

# The Guildhall Middle Row Chipping Norton Oxfordshire

Tree-ring Analysis of Oak and Elm Timbers

Martin Bridge and Cathy Tyers

Discovery, Innovation and Science in the Historic Environment



Front Cover: The Guildhall, Chipping Norton, Oxfordshire © Historic England. Photograph by Martin Bridge

Research Report Series 3-2020

## THE GUILDHALL MIDDLE ROW CHIPPING NORTON OXFORDSHIRE

## **Tree-ring Analysis of Oak and Elm Timbers**

Martin Bridge and Cathy Tyers

NGR: SP 31385 27230

© Historic England

ISSN 2059-4453 (Online)

The Research Report Series incorporates reports by Historic England's expert teams and other researchers. It replaces the former Centre for Archaeology Reports Series, the Archaeological Investigation Report Series, the Architectural Investigation Report Series, and the Research Department Report Series.

Many of the Research Reports are of an interim nature and serve to make available the results of specialist investigations in advance of full publication. They are not usually subject to external refereeing, and their conclusions may sometimes have to be modified in the light of information not available at the time of the investigation. Where no final project report is available, readers must consult the author before citing these reports in any publication.

For more information write to Res.reports@HistoricEngland.org.uk or mail: Historic England, Fort Cumberland, Fort Cumberland Road, Eastney, Portsmouth PO4 9LD

Opinions expressed in Research Reports are those of the author(s) and are not necessarily those of Historic England.

3-2020

#### SUMMARY

Twelve cores were taken from timbers in the roof and at ground-floor level from the primary sections of the building, which has subsequently been extended south and north. Two were found to have too few rings for further analysis and one was of elm (*Ulmus* spp) and was also excluded. Eight of the remaining series cross-matched and were combined into a 171-year site chronology, subsequently dated to the period AD 1338–1508. Sapwood was complete on two cores, but the outermost rings were degraded and a short felling date range has therefore been derived based on the approximate number of rings present in these degraded sections. It appears that all the timbers were likely from trees felled at the same time, in AD 1514–20. Several purlins were thought to be later replacements but, of the two potentially later examples sampled, one was the elm sample and the other could not be dated independently. At least one of the purlins, however, was shown to be original to the roof.

CONTRIBUTORS Martin Bridge and Cathy Tyers

#### ACKNOWLEDGEMENTS

We are grateful to the owners for allowing this work to be carried out. The site was one of several examined as part of the Historic Fabric in Historic Towns: Chipping Norton project, and we thank Rebecca Lane for managing the project on behalf of Historic England. We'd like to thank the Guildhall staff who were very helpful and accommodating during fieldwork.We are indebted to members of the Oxfordshire Buildings Record and Chipping Norton Buildings Record, especially Victoria Hubbard for her extensive input on coordinating the project, and her friendly encouragement, and Jan Cliffe for permission to reproduce her drawings in Figures 2–3. We'd also like to thank Shahina Farid for commissioning the work, and her input into preparing this report.

#### ARCHIVE LOCATION

Oxfordshire Historic Environment Record County Archaeology Planning Regulation Communities County Hall New Road Oxford OX1 1ND

DATE OF INVESTIGATION 2015

CONTACT DETAILS Martin Bridge UCL Institute of Archaeology 31-34 Gordon Square London WC1H 0PY <u>martin.bridge@ucl.ac.uk</u>

Cathy Tyers Historic England Cannon Bridge House 25 Dowgate Hill London EC4R 2YA cathy.tyers@historicengland.org.uk

## CONTENTS

ntroduction1	-
Early Fabric in Chipping Norton Project1	
The Guildhall	
Methodology2	•
Ascribing felling dates and date ranges	•
Results and Discussion	;
References5	,
Гаbles7	,
Figures	)
Appendix13	;

### INTRODUCTION

The Early Fabric in Historic Towns: Voluntary Group Projects, funded by Historic England, have been developed in the recognition and acknowledgement of the excellent work being undertaken by local vernacular groups in the study of local architectural trends and fabrics. The intention of these projects is to encourage this type of study through the provision of support and facilitate training of more people in building analysis and recording. The local projects were coordinated by Rebecca Lane (Historic England South West Region: Architectural Investigation).

