined at the relevant offset position to form NBFHSQ01, a site sequence of 121 rings (Fig 9). This site sequence was then compared against a series of relevant reference chronologies for oak where it was found to match consistently and securely at a first-ring date of AD 1357 and a last-measured ring date of AD 1477. The evidence for this dating is given by the *t*-values in Table 2.

INTERPRETATION

All ten samples taken from this bellframe have been successfully dated. Seven of these have the heartwood/sapwood boundary ring which, although showing a variation of 21

years can still be said to be broadly contemporary and likely to suggest a single felling. The average heartwood/sapwood boundary ring date of these samples is AD 1461, allowing an estimated felling date to be calculated for the seven timbers to within the range AD 1478–1501. This range makes allowance for sample NBF-H01 having a last-measured ring date of AD 1477 with incomplete sapwood.

The remaining three dated samples do not have the heartwood/sapwood boundary ring date and so estimated felling dates cannot be calculated for them. However, with last-measured ring dates of 1441 (NBF-H09), 1451 (NBF-H06), and 1462 (NBF-H03) it is possible that these timbers were also felled in AD 1478–1501. Additionally, one of these samples (NBF-H03) matches sample NBF-H01 at the value of t=19.7, high enough to say that the two beams represented were almost certainly cut from the same tree and therefore have the same felling.

DISCUSSION

Short headed bellframes are generally thought of belong to the fourteenth, fifteenth, and early-sixteenth centuries. With the timbers associated with the primary construction of this frame now being known to have been felled in AD 1478–1501 it is likely that this bellframe belongs to the final quarter of the fifteenth century or possibly the first years of the sixteenth century.

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ACKNOWLEDGEMENTS

The Laboratory and George Dawson would like to thank Ray State for facilitating access and, along with John Allen, Professor John Beckett, and Dr Chris Brooke, for the information on the Southwell and Nottingham Church History website. Thanks are also given to Dr Chris Brooke for his comments on early drafts of this report and for providing the photograph on the front page. The research was undertaken as part of the Southwell and Nottingham Church History Project and this element was joint funded by The Heritage Lottery Fund and Nottinghamshire County Council.

Table 1: Details of samples taken from the bellframe at the Church of Holy Trinity, Ratcliffe-on-Soar, Nottinghamshire

Sample number	Sample location	Total rings	*Sapwood rings	First measured ring date (AD)	Last heartwood ring date (AD)	Last measured ring date (AD)
NBF-H01	Headstock, truss A	73	04	1405	1473	1477
NBF-H02	West post, truss A	66	12	1404	1457	1469
NBF-H03	Bottom cill, truss B	65	--	1398	----	1462
NBF-H04	East post, truss B	61	h/s	1392	1452	1452
NBF-H05	West post, truss B	65	12	1404	1456	1468
NBF-H06	East post, truss C	54	--	1398	----	1451
NBF-H07	West post, truss C	64	h/s	1393	1456	1456
NBF-H08	Headstock, truss D	76	h/s	1389	1464	1464
NBF-H09	Bottom cill, truss D	85	--	1357	----	1441
NBF-H10	East post, truss D	63	h/s	1407	1469	1469

**h/s = the heartwood/sapwood boundary ring is the last-measured ring on the sample

Table 2: Results of the cross-matching of site sequence NBFHSQ01 and relevant reference chronologies when the first-measured ring date is 1357 and the last-measured ring date is 1477

Reference chronology	t-value	Span of chronology	Reference
Stoneleigh Abbey, Stoneleigh, Warwickshire	7.8	AD 1398–1658	Howard *et al* 2000
Thatched Cottage, Hill Wootton, Warwickshire	6.3	AD 1392–1469	Alcock *et al* 1989
Durham Cathedral (choir roof), Durham,	5.7	AD 1346–1458	Howard *et al* 1992
Crook Hall, Sidegate, Durham	5.6	AD 1354–1467	Howard *et al* 1992
27 High Street, Lymington, Hampshire	5.6	AD 1378–1460	Esling *et al* 1990
Hitchins Onset, Scaleby, Cumbria	5.5	AD 1364–1491	Howard *et al* 1997
Wakelyn Old Hall, Hilton, Derbyshire	5.4	AD 1415–1573	Arnold *et al* 2008

