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THE BELLFRAME
ST KATHERINE'S CHURCH
TEVERSAL
NOTTINGHAMSHIRE

SURVEY, RECORDING AND TREE-RING ANALYSIS OF TIMBERS

Alison Arnold, Robert Howard, and George Dawson

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NTRDL, 20 Hillcrest Grove, Sherwood, Nottinghamshire NG5 1FT
Telephone 0115 960 3833 (Office); 07980 305583 (Mobile)

SURVEY, RECORDING, AND TREE-RING ANALYSIS OF TIMBERS FROM THE BELLFRAME OF ST KATERINE'S CHURCH, TEVERSAL, NOTTINGHAMSHIRE

ALISON ARNOLD
ROBERT HOWARD
GEORGE DAWSON

SUMMARY

Dendrochronological analysis undertaken on samples taken from timbers of the bellframe at this church resulted in the construction of two site sequences.
Site sequence NBFLSQ01 contains two samples and spans the period AD 1587–1697 and NBFLSQ02 contains six samples and spans the period AD 1606–1732. Interpretation of sapwood suggests felling of timbers in AD 1733–54.

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INTRODUCTION

The Grade I listed church of St Katherine's in the village of Teversal (Figs 1 and 2) is thought to date back to the twelfth century, with further work in the thirteenth and fifteenth centuries being undertaken. The building consists of a chancel, nave, aisles, south porch, and embattled west tower. The tower is thought to date to the thirteenth century but was raised in the late-seventeenth century (http://southwellchurches.nottingham.ac.uk/teversal/hintro.php).

Bellframe

The bellframe is of a mix of truss types, Pickford Groups 6.A, 6.D and an inverse of 6.B (Fig 3). It is clear that the frame was all built at one time, more than likely when the bells were augmented from four to five in AD 1758, and may be by the bellfounder Thomas I Hedderly himself, or perhaps John Wright, a bellframe builder, of Nottingham.

The Bells

1 Shoulder. [50] T

(i). THE GIFT OF SIR CHARLES MOLYNEUX BAR [46] 1758

2 Shoulder. [50] T

(i). : THE GIFT OF SIR IOHN MOLYNEUX BAR O [46]

(ii). I WAS : NEW : CAST : AND : ADDED : TO : ME : IN [Molyneux Arms] 1758

3(i). GLORIA IN EXCELSIS DEO 1617

(ii). P H

4(i). EX DONO ROGER GRENAL ARMIGER ORTO SEPTE AO I SS i [35]

Soundbow: IHV BEDICTV SIT NOME DM

5 Shoulder. [50]

(i). [Molyneux Arms] Hec [46] Campana [46] Sacra [46] Fiat [46] Trinitate [46] Beata 1683

(ii). T W I C WARDENS

Badge numbers are taken from the Church Bells of Nottinghamshire.

Physical data:

	Diameter(cm)	Estimated weight
Treble.	70.5	*c* 4.25cwt
2.	73.5	*c* 4.75cwt
3.	80	*c* 5.5cwt
4.	86.5	*c* 6.5 cwt
Tenor.	94	*c* 9cwt

The bells were reportedly rehung and quarter turned by Taylors in 1921, although the fittings are not of Taylor's style. All five bells have lost their canons. The two trebles are the work of Thomas I Hedderly of Nottingham whilst the second is clearly a recast of an earlier bell. The third is a bell from the Chesterfield foundry; the initials would seem to be those of Paul Heathcote. The only other bell with his initials on is the Hathersage, Derbyshire, tenor cast in the same year. The fourth bell is an early bell by Henry I Oldfield of Nottingham dated AD 1551. It bears the rare crowned Oldfield badge [35]. The tenor is the work of William Noone of Nottingham. Both the second and the tenor bear the Molyneux family arms.

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 nine samples were taken from various timber elements with each sample being given the code NBF-L and numbered 01–09. The location of all samples was noted at the time of sampling and has been marked on Figures 4–11. Further details can be found in Table 1.

ANALYSIS & RESULTS

At this stage sample NBF-L08, from a jack brace, was found to have too few rings for secure dating to be a possibility and so was rejected prior to preparation. The remaining eight samples were prepared by sanding and polishing and their growth-ring widths measured. The growth-ring widths were then compared with each other resulting in all eight samples matching to form two groups.

Firstly, two samples matched each other at the relevant offset positions to form NBFLSQ01, a site sequence of 111 rings (Fig 12). This site sequence was compared against a series of relevant reference chronologies where it was found to match consistently and securely to span the period AD 1587–1697. The evidence for this dating is given by the *t*-values in Table 2.

Six further samples matched each other and were combined at the relevant offset position to NBFLSQ02, a site sequence of 127 rings (Fig 13). 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-measured ring date of AD 1606 and a last-measured ring date of AD 1732. The evidence for this dating is given by the *t*-values in Table 3.

INTERPRETATION

Eight of the samples taken from this bellframe have been successfully dated (Fig 14). Although none of these samples have complete sapwood, five do have the heartwood/sapwood boundary ring which in all cases can be seen to be broadly contemporary (Fig 14). The average heartwood/sapwood boundary ring date for these five samples is AD 1714, allowing an estimated felling date to be calculated for the timbers represented to within the range AD 1733–54. This date range allows for sample NBF-L02 having a last-measured ring date of AD 1732 with incomplete sapwood.

The other dated samples do not have the heartwood/sapwood boundary ring and so estimated felling dates cannot be calculated for them. However, with last-measured ring dates of AD 1672 (NBF-L06), AD 1691 (NBF-L03), and AD 1697 (NBF-L05) the timbers represented can be said to have *terminus post quem* felling dates of AD 1687, AD 1706, and AD 1712, respectively.