#### Early Fabric in Chipping Norton Project

Whilst Chipping Norton features in a study on historic towns in Oxfordshire (Rodwell 1975), and some buildings have been recorded and published in detail (eg Simons and Phimester 2005), no systematic research had been undertaken on the buildings of the town before this project.

The project examined vernacular historic buildings in the centre of Chipping Norton, aiming to improve understanding of the morphology and development of the historic town plan and to understand this within the framework of economic and social change. It aimed to identify early plan forms and to understand the dates of the introduction of vernacular architectural details (eg in materials, carpentry, fenestration, and decorative features), thus mapping the survival of early (pre-1900) fabric and revealing the architectural evolution of the town's buildings.

Initially, 21 properties were identified that were thought to be key to understanding the town's architectural development for a programme of comprehensive investigation. These properties were assessed for their suitability for dendrochronology and 12 that contained oak timber considered suitable for analysis were initially sampled and analysed. Oak timbers from seven of these buildings could be dated by ring-width dendrochronology, whilst radiocarbon wiggle-matching was undertaken for one of the buildings where the ring-width dendrochronology had produced an undated site master chronology.

The results of the project are presented by Rosen and Cliffe (2017). The reports produced on the historic buildings recorded as part of this project by the Chipping Norton Buildings Record/Oxfordshire Buildings Record (OBR) will be deposited in the Oxfordshire Historic Environment Record.

#### The Guildhall

This grade II listed building (LEN 1052632) is situated north of the market place in a prominent part of the town (Fig 1). It consists principally of a three-bay twostorey building, stylistically dated to around AD 1520, this date being based mostly on the form of mullioned first-floor stone windows, with a substantial eighteenthcentury extension to the south, and a smaller northern extension. It has been suggested that the building may have originated earlier, perhaps to the time of the foundation of the Trinity Guild around AD 1450, as a three-bay ground-floor hall, which became incorporated into the later building. As an important early building in the town, it was a natural candidate for dendrochronological investigation as part of the *Early Fabric in Historic Towns: Chipping Norton* project. It was hoped that any results might give additional evidence on the development of the building and hence enhance understanding of its part in the early development of this historic town.

## METHODOLOGY

Fieldwork for the present study was carried out in early September 2015, following an initial assessment of the potential for dating a few weeks beforehand, and consultation with those involved in the project and the Guildhall staff. In the initial assessment, accessible oak timbers with more than 50 rings and where possible traces of sapwood were sought, although slightly shorter sequences are sometimes sampled if little other material is available. Those timbers judged to be potentially useful were cored using a 16mm auger attached to an electric drill. The cores were labelled, and stored for subsequent analysis.

The cores were polished on a belt sander using 80 to 400 grit abrasive paper to allow the ring boundaries to be clearly distinguished. The samples had their treering sequences measured to an accuracy of 0.01mm, using a specially constructed system utilising a binocular microscope with the sample mounted on a travelling stage with a linear transducer linked to a PC, which recorded the ring widths into a dataset. The software used in measuring and subsequent analysis was written by Ian Tyers (2004). Cross-matching was attempted by a process of qualified statistical comparison by computer, supported by visual checks. The ring-width series were compared for statistical cross-matching, using a variant of the Belfast CROS program (Baillie and Pilcher 1973). Ring sequences were plotted on the computer monitor to allow visual comparisons to be made between sequences. This method provides a measure of quality control in identifying any potential errors in the measurements when the samples cross-match.

In comparing one sample or site master against other samples or chronologies, *t*-values over 3.5 are considered significant, although in reality it is common to find demonstrably spurious *t*-values of 4 and 5 because more than one matching position is indicated. For this reason, dendrochronologists prefer to see some *t*-value in the range of 5, 6, and higher, and for these to be well replicated from different, independent chronologies with both local and regional chronologies well represented, except where imported timbers are identified. Where two individual samples match together with a *t*-value of 10 or above, and visually exhibit exceptionally similar ring patterns, they may have originated from the same parent tree. Same-tree matches can also be identified through the external characteristics of the timber itself, such as knots and shake patterns. Lower *t*-values however do not preclude same tree derivation.