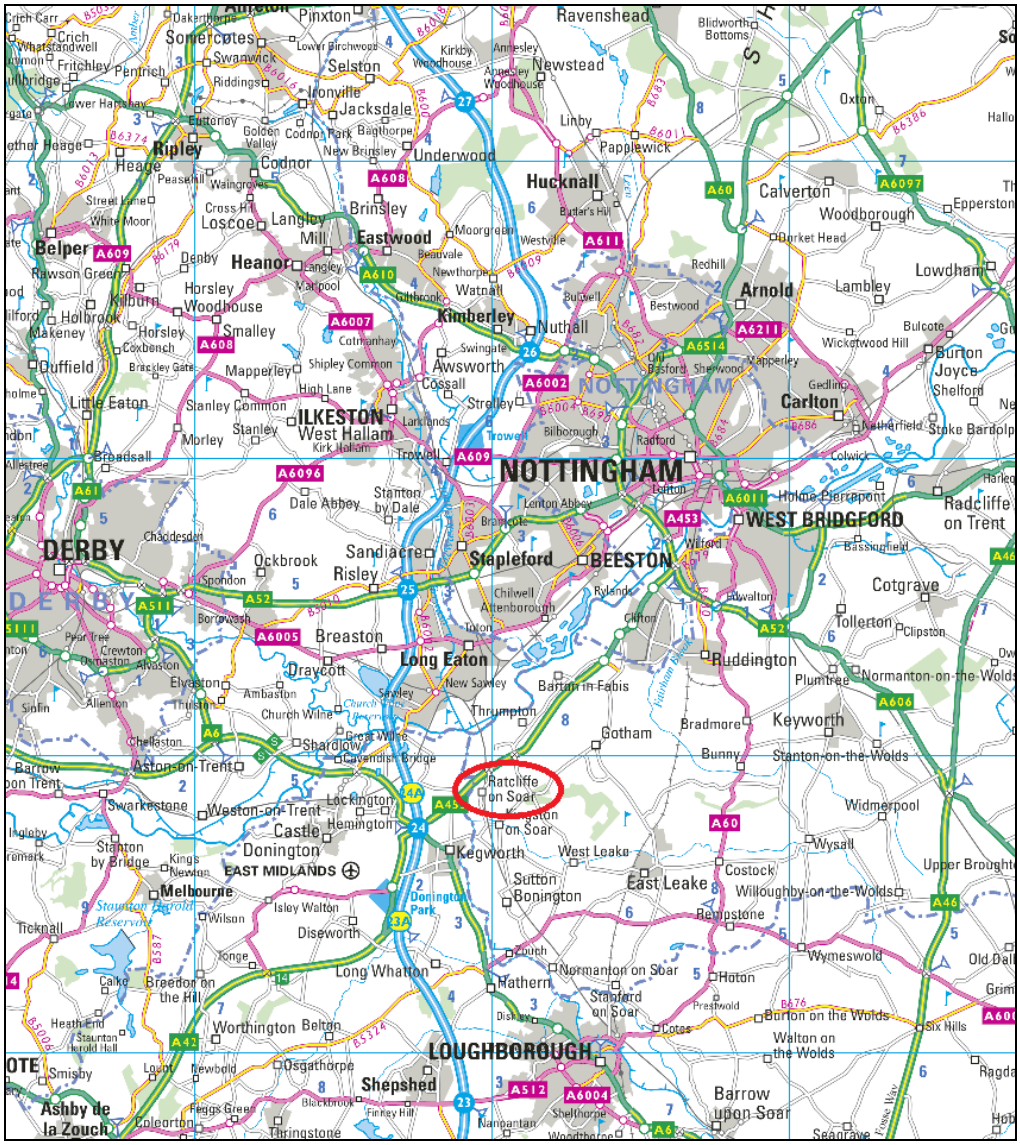

Figure 1: Map to show the general location of Ratcliffe-on-Soar, circled (based on the Ordnance Survey map with permission of the Controller of Her Majesty's Stationery Office, ©Crown Copyright

