Research Report Series 3/2026

21 Chapel Street, Stratford-upon-Avon, Warwickshire

Tree-ring analysis of elm and oak timbers

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National Grid Reference: SP 20093 54777

Print: ISSN 2398-3841
Online: ISSN 2059-4453

Summary

The main structural timber elements of this multiphase building were found to be elm, with the presence of oak limited to some small re-used joists in the rear range, some inaccessible beams in the rear extension and a beam embedded in the north wall, at first-floor level, in the stairwell block; this latter timber being sampled but undated. Therefore, sampling was mostly limited to a few elm timbers from various areas within the building, these samples are unsuitable for conventional ring-width dendrochronology but potentially suitable for other complementary scientific dating techniques.

Contributors

Martin Bridge

Acknowledgements

The owners are thanked for allowing access, and for their cooperation and support during assessment and sampling. The *StratFire* project team are thanked for their assistance, especially Ric Tyler who made available his drawings of the property and Jonathan Devereux, who made arrangements for access, and assisted during the fieldwork. This study was commissioned by Shahina Farid, Alison Arnold collated the maps reproduced as Figure 1 and Cathy Tyers commented on earlier drafts of this report (Historic England Scientific Dating Team),

Front cover image

21 Chapel Street, Stratford-upon-Avon, Warwickshire. [©Historic England. Photograph Martin Bridge]

Archive location

Historic England, The Engine House, Fire Fly Avenue, Swindon, SN2 2EH

Historic environment record

Warwickshire Historic Environment Record, Archaeological Information and Advice, Communities, Warwickshire County Council, PO Box 43, Shire Hall, Warwick, CV34 4SX

Date of investigation

Fieldwork was undertaken in July 2022 and the report written in 2025.

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Introduction

This building was investigated as part of the *StratFire* project, a project proposed by the Stratford-upon-Avon Society and subsequently supported by Historic England.

The project focusses on the impact of two major fires in the late-sixteenth century in AD 1594 and AD 1595, as well as taking into account another major fire in AD 1614. Bearman (2000) investigated the two late sixteenth-century fires in detail using documentary sources. Subsequently the Stratford-upon-Avon Society have been highlighting the architectural heritage along the main thoroughfare through on-going volunteer-led research (Historic Spine (stratfordsociety.co.uk)) which has itself led to the development of the *StratFire* project (*StratFire* Project (stratfordsociety.co.uk)) which combines detailed archival research with comprehensive building recording and analysis, as well as dendrochronology. The project summary, as per the final agreed project design (Historic England Project number 8452) is as follows:

“The aim of this project, by means of high-level building recording and analysis, detailed archival research and dendrochronology, is to establish, following Stratford-upon-Avon’s town fires of 1594 and 1595, the chronology, extent and nature of the reconstruction of buildings along High Street and Chapel Street, the epicentre of one or both of these fires. Post-fire documentary sources record damage to certain buildings, and architectural appraisal indicates that several timber-framed buildings surviving today date from the post-fire period. However, more needs to be established concerning the scale, nature and speed of this rebuilding, and the impact of the fires, both on the economic well-being of the town and the fortunes of the families most seriously affected. For many buildings there is simply no documentary evidence to draw on. Moreover, even when documentary evidence exists, it is either confusing or only establishes a date by which rebuilding had taken place. Conversely, it may record fire damage to properties that, from surviving architectural features, appear not to have been entirely rebuilt. High-level building analysis and dendrochronological investigation will resolve much of this uncertainty, provide a sound base for the interpretation of the documentary evidence, and throw definitive light on a crucial episode in the evolution of the architectural and cultural heritage of this internationally renowned town.”

21 Chapel Street

This Grade II-listed building (National Heritage List Entry Number: 1187775; https://historicengland.org.uk/listing/the-list/list-entry/1187775) sits on the east side of Chapel Street, approximately 35m north-east of its junction with Chapel Lane/Scholars Lane, commonly known as “Chaucer Bookshop” (Fig. 1). It consists of five principal units, A–E (Figs 2–4; key plan). A two-storey street frontage block, aligned parallel to the street and heavily remodelled in the late eighteenth century (A), perpendicular to this, and forming the southern side of a rear courtyard is another two-storey block (B), behind which is a single storey extension to it (C). In the angle between blocks A and B is a Victorian stairwell block (D). Finally, there is a twentieth century single storey extension (E) at the far east end (not considered in this investigation). Background information is given in Tyler (2022). The site is notable as the one-time home of Julius Shaw, who was a friend of Shakespeare.