Furthermore, samples NBF-L05 and NBF-L06 match each other at the extremely high value of t=15.9 and were almost certainly cut from the same tree and would, therefore, both have been felled after AD 1712.

Felling date ranges have been calculated using the estimate that 95% of mature oak trees in this region have between 15 and 40 sapwood rings.

DISCUSSION

Prior to the tree-ring analysis being undertaken this bellframe was thought likely to date to when the bells were augmented from four to five in AD 1758. This analysis has demonstrated felling of timber utilised in AD 1733–54. If construction occurred immediately post felling this would make the frame slightly older than the latest bells. However, it may be that felling occurred a couple of years prior to the construction of the frame in preparation.

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The Laboratory and George Dawson would like to thank John Caunt for facilitating access and Professor John Beckett and Dr Chris Brooke for the information on the Southwell and

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Table 1: Details of samples taken from the bellframe at St Katherine's Church, Teversal, 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-L01	Top cill, truss 2	119	10	1606	1714	1724
NBF-L02	Top cill, truss 3	117	18	1616	1714	1732
NBF-L03	West brace, truss 3	44	--	1648	----	1691
NBF-L04	East jack brace, truss 4	55	09	1675	1720	1729
NBF-L05	Top cill, truss 5	100	--	1598	----	1697
NBF-L06	Top cill, truss 6	86	--	1587	----	1672
NBF-L07	South brace, truss 6	55	12	1672	1714	1726
NBF-L08	North jack brace, truss 7	NM	--	----	----	----
NBF-L09	Top cill, truss 7	62	h/s	1645	1706	1706

*NM = not measured

**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 NBFLSQ01 and relevant reference chronologies when the first-ring date is AD 1587 and the last-measured ring date is AD 1697

Reference chronology	*t*-value	Span of chronology	Reference
Staircase House, Stockport, Greater Manchester	8.2	AD 1489–1656	Howard *et al* 2003
Cheddleton Grange, Cheddleton, Staffordshire	7.4	AD 1551–1682	Arnold *et al* 2008
15/17 St John's St, Wirksworth, Derbyshire	7.3	AD 1586–1676	Howard *et al* 1995
Turton Tower, Lancashire	6.5	AD 1483–1665	Arnold and Howard 2008
Hempshill Hall, Nottinghamshire	6.4	AD 1566–1702	Arnold and Howard 2007
Auckland Castle, Bishop Auckland, County Durham	6.3	AD 1425–1698	Arnold and Howard 2013a
St Marys Chare, Hexham, Northumberland	6.3	AD 1536–1689	Arnold *et al* 2004

Table 3: Results of the cross-matching of site sequence NBFLSQ02 and relevant reference chronologies when the first-ring date is AD 1606 and the last-measured ring date is AD 1732

Reference chronology	*t*-value	Span of chronology	Reference
Weelwright's Shop, Chatham Docks, Kent	7.0	AD 1615–1780	Bridge 1998
Kirkleatham Stables, Redcar, North Yorkshire	6.2	AD 1622–1722	Arnold and Howard 2013b
Bolsover Castle (Riding house), Bolsover, Derbyshire	6.0	AD 1494–1744	Howard *et al* 2005
Clifton Hall Tower, Clifton, Near Penrith, Cumbria	5.4	AD 1655–1740	Arnold *et al* 2003
Tonge Hall, Rochdale, Lancashire	5.4	AD 1449–1687	Arnold and Howard 2014
Cheddleton Grange, Cheddleton, Staffordshire	5.4	AD 1551–1682	Arnold et al 2008
Old Hall, West Auckland, County Durham	5.0	AD 1506–1668	Hurford et al 2010