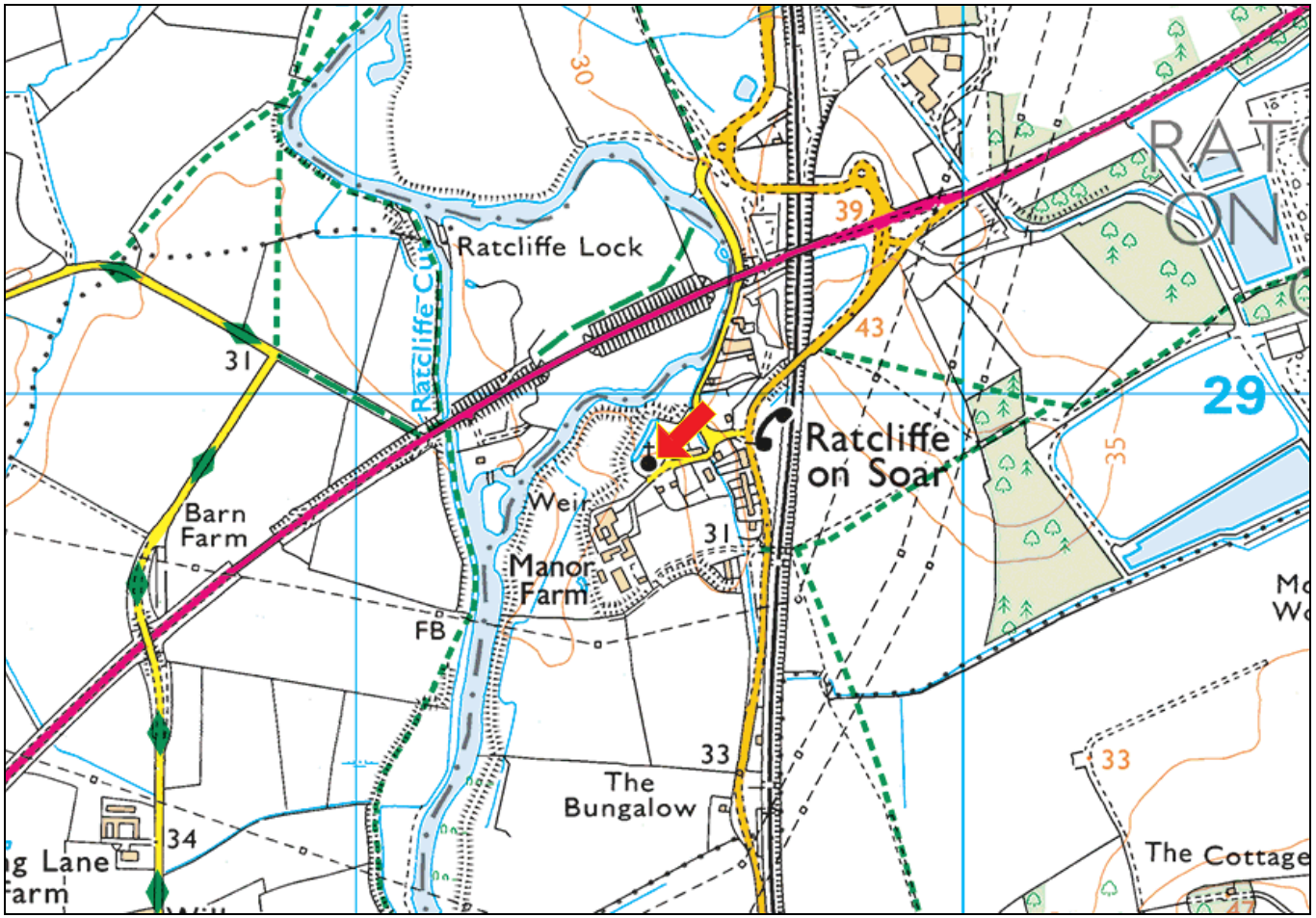

Figure 2: Map to show the location of the Church of Holy Trinity, arrowed (based on the Ordnance Survey map with permission of the Controller of Her Majesty's Stationery Office, ©Crown Copyright)