#### Ascribing felling dates and date ranges

Once a tree-ring sequence has been firmly dated in time, a felling date, or date range, is ascribed where possible. With samples which have sapwood complete to the underside of, or including bark, this process is relatively straightforward.

Depending on the completeness of the final ring (ie if it has only the spring vessels or earlywood formed, or the latewood or summer growth) a precise felling date and season can be given. If the sapwood is partially missing, or if only a heartwood/sapwood transition boundary survives, then an estimated felling date range can be given for each sample. The number of sapwood rings can be estimated by using an empirically derived sapwood estimate with a given confidence limit. If no sapwood or heartwood/sapwood boundary survives then the minimum number of sapwood rings from the appropriate sapwood estimate is added to the last measured ring to give a *terminus post quem* (*tpq*) or felled-after date.

A review of the geographical distribution of dated sapwood data from historic timbers has shown that a sapwood estimate relevant to the region of origin should be used in interpretation, which in this area is 9-41 rings (Miles 1997). It must be emphasised that dendrochronology can only date when a tree has been felled, not when the timber was used to construct the structure or object under study.

#### **RESULTS AND DISCUSSION**

The ground-floor ceiling beams in the older (northern) section of the building were covered in thick black paint, although the heartwood/sapwood boundary was apparent on two of them and the decision was therefore made to sample some of them to see if they contained sufficient numbers of rings for full analysis. In addition, a lintel above a doorway at the western end of the entrance passageway was also sampled. Details of the timbers sampled are given in Table 1 and their locations are illustrated on Figure 2. One of the ceiling timbers, core cngldh02, had a knot in mid-sequence and was not measured.

Two trusses remain in the roof area, with associated purlins, some of which were clearly replacements, based on their appearance. Eight timbers were sampled from this roof, with two cores takes from the east principal rafter of the north truss (cngldh08a-b) in an effort to obtain sapwood complete to the bark edge. Details of the timbers sampled are given in Table 1 and their locations are illustrated on Figure 3.

Four of the purlins were sampled, one of which was found to be of elm (cngldh12) and one of which was found to contain too few rings for further analysis (cngldh05). In addition one of the ceiling beams (cngldh02) was rejected as the ring sequence was severely distorted. Cross-matching, supported by good consistent individual cross-dating of the individual series with the oak reference database, was identified between eight of the measured samples, representing timbers from both the roof and the ground-floor timbers (Table 2; Fig 4). This indicates that the roof timbers, including one of the purlins, and ground-floor timbers are probably a single batch of timbers, most likely felled at the same time. The ring-width series from the cross-matched samples were combined into a 171-year long site master chronology, CNGLDHLL, subsequently dated to the period AD 1338–1508. The strongest matches for this site master were with sites to the north and north-west of Chipping Norton (Table 3), right up into Yorkshire and Cheshire, despite there being many potential matches to the south. It still seems likely that the timber is of relatively local in origin.

Two of the dated samples retained sapwood, but in both the outermost rings were very degraded and it was not possible to measure them, although a reasonable estimate of the number of remaining rings made it possible to determine a narrow felling date range for each. One of these timbers had a second core taken from it consisting of sapwood only, complete to the outside ring, where it was possible to measure 23 rings. This confirmed the approximate number of sapwood rings for this timber (cngldh08a-b), although this short series could not be cross-matched with its longer counterpart to provide a precise felling date. The heartwood/sapwood boundary dates for all those timbers that retained the boundary are very similar and the likely felling date range for the group is c AD 1514–20. This agrees very well with the stylistic dating evidence derived from the stone window frames on the first floor.