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

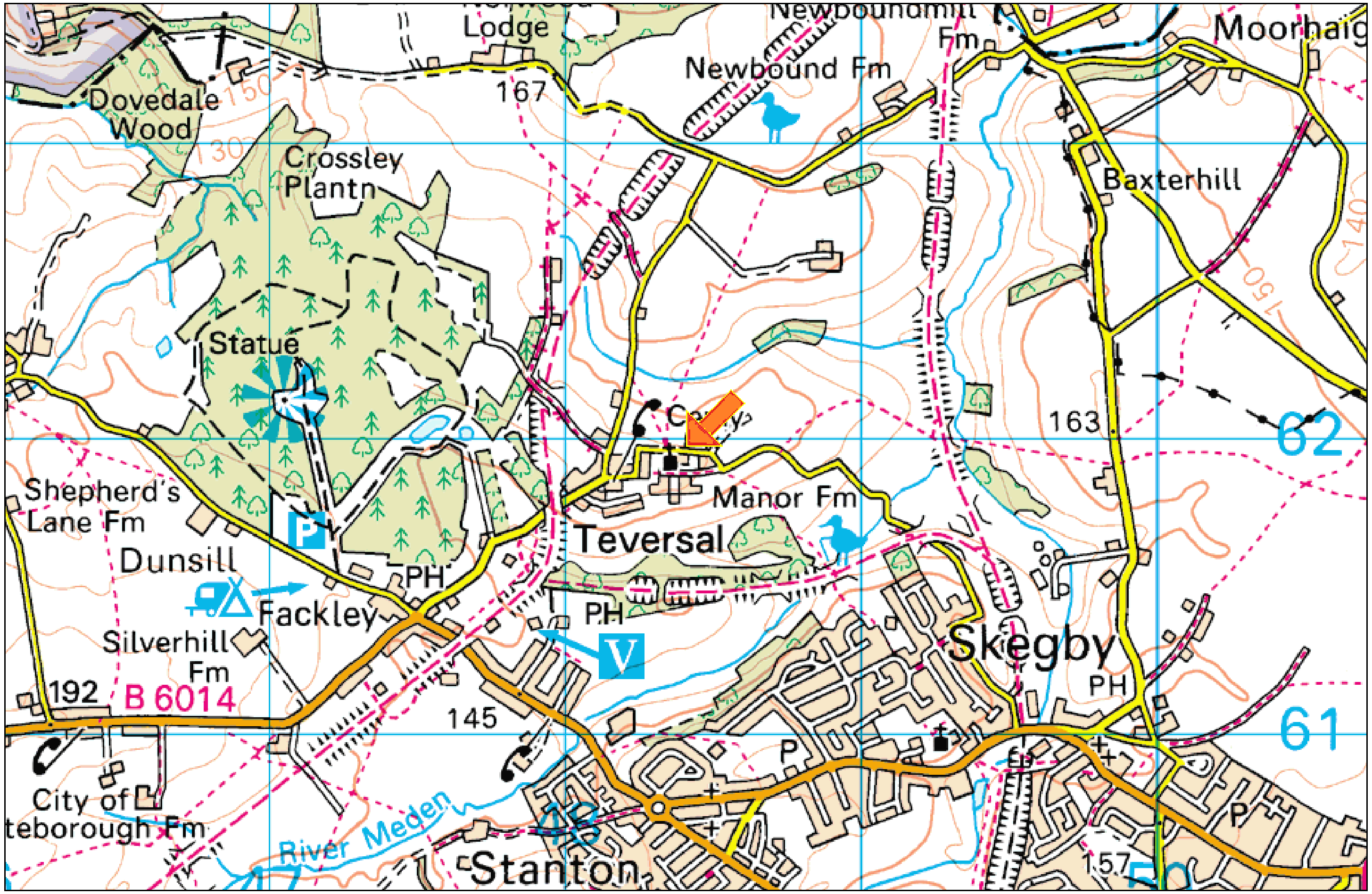

Figure 2: Map to show the location of St Katherine's Church, arrowed (based on the Ordnance Survey map with permission of the Controller of Her Majesty's Stationery Office, ©Crown Copyright)