Figure 3: Truss D, photograph taken from the north-west

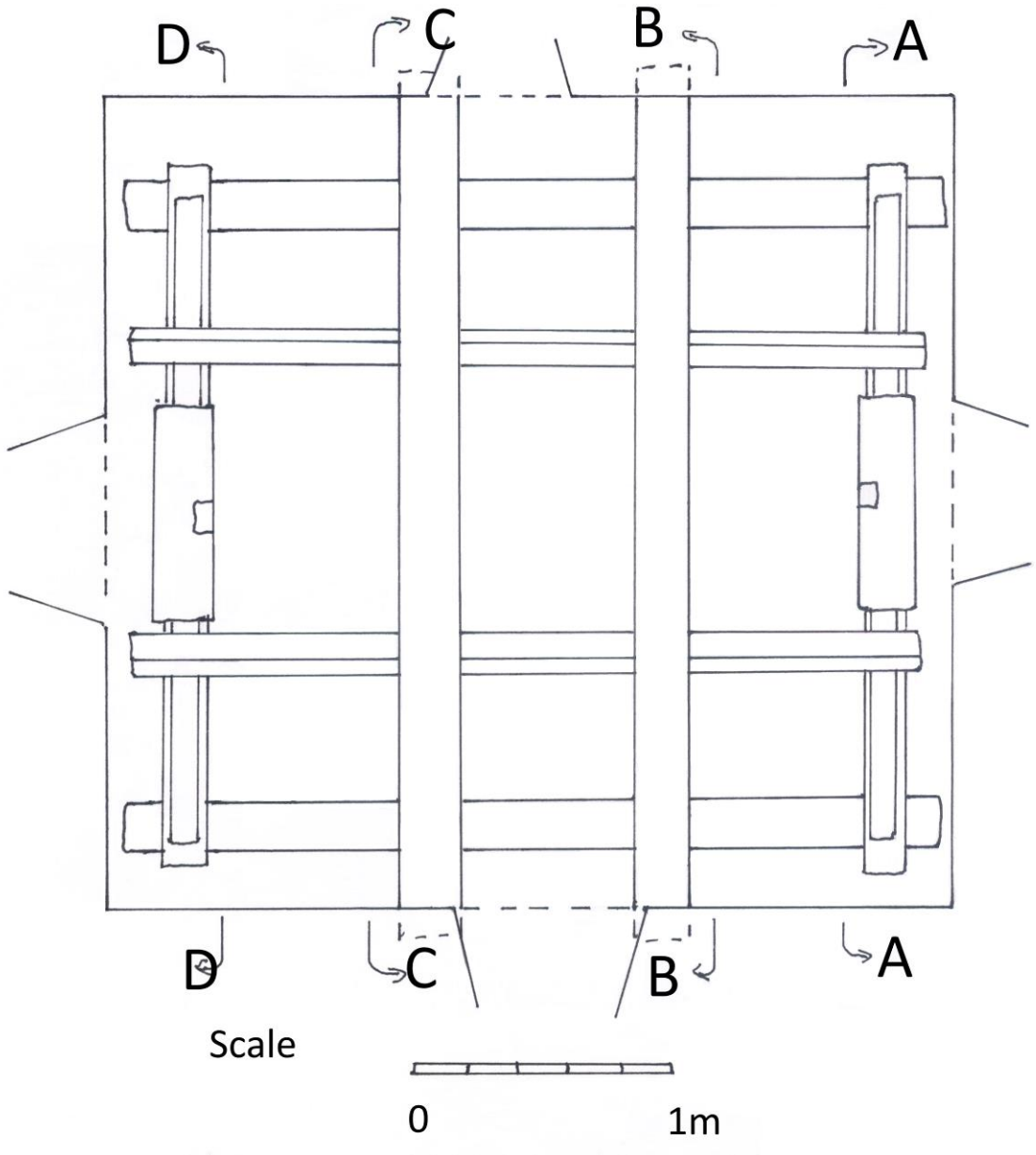

Figure 4: Plan of bellframe, showing truss labelling

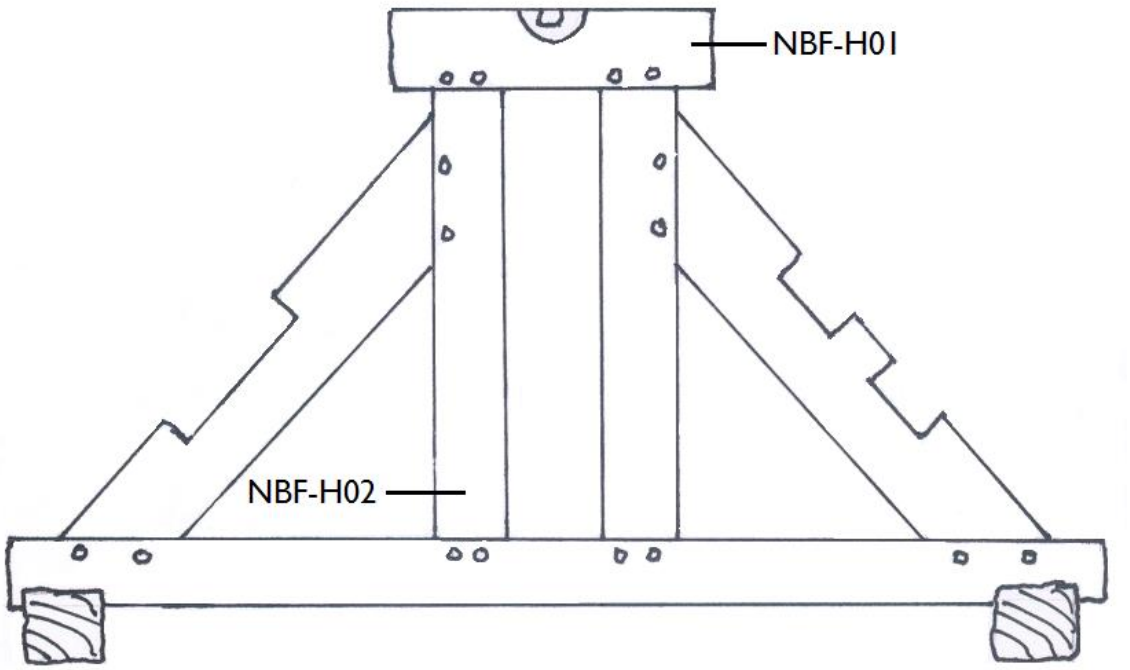

Figure 5: Truss A, showing the location of samples NBF-H01 and NBF-H02

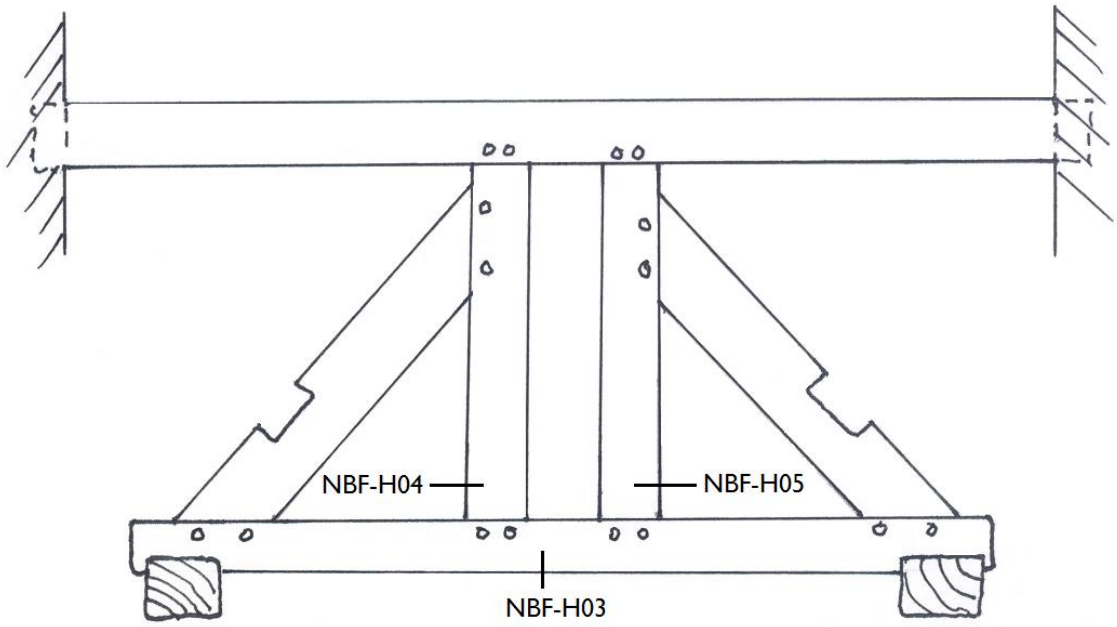

Figure 6: Truss B, showing the location of samples NBF-H03–05

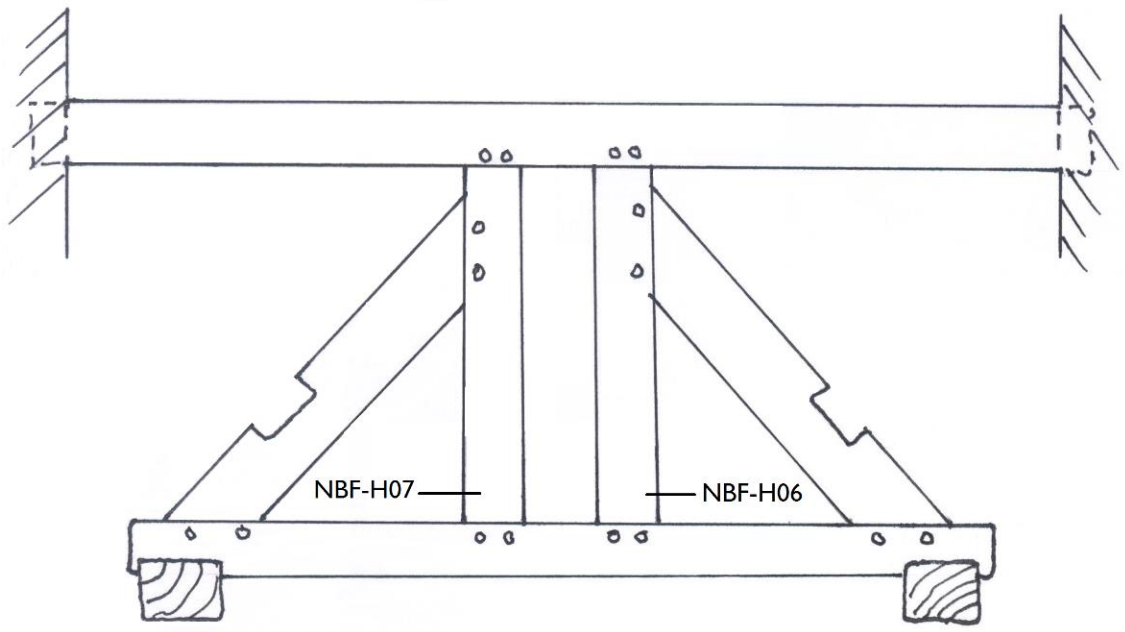

Figure 7: Truss C, showing the location of samples NBF-H06 and NBF-H07

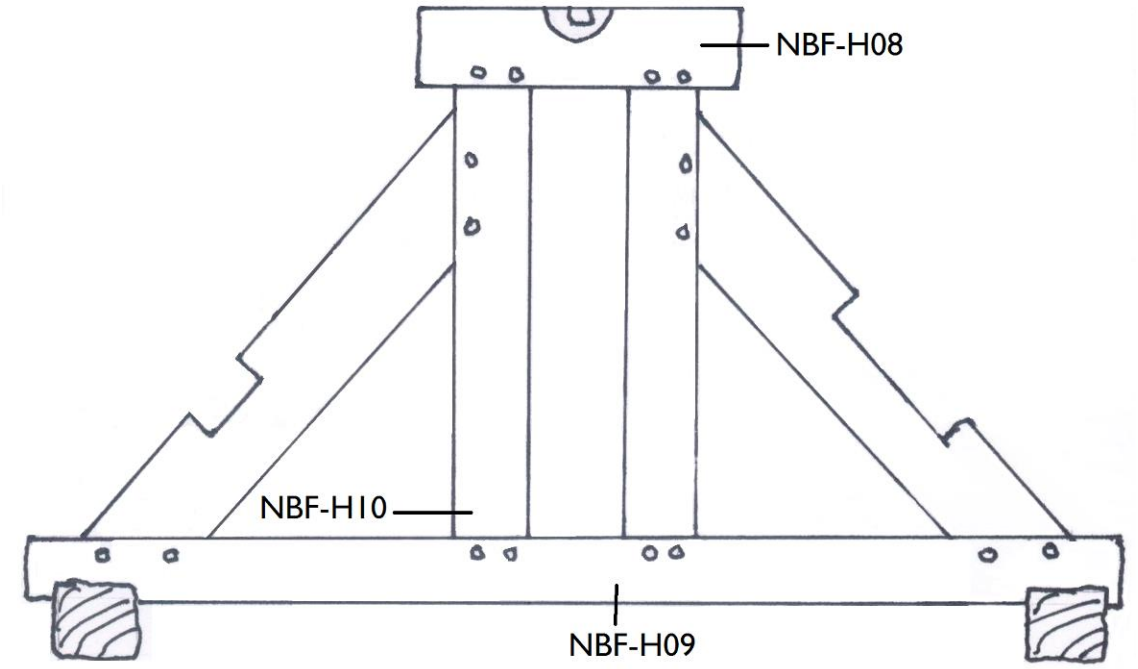

Figure 8: Truss D, showing the location of samples NBF-H08–10

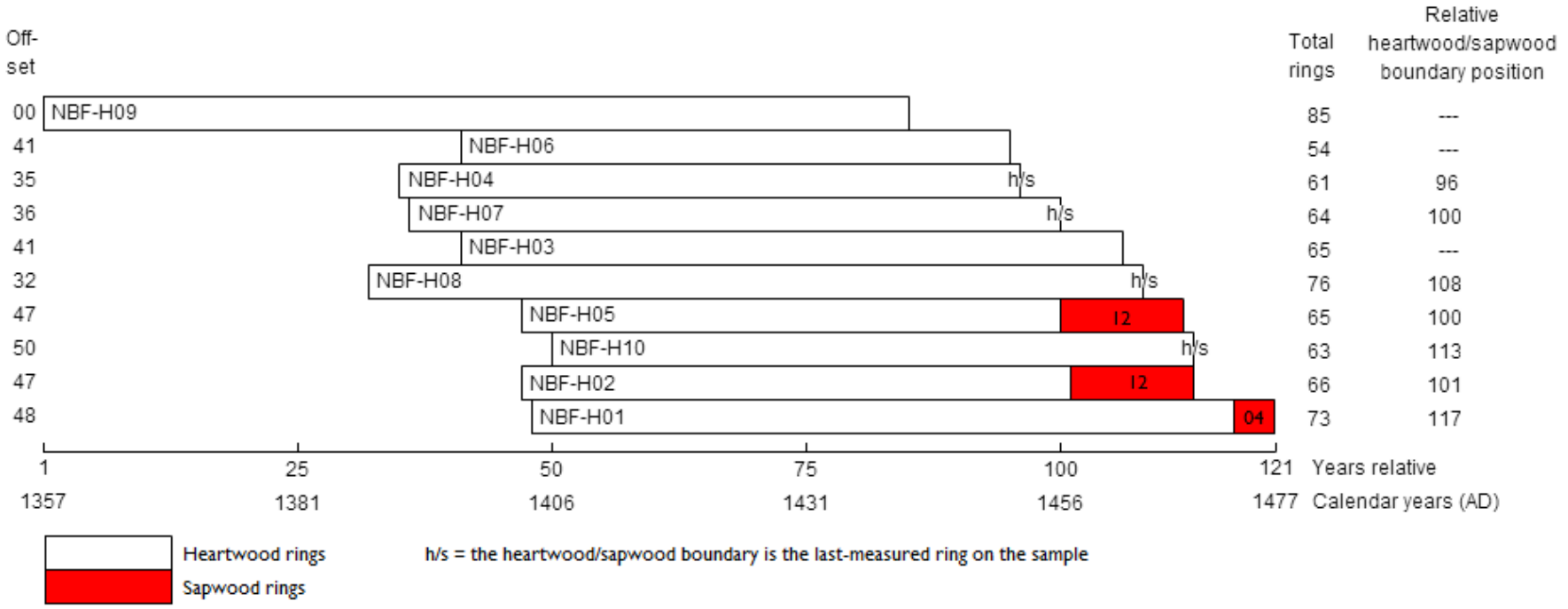

Figure 9: Bar diagram of samples in site sequence NBFHSQ01

DATA OF MEASURED SAMPLES