The ring-width series for the elm timber (cngldhl12) was compared with the oak site master, CNGLDHLL, and the database of oak reference chronologies, but no dating was obtained for it. It was also subsequently compared to the elm series obtained during the HE funded elm project (Bridge and Tyers forthcoming) but again without success.

The ring width data for all the measured samples are given in the Appendix.

#### REFERENCES

Arnold, A, Howard, R, and Litton, C, 2006a *Tree-ring Analysis of Timbers from Kingsbury Hall, Kingsbury, Warwickshire*, English Heritage Res Dept Rep Ser, **53/2006** 

Arnold, A, Howard, R, and Litton, C, 2006b *Tree-ring Analysis of Timbers from the Guildhall Complex and Pedagogue's House, Stratford-upon-Avon, Warwickshire,* English Heritage Res Dept Rep Ser, **68/2006** 

Arnold, A, and Howard, R, 2015 *Westgate End House, Kemps Bridge, Wakefield, West Yorkshire, Tree-ring Analysis of Timbers*, Historic England Res Rep Ser, **28/2015** 

Baillie, M G L, and Pilcher, J R, 1973 A simple cross-dating program for tree-ring research, *Tree Ring Bulletin*, **33**, 7–14

Bridge, M, and Tyers, C, forthcoming Elm in vernacular buildings and its potential for dating, *Vernacular Architect* 

Howard, R E, Laxton, R R, and Litton, C D, 2003 *Tree-ring analysis of timbers from Combermere Abbey, Whitchurch, Cheshire*, Centre for Archaeol Rep, **83/2003** 

Howard, R E, Laxton, R R, and Litton, C D, 2004 *Tree-ring analysis of timbers from Springfield, Post Office Lane, South Chard, Somerset*, Centre for Archaeology Rep, **83/2004** 

Miles, D H, 1997 The interpretation, presentation, and use of tree-ring dates, *Vernacular Architect*, **28**, 40–56

Miles, D H, and Worthington, M J, 2002 Tree-ring dates, *Vernacular Architect*, **33**, 81–102

Miles, D H, Worthington, M J, and Bridge, M C, 2006 Tree-ring dates, *Vernacular Architect*, **37**, 118–32

Miles, D H, Worthington, M J, and Bridge, M C, 2009 Tree-ring dates, *Vernacular Architect*, **40**, 122–31

Nayling, N, 2006 *Tree-ring Analysis of Timbers from Gorcott Hall, Warwickshire*, English Heritage Res Dept Rep Ser, **54/2006** 

Rodwell, K, 1975 *Historic towns in Oxfordshire: a survey of the New County*, Oxford (Oxford Archaeologial Unit)

Rosen, A, and Cliffe, J, 2017 *The making of Chipping Norton: a guide to its buildings and history to 1750*, Cheltenham (The History Press)

Simons, E, and Phimester, J, 2005 A late medieval inn at the White Hart Hotel, Chipping Norton, Oxfordshire, *Oxoniensia*, **70**, 309–24

Tyers, I, 1999 Dendrochronological analysis of timbers from Black Ladies, near Brewood, Staffordshire, ARCUS Rep, **484** 

Tyers, I, 2001 Dendrochronological analysis of timbers from Headlands Hall, Liversedge, Yorkshire, ARCUS Rep, **574c** 