Figure 3: The bellframe, photograph taken from above

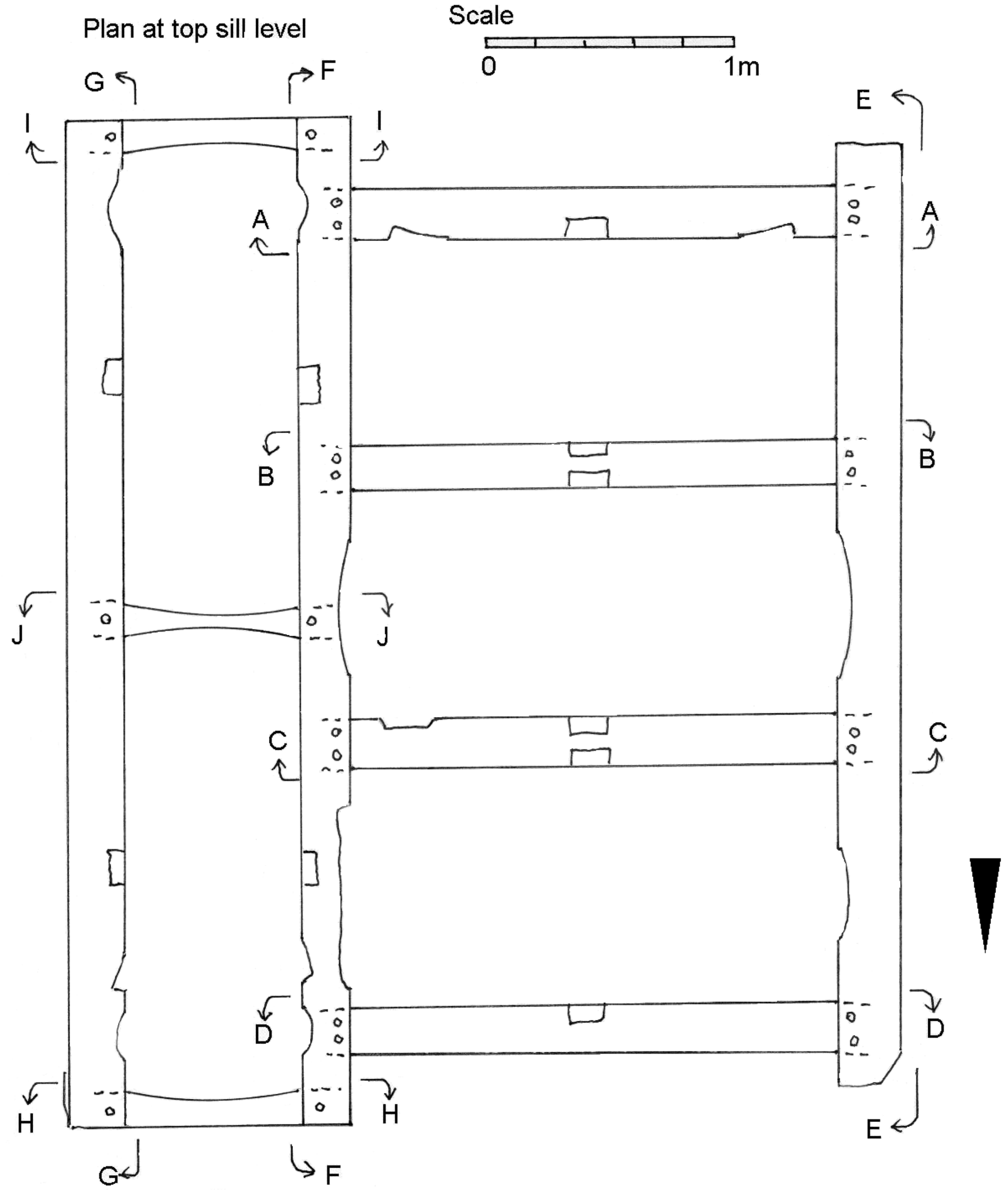

Figure 4: Plan, showing truss labelling (George Dawson)

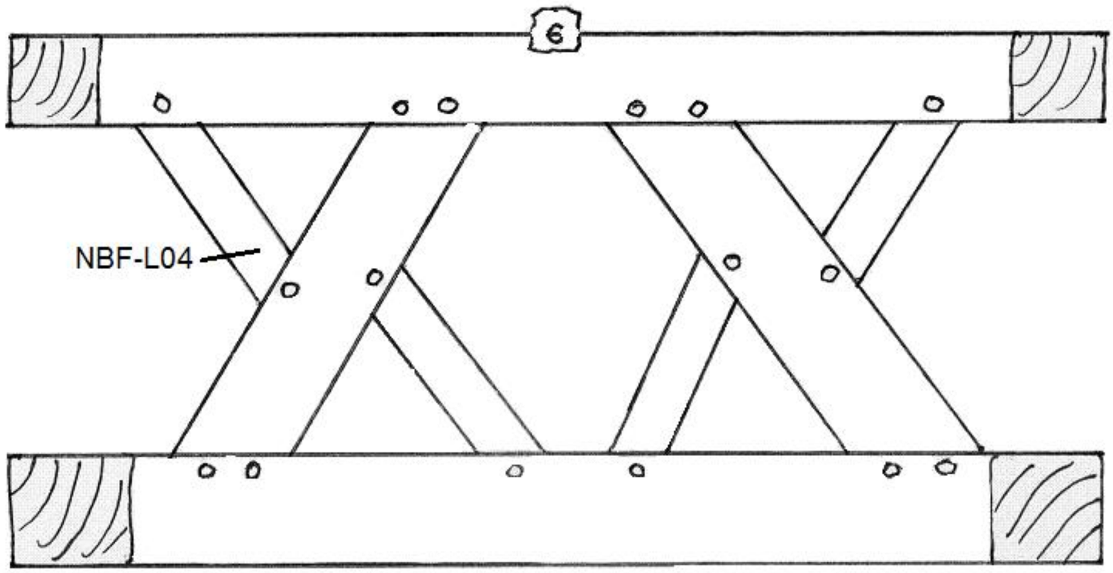

Figure 5: Truss A–A, showing the location of sample NBF-L04 (George Dawson)

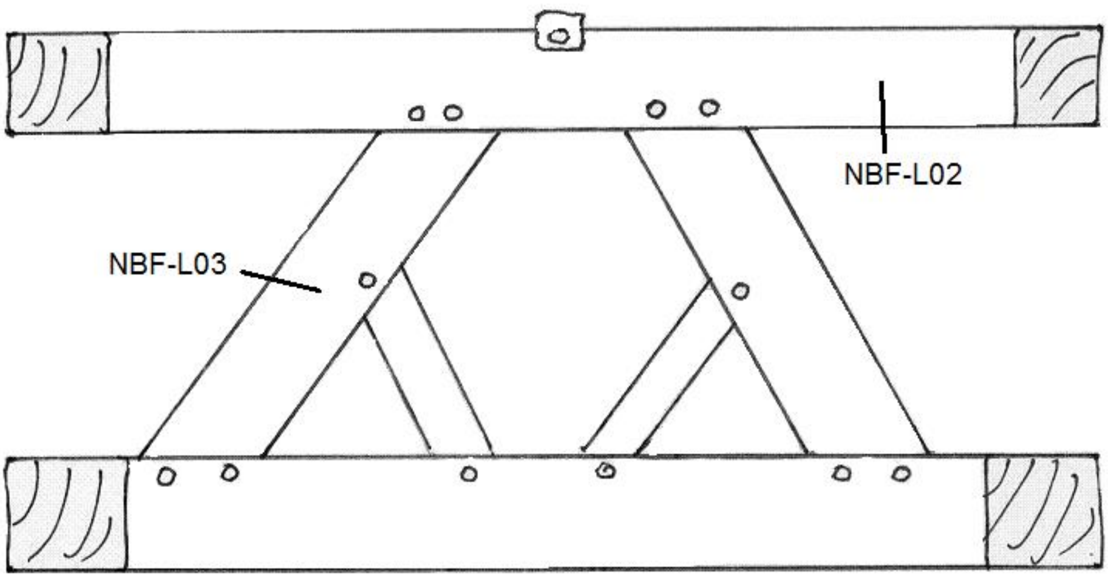

Figure 6: Truss B–B, showing the location of samples NBF-L02 and NBF-L03 (George Dawson)