Measurements in 0.01mm units

NBF-H01A 56
143 154 162 111 110 202 218 134 135 148 217 127 112 119 95 93 112 107 74 118
96 125 134 93 73 72 97 84 88 152 132 103 117 95 162 85 66 51 55 57
53 73 64 79 80 89 120 129 134 93 115 118 99 101 93 90
NBF-H01B 52
366 357 278 425 348 168 107 120 68 68 114 99 114 109 66 198 144 136 190 160
129 98 168 217 130 136 142 238 133 128 112 99 109 121 115 77 135 86 131 140
85 91 63 109 88 105 144 136 98 101 111 163
NBF-H02A 66
213 195 160 164 161 182 182 199 125 103 62 75 115 140 235 123 119 122 137 180
182 87 127 204 253 222 178 202 224 219 167 256 348 213 227 132 137 176 169 106
164 119 97 101 99 99 109 171 182 168 144 64 52 42 37 32 65 61 66 86
85 82 79 78 103 125
NBF-H02B 66
230 206 169 176 175 192 184 204 140 98 61 55 111 141 244 137 112 130 152 168
198 88 129 221 269 224 182 207 229 216 169 258 351 193 232 141 153 207 167 138
197 126 95 120 115 104 135 185 187 170 153 58 39 49 50 41 60 65 71 100
88 91 67 96 84 115
NBF-H03A 65
511 413 461 484 442 692 654 500 445 301 443 367 199 125 133 85 104 135 112 150
207 131 339 250 207 349 239 205 136 233 273 169 149 188 290 175 152 147 129 126
116 131 103 167 101 160 161 106 103 88 134 106 119 175 163 122 120 94 165 87
69 41 59 61 69
NBF-H03B 65
516 410 463 476 448 692 656 500 444 302 444 369 201 122 131 92 102 135 112 156
202 130 338 246 208 348 244 206 133 236 264 170 155 182 294 176 159 147 122 129
117 132 106 160 106 154 155 110 103 92 130 105 121 174 172 112 119 102 166 88
69 43 63 58 70
NBF-H04A 61
118 116 87 87 86 57 109 96 193 332 338 442 431 328 400 253 240 233 240 129
85 85 76 126 78 139 165 113 165 139 117 123 99 52 63 89 121 124 79 92
118 93 68 83 49 51 44 53 60 87 73 81 64 42 44 52 44 50 41 63
77
NBF-H04B 61
119 111 89 89 78 66 103 109 182 333 337 440 419 340 389 280 242 236 249 136
76 83 88 119 78 140 165 117 160 137 118 130 97 54 61 88 118 125 83 87
122 107 76 76 44 51 43 57 52 90 71 83 60 48 43 51 47 46 40 65
83
NBF-H05A 65
403 277 292 191 195 251 184 166 65 90 43 65 72 111 173 108 154 120 131 257
203 90 89 146 150 156 103 148 206 141 123 157 144 73 63 49 75 159 110 176
179 118 100 93 81 92 80 128 149 122 100 46 33 34 18 40 38 61 85 66