Tyers, I, 2004 Dendro for Windows Program Guide 3rd edn, ARCUS Report, 500b

# TABLES

 $\overline{\phantom{a}}$ 

#### Table 1: Details of the samples taken from The Guildhall, Middle Row, Chipping Norton

Sample	Timber and position	No of rings	Mean ring	Dates	h/s	Sapwood	Mean	Felling date
number			width	spanning	boundary	rings	sensitivity	ranges (AD)
			(mm)	(AD)	date (AD)			
Ground Fle	oor							
cngldhl01	Lintel over steps, rear of cross	82	0.87	1401-82	-	-	0.22	after 1491
	passage							
cngldhl02	North-South ceiling beam, over	c56§	NM	-	-	-	-	-
	cross-passage							
cngldhl03	South ceiling beam in north room	67	2.25	1426-92	1492	h/s	0.14	1501-33
cngldhl04	North ceiling beam in north room	80 (+2NM)	2.43	1419–98	(1500)	(+2NM to	0.22	1509-41
						h/s)		
Roof								
cngldhl05	East purlin in south end bay	30	NM	-	-	-	-	-
cngldhl06	West purlin in south end bay	107	1.42	1383-1489	1489	h/s	0.25	1498-1530
cngldhl07	East principal rafter, south truss	86	1.60	1375-1460	-	-	0.15	after 1469
cngldhl08a	East principal rafter, north truss	101 (+6NM)	1.39	1408-1508	1489	19 (+c6NM)	0.16	1514-c20
cngldhl08b	ditto	23	NM	-	-	23C	-	-
cngldhl09	West principal rafter, north truss	89	2.09	1372-1460	-	-	0.16	after 1469
cngldhl10	Collar, north truss	171 (+c4NM)	1.50	1338-1508	1489	19 (+c4NM)	0.22	1512-c20
cngldhl11	East purlin, north bay	79	1.64	-	-	26C	0.25	-
cngldhl12	East purlin, central bay	95	1.08	-	-	-	0.30	-

Key: \$ = distorted by a knot in mid-sequence; NM = not measured; h/s = heartwood/sapwood boundary; C = complete sapwood, winter felled; \* = elm (*Ulmus*sp.)

				<i>t</i> -values						
Sample number	cngldhl03	cngldhl04	cngldhl06	cngldhl07	cngldhl08a	cngldhl09	cngldhl10			
cngldhl01	0.9	2.7	5.7	1.4	2.6	1.1	3.9			
cngldhl03		3.6	1.4	2.3	3.7	0.7	1.1			
cngldhl04			4.4	2.6	4.3	0.7	3.2			
cngldhl06				1.1	2.4	1.9	5.5			
cngldhl07					5.3	3.0	4.9			
cngldhl08a						3.2	3.6			
cngldhl09							1.6			

Table 2: Cross-matching between the dated series derived from samples from The Guildhall, Chipping Norton. Values of t- in excess of 3.5 are significant

Table 3: Dating evidence for the site master, CNGLDHLL, as spanning AD 1338–1508

8	Source region:	Chronology name:	Publication reference:	File name:	Span of	Overlap	t-value
					chronology (AD)	(years)	
	Warwickshire	Kingsbury Hall	(Arnold <i>et al</i> 2006a)	KNGHSQ01	1391–1564	118	8.6
	Cheshire	Combermere Abbey,	(Howard <i>et al</i> 2003)	CBMASQ01	1371-1564	138	8.5
	West Yorkshire	Westgate End House, Wakefield	(Arnold and Howard 2015)	WFFBSQ01	1377-1567	132	8.4
	West Yorkshire	Headlands Hall, Liversedge	(Tyers 2001)	HEADLAND	1388–1487	100	8.4
	Warwickshire	Gorcott Hall	(Nayling 2006)	GORC_T17	1385-1531	124	8.1
	Somerset	Springfield Post Office, Chard	(Howard <i>et al</i> 2004)	SPOLSQ03	1366-1445	80	8.0
	Warwickshire	Guildhall, Stratford-on-Avon	(Arnold <i>et al</i> 2006b)	SUABSQ02	1377-1502	126	7.9
	Staffordshire	Black Ladies, nr Brewood	(Tyers 1999)	BLADIES	1372–1671	137	7.8
	Oxfordshire	Yelford Manor	(Miles and Worthington 2002)	YELFORD	1370-1499	130	7.7
	Gloucestershire	Algars Manor, Iron Acton	(Miles <i>et al</i> 2009)	ALGARS	1381-1559	128	7.7
	Shropshire	Abcott Manor, Clungunford	(Miles and Worthington 2002)	CGFA	1422-1545	87	7.7
	Shropshire	Dutch Cottage, Clunbury	(Miles <i>et al</i> 2006)	DUTCHCOT	1424-1549	85	7.2