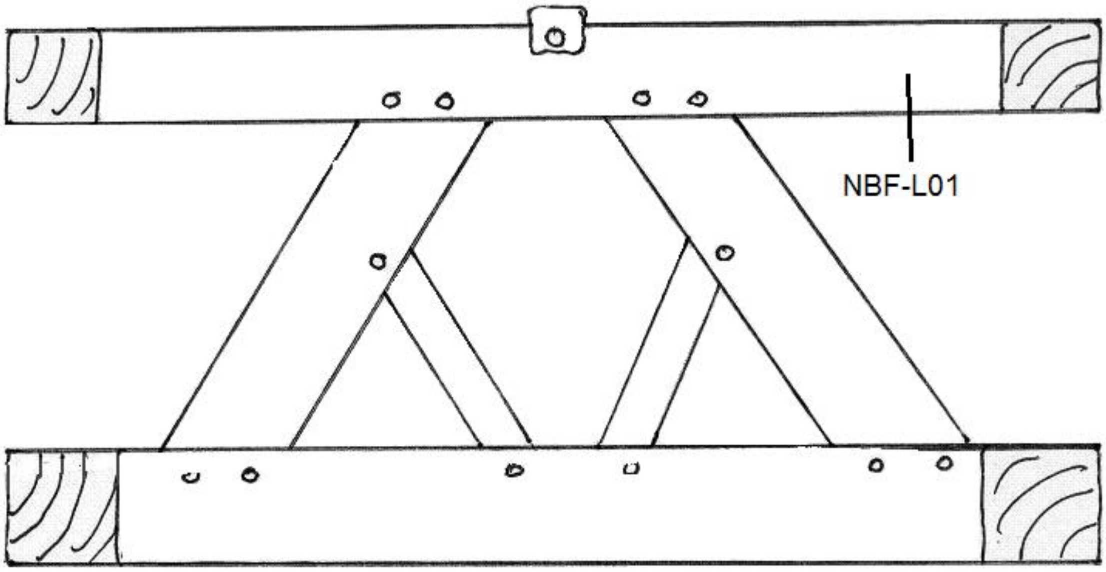

Figure 7: Truss C–C, showing the location of sample NBF-L01 (George Dawson)

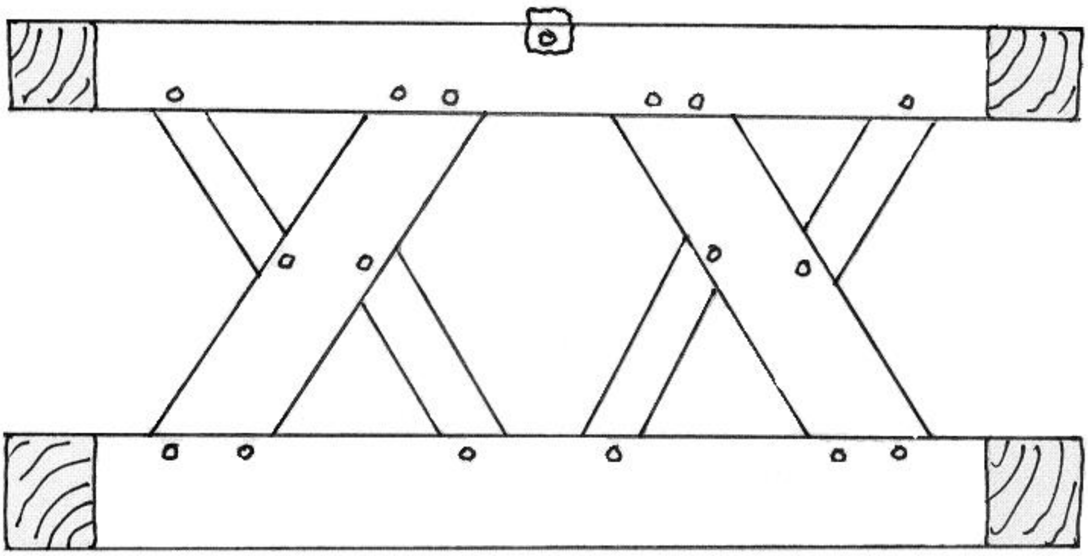

Figure 8: Truss D–D (George Dawson)

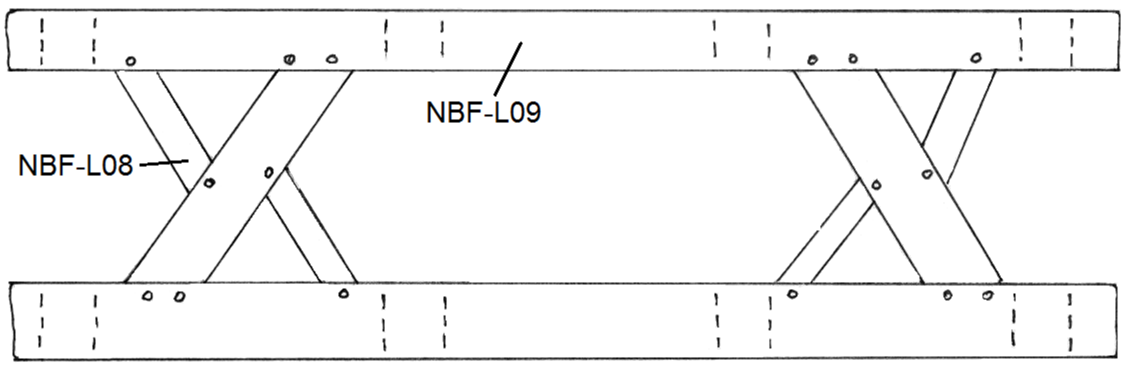

Figure 9: Truss E–E, showing the location of samples NBF-L08 and NBF-L09 (George Dawson)