105 90 99 124 201
NBF-H05B 65
429 264 296 197 190 259 184 163 55 96 45 59 74 112 174 108 160 127 115 268
198 91 87 145 150 159 96 151 201 146 134 167 138 73 58 56 67 149 122 157
190 114 113 89 80 79 86 129 145 129 115 40 42 32 42 26 47 56 75 70
89 94 103 123 209
NBF-H06A 54
280 243 374 266 288 330 348 292 298 256 301 307 245 129 80 95 89 168 167 277
396 201 321 327 267 287 281 167 243 320 347 293 238 254 312 206 225 174 125 115
118 135 127 201 125 140 115 100 69 75 73 82 77 107
NBF-H06B 54
286 236 378 327 292 334 340 282 298 258 291 331 259 141 93 93 95 175 164 282
387 215 333 343 268 278 278 174 250 325 348 296 236 268 326 216 216 182 127 107
126 132 126 202 123 135 123 95 75 79 71 78 76 111
NBF-H07A 64
239 161 135 155 101 106 118 195 131 141 211 281 248 244 152 140 155 130 111 68
50 59 80 57 121 162 107 201 177 144 159 132 97 102 198 223 123 169 237 213
122 118 131 99 82 72 74 71 105 103 158 165 127 95 73 83 112 103 93 85
80 101 84 102
NBF-H07B 64
255 165 145 162 105 109 118 194 113 156 227 296 232 226 153 143 157 138 110 54
48 51 80 49 116 170 96 198 165 140 163 126 90 102 190 223 133 167 214 226
118 117 137 89 89 65 78 74 97 93 164 167 126 104 77 79 113 102 84 93
84 104 83 102
NBF-H08A 76
145 159 122 141 98 146 112 238 147 193 112 219 278 181 328 340 240 243 166 227
159 85 64 42 48 55 78 65 109 138 79 139 157 167 216 196 137 138 310 293
225 215 214 270 184 211 205 195 96 120 121 152 182 171 179 205 135 134 111 111
116 99 220 150 151 149 151 209 89 47 25 34 29 37 33 52
NBF-H08B 76
141 149 133 140 90 146 124 238 148 186 115 220 273 176 333 355 234 235 163 226
153 91 56 45 52 53 72 70 144 134 90 141 160 153 226 202 140 136 322 264
213 196 221 267 182 209 213 193 95 127 118 150 184 169 178 204 132 129 125 112
98 122 218 163 142 151 152 206 83 42 25 29 30 29 31 67
NBF-H09A 85
133 128 185 113 147 184 156 192 207 274 259 146 135 128 208 153 107 174 177 220
162 217 256 341 248 209 319 452 327 279 313 376 290 285 251 308 233 189 226 183
155 245 155 253 223 174 210 207 150 97 101 118 142 150 90 75 50 43 59 89
140 165 93 116 188 168 153 189 118 128 142 170 127 111 155 140 113 167 169 162
147 133 140 169 138
NBF-H09B 85
142 127 187 110 159 184 163 137 199 264 253 163 131 129 199 143 94 158 154 212
159 219 255 328 261 205 327 459 323 289 317 374 285 292 243 302 239 192 220 177
162 250 153 253 224 176 213 203 150 98 98 126 137 147 84 80 49 41 60 88
144 161 90 119 204 174 157 185 128 125 138 168 128 114 154 136 125 163 159 174
146 154 129 165 141
NBF-H10A 63

300 292 289 297 130 149 95 127 118 129 196 190 138 287 255 164 220 157 111 129
200 194 163 78 84 101 109 114 140 140 104 55 77 97 130 121 207 208 131 107
 91 100 133 135 146 193 110 80 82 142 110 132 106 137 129 177 172 122 143 106
114 109 95
NBF-H10B 63
300 276 295 301 125 149 99 117 124 122 183 182 132 286 250 167 227 151 118 130
199 196 166 80 85 96 112 113 142 132 105 60 79 96 132 123 205 206 133 107
 91 88 141 140 151 194 101 85 77 142 114 125 108 137 136 173 171 114 141 114
109 107 88