## FIGURES



Figure 1: Maps to show the location of The Guildhall in Chipping Norton, marked in red. Scale: top right 1:15000; bottom 1:2000. © Crown Copyright and database right 2020. All rights reserved. Ordnance Survey Licence number 100024900. © British Crown and SeaZone Solutions Ltd 2020. All rights reserved. Licence number 102006.006. © Historic England



Figure 2: Plan of the ground floor, showing the locations of samples taken for dendrochronology (adapted from original drawings by Jan Cliffe, Chipping Norton Buildings Record working with the Oxfordshire Buildings Record)





Figure 3: Cross-sectional drawing of the building, looking west, showing the roof timbers samples for dendrochronology (adapted from original drawings by Jan Cliffe, Chipping Norton Buildings Record working with the Oxfordshire Buildings Record)



→after AD1491 AD1501-33 AD1509-41 → after AD1469 → after AD1469 AD1498-1530 AD1512-c20 AD1514-c20 Calendar Years AD1400 AD1450 AD1500

*Figure 4: Bar diagram showing the relative positions of overlap of the dated samples, and their individual felling dates/date* ranges, from The Guildhall, Chipping Norton. White bar – heartwood; yellow hatched bar - sapwood; narrow bar sections – additional unmeasured rings

12

## APPENDIX

Ring width values (0.01mm) for the sequences measured

Oak									
cngld	lh01								
72	82	98	82	88	53	52	51	38	26
35	42	54	51	54	49	63	38	55	85
78	58	97	106	66	54	86	101	154	251
276	289	163	160	124	81	48	77	49	86
94	86	90	118	99	64	59	63	77	82
100	82	85	76	69	63	60	65	86	117
111	97	113	127	78	72	69	52	54	59
52	54	76	92	96	173	127	84	93	69
99	118		. –			,			
	_								
cngld	lh03								
316	273	429	362	340	367	425	334	353	372
350	273	260	181	213	227	190	188	187	170
194	203	184	181	135	191	187	193	154	195
172	194	212	167	182	180	163	179	164	176
228	210	191	268	312	299	209	252	180	241
190	193	177	192	206	258	250	258	207	140
152	197	175	172	175	157	149			
cngld	h04								
340	438	362	226	282	262	219	188	262	395
296	304	383	501	343	382	440	391	351	219
179	253	243	233	254	256	197	177	245	212
295	231	200	213	171	113	186	206	223	189
240	362	190	243	314	226	165	223	244	175
196	261	271	292	251	169	268	265	141	155
234	206	327	211	217	193	201	203	242	216
230	292	162	134	146	143	123	217	158	110
cngld	h06								
207	205	214	261	140	102	87	126	171	143
149	137	141	217	206	224	201	139	239	200
216	243	159	134	101	110	66	102	91	131
148	159	139	76	68	67	78	128	124	102
215	181	132	73	87	102	132	159	181	182
113	225	157	114	79	96	97	107	190	154
152	160	116	98	82	108	163	164	205	212
147	104	99	117	105	125	159	178	129	168
185	103	38	67	128	95	87	76	69	60
117	138	227	256	178	103	124	124	140	176
142	175	191	153	212	277	63			
cngio	107	010	007	001	040	100	010	101	105
108	10/	219	23/ 200	231	243	109	218	191	100
21/	20/	208	223	1/4	15/	1/4	153	105	182
193	223	1/8	215	237	238	21/	232	244	241