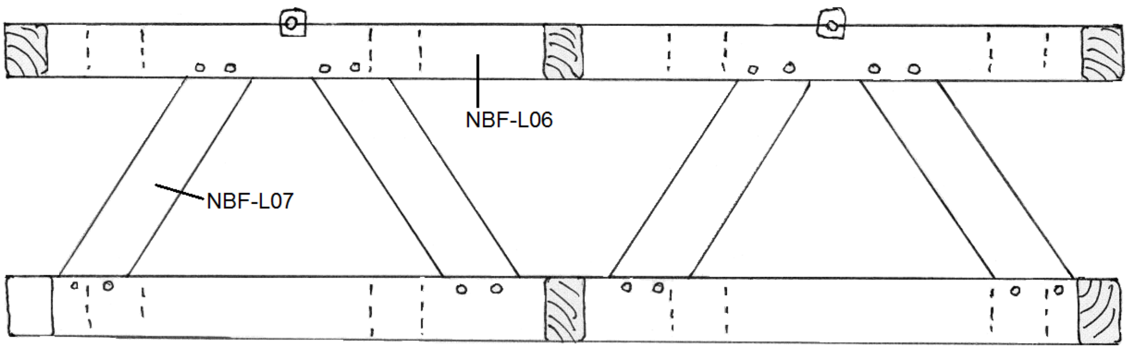

Figure 10: Truss F–F, showing the location of samples NBF-L06 and NBF-L07 (George Dawson)

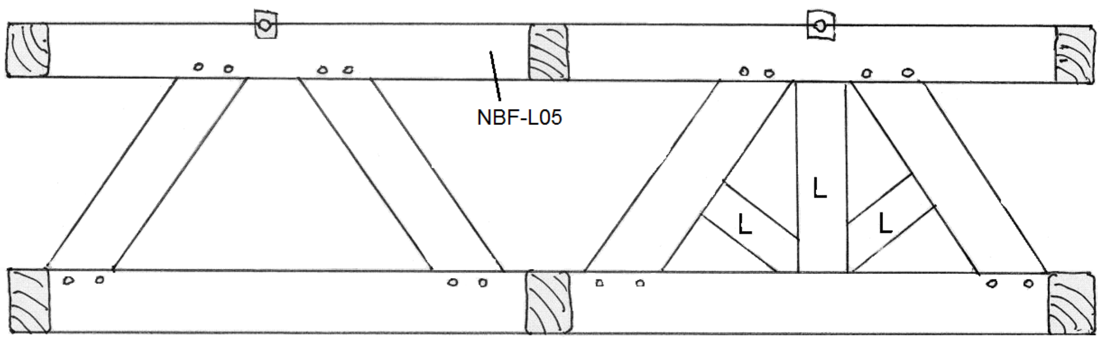

Figure 11: Truss G–G, showing the location of sample NBF-L05 (George Dawson)

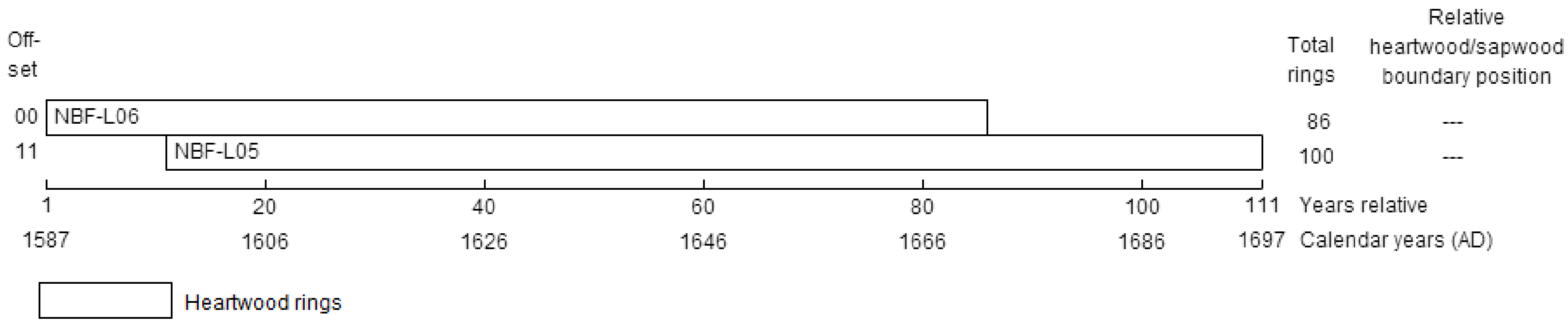

Figure 12: Bar diagram to show the position of samples in site sequence NBFLSQ01

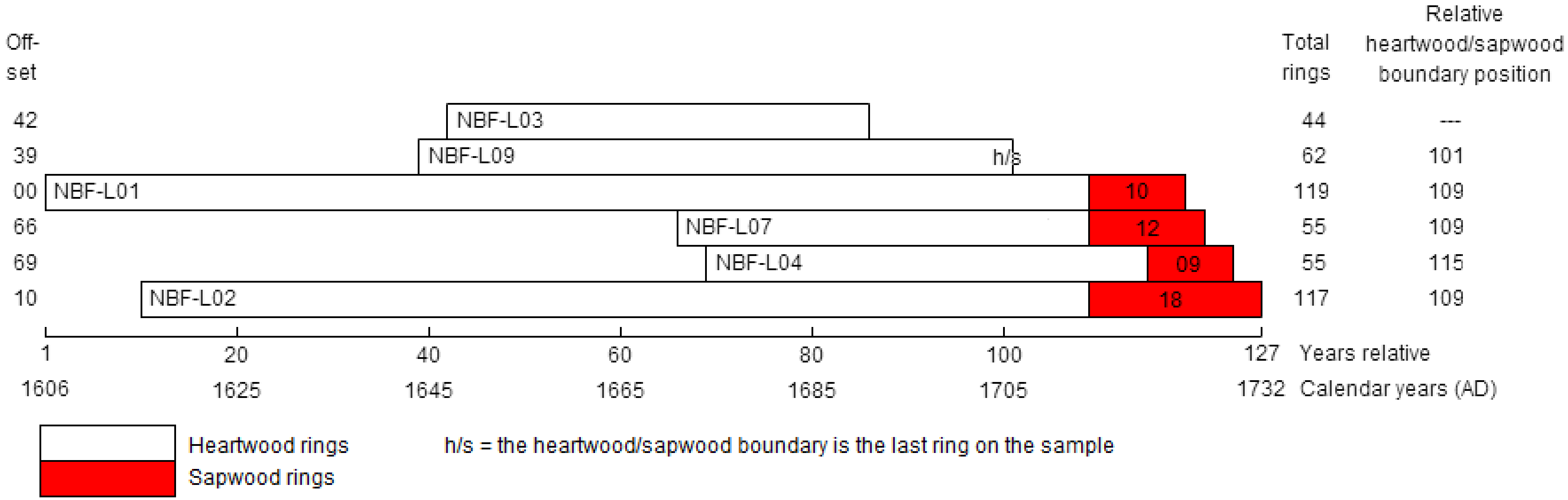

Figure 13: Bar diagram of samples in site sequence NBFLSQ02

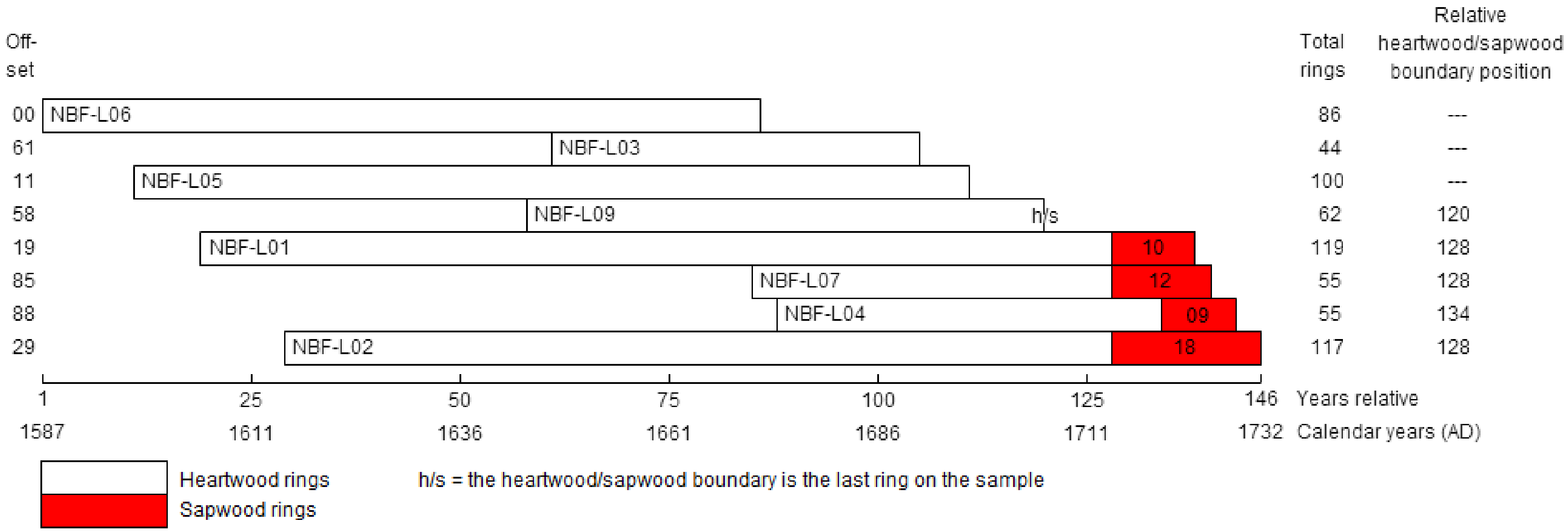

Figure 14: Bar diagram of all dated samples

DATA OF MEASURED SAMPLES

Measurements in 0.01mm units

NBF-L01A 119
289 332 193 113 118 148 180 194 168 249 158 121 231 215 200 164 251 205 139 116
143 113 111 162 157 114 118 119 117 77 90 144 158 215 190 270 68 118 96 157
222 202 85 63 66 125 78 198 315 206 351 237 240 385 283 187 201 203 246 215
145 191 178 290 373 235 276 192 262 159 232 188 221 291 143 142 201 187 297 119
265 280 251 351 151 289 187 239 133 225 176 222 209 153 111 164 107 164 289 207
219 212 193 169 96 154 185 158 171 135 156 194 168 160 134 147 250 206 281
NBF-L01B 119
289 328 190 105 99 124 200 186 163 262 147 110 210 211 197 166 220 185 146 118
130 110 117 171 156 116 116 119 117 78 94 140 158 242 184 277 70 116 99 155
219 190 90 61 73 124 83 197 303 188 340 224 243 383 281 184 203 211 255 215
144 186 192 290 364 234 280 187 259 158 237 187 218 286 146 145 200 188 297 125
271 276 257 350 149 291 187 243 134 227 179 225 208 150 108 167 112 161 281 215
223 212 195 155 95 156 180 158 173 126 147 223 149 159 138 146 245 224 296
NBF-L02A 117
155 146 272 245 260 226 232 240 232 205 227 208 201 324 203 191 172 192 223 156
200 231 208 230 191 307 113 205 109 181 245 214 137 112 121 151 142 222 326 231
268 264 241 264 231 182 246 217 260 245 328 285 222 262 331 258 226 224 289 179
324 231 225 317 205 162 206 231 306 193 316 287 270 307 195 303 117 47 39 83
56 69 58 64 75 106 67 101 170 115 179 179 174 172 96 147 145 144 194 170
165 175 165 253 153 132 174 202 317 130 194 131 144 196 157 178 144
NBF-L02B 117
147 156 274 241 264 220 240 241 224 208 233 208 198 330 196 190 166 198 222 150
205 231 207 228 197 301 120 198 106 180 244 214 134 105 117 143 149 219 325 231
268 264 240 259 236 186 246 220 261 259 319 290 220 268 334 252 225 219 293 179
319 235 223 323 196 162 207 227 304 187 323 281 265 331 196 300 115 48 40 77
66 59 64 68 73 106 64 106 166 115 179 186 171 182 88 142 135 141 188 165
161 181 153 249 152 135 175 199 318 131 190 135 138 195 162 169 142
NBF-L03A 44
259 199 292 388 253 334 604 576 334 357 423 395 441 358 317 406 352 352 293 282
282 334 555 376 300 354 397 325 327 354 348 392 359 288 578 503 337 332 594 497
354 340 251 314
NBF-L03B 44
206 199 297 384 264 332 600 577 335 364 423 387 437 357 331 414 345 346 290 268
288 324 561 379 304 353 392 336 320 353 346 391 357 293 574 504 337 335 596 504
349 343 256 310
NBF-L04A 55
317 356 262 348 431 434 416 518 353 341 349 477 455 439 386 324 486 271 389 253