182	196	136	167	192	127	110	135	185	185
168	195	148	154	165	182	208	159	237	174
197	163	177	195	156	99	112	113	94	100
110	106	92	81	98	125	142	106	129	107
86	81	103	101	82	112	106	91	105	101
94	84	101	114	111	128				
cngld	h08a								
406	399	206	194	234	293	216	261	244	234
241	171	235	271	205	376	248	286	223	233
319	237	179	200	219	171	156	200	188	142
130	123	132	128	108	112	101	108	77	77
73	99	91	106	98	91	114	93	75	82
85	94	82	74	60	94	73	80	106	85
76	70	69	79	77	89	100	117	107	78
78	83	101	118	117	118	118	102	133	152
93	107	109	113	80	89	104	102	105	76
82	90	91	111	113	110	112	107	69	82
100									
on al d	<b>b</b> 00								
	1109	206	201	204	076	001	406	240	200
249	228	280	301	284	2/0	331	406	349	290
310	331	305	311	454	334	242	205	251	241
256	360	288	253	437	384	403	377	351	181
193	218	221	196	164	1/5	209	225	126	141
185	181	199	188	207	1/9	211	155	1/6	202
181	291	238	2/3	205	205	266	207	190	215
242	190	232	233	185	165	171	139	54	56
66	/9	/5	92	84	103	98	98	/9	104
89	8/	85	86	82	8/	//	95	116	
cngld	h10								
173	166	117	75	74	104	154	110	74	107
96	111	85	71	80	100	96	134	100	62
71	42	83	99	117	171	112	97	86	95
173	135	69	106	58	107	117	128	189	187
128	128	162	144	173	174	183	183	241	189
142	71	125	169	185	173	193	180	213	185
156	184	175	187	204	232	272	243	235	153
130	119	94	73	92	179	161	171	148	124
131	127	165	146	155	234	256	184	122	98
185	203	255	260	286	181	252	217	174	160
126	134	197	288	213	298	297	188	140	129
188	185	248	313	217	164	136	155	122	92
119	126	195	157	179	158	137	135	105	111
97	63	57	56	80	94	141	157	132	113
97	89	114	127	123	116	128	140	157	220
150	157	179	131	127	148	196	274	261	207
175	168	143	130	139	193	143	120	143	59
100									
	1								
cngld	hll	01-	0.61	oc -	100	01	0.0	1 = 0	0.10
309	218	215	261	335	120	81	98	153	349

357	317	411	296	323	331	244	276	303	405	
265	388	308	130	84	74	74	99	111	109	
223	223	154	212	208	210	86	58	67	78	
88	91	90	88	126	166	129	120	150	154	
187	242	308	217	195	239	307	89	51	39	
69	63	65	79	97	114	112	94	112	52	
37	48	54	49	65	47	54	60	48		
Elm										
cngld	lh12									
61	70	125	132	136	83	77	63	49	52	
56	79	111	85	96	115	67	133	96	96	
138	99	130	101	128	108	141	218	161	116	
92	111	172	76	103	139	119	83	62	55	
47	44	84	59	62	56	59	57	39	92	
187	220	183	149	75	65	66	179	109	63	
64	44	59	70	49	45	51	67	98	67	
49	51	43	52	41	47	66	122	130	201	
146	158	96	131	179	218	75	126	162	430	
427	335	152	97	122						



## Historic England Research and the Historic Environment

We are the public body that looks after England's historic environment. We champion historic places, helping people understand, value and care for them.

A good understanding of the historic environment is fundamental to ensuring people appreciate and enjoy their heritage and provides the essential first step towards its effective protection.

Historic England works to improve care, understanding and public enjoyment of the historic environment. We undertake and sponsor authoritative research. We develop new approaches to interpreting and protecting heritage and provide high quality expert advice and training.

We make the results of our work available through the Historic England Research Report Series, and through journal publications and monographs. Our online magazine Historic England Research which appears twice 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 Reports, with abstracts and information on how to obtain copies, may be found on www.HistoricEngland.org.uk/researchreports

Some of these reports are interim reports, making the results of specialist investigations available in advance of full publication. They are not usually subject to external refereeing, and their conclusions may sometimes have to be modified in the light of information not available at the time of the investigation.

Where no final project report is available, you should consult the author before citing these reports in any publication. Opinions expressed in these reports are those of the author(s) and are not necessarily those of Historic England.

The Research Reports' database replaces the former:

Ancient Monuments Laboratory (AML) Reports Series The Centre for Archaeology (CfA) Reports Series The Archaeological Investigation Report Series and The Architectural Investigation Reports Series.