335 309 285 414 284 270 232 210 249 395 249 243 316 368 324 189 212 302 308 320
373 292 349 286 322 322 395 356 257 402 267 357 344 319 232
NBF-L04B 55
302 366 253 356 440 437 436 551 358 351 369 486 475 458 398 334 494 279 390 260

338 302 289 427 290 268 228 213 261 385 257 245 320 386 329 194 217 311 313 328
380 297 352 293 328 326 402 360 252 398 269 354 348 314 228
NBF-L05A 100
315 310 296 250 154 178 238 250 334 465 363 304 347 260 331 374 335 338 281 298
307 247 327 273 305 254 212 171 196 176 239 250 241 218 320 235 211 263 159 249
309 266 296 379 182 188 228 254 292 298 201 187 148 167 117 198 201 240 296 247
274 253 239 187 243 280 194 172 129 154 195 237 278 245 253 224 192 179 173 191
279 239 176 186 234 179 173 155 139 172 169 206 141 174 120 133 160 126 167 186
NBF-L05B 100
329 309 291 250 144 159 232 254 334 457 352 303 346 261 337 376 331 341 273 307
306 249 329 264 314 254 216 170 196 181 237 260 237 223 323 235 208 261 162 244
314 258 295 387 181 191 232 259 278 309 197 182 141 164 119 200 198 242 300 235
282 252 239 186 241 282 199 177 119 162 195 239 277 253 254 219 188 183 161 151
272 239 180 183 239 178 179 147 142 172 169 192 151 160 127 137 160 106 146 143
NBF-L06A 86
226 268 273 146 209 345 431 420 399 330 253 244 172 165 162 71 95 167 179 241
327 293 255 314 247 309 396 301 308 271 286 284 269 282 243 261 240 198 213 204
171 231 287 212 205 251 194 178 238 163 247 350 321 287 388 187 182 250 271 279
264 195 138 106 117 110 171 194 262 291 247 272 253 277 192 260 230 221 184 126
171 196 265 305 239 251
NBF-L06B 86
225 270 268 137 223 339 416 417 338 393 264 229 168 170 157 65 96 170 172 242
334 299 255 310 251 313 399 298 310 278 287 290 269 282 247 264 237 203 212 204
170 237 278 213 198 254 189 186 242 168 253 348 316 296 380 188 184 249 278 268
274 195 136 110 119 111 171 186 261 283 249 276 248 269 191 255 243 209 182 138
169 199 269 315 230 209
NBF-L07A 55
247 419 337 300 346 391 379 488 513 278 518 393 270 207 423 360 266 299 232 396
306 257 220 287 351 286 237 165 150 146 124 180 181 137 161 149 195 180 96 158
211 168 165 225 163 202 136 191 133 115 138 113 318 298 247
NBF-L07B 55
243 412 336 305 356 377 363 464 506 278 521 388 267 212 431 366 264 295 232 378
302 259 230 291 357 299 236 163 145 148 121 178 174 140 164 153 189 189 96 158
214 181 154 230 164 200 139 196 127 109 155 114 333 303 198
NBF-L09A 43
364 380 310 265 296 337 474 501 298 364 353 251 341 332 317 412 362 246 325 294
248 247 417 353 234 262 229 362 268 214 245 247 361 284 251 207 179 187 150 180
199 181 139
NBF-L09B 45
270 310 302 268 233 305 373 312 331 460 576 364 374 452 399 460 420 383 459 401
369 323 277 295 327 493 508 331 371 334 262 361 337 310 390 358 237 308 298 241
230 431 345 252 283