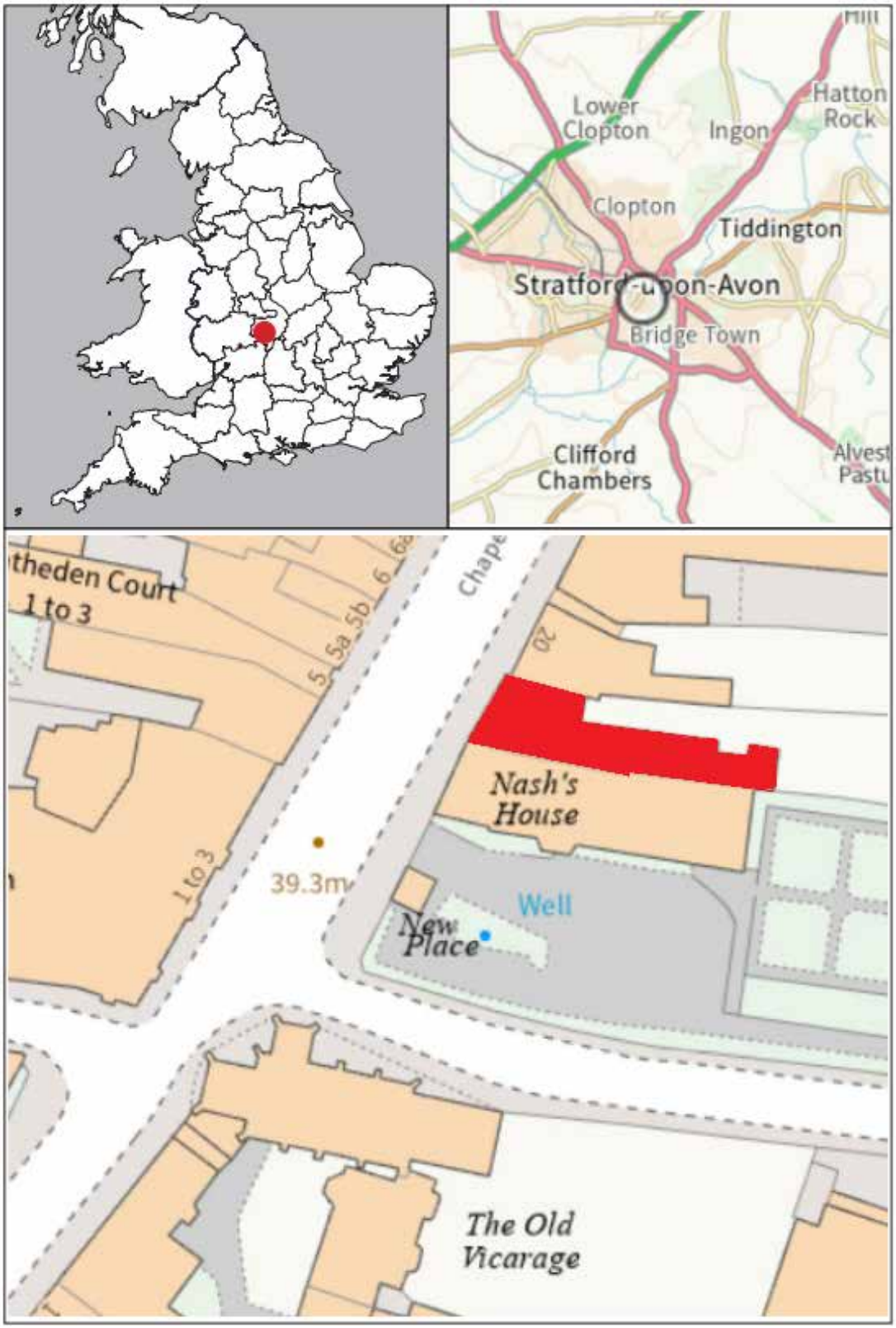

Figure 1: Maps to show the location of 21 Chapel Street, Stratford-upon-Avon. Scale: top-right 1:150,000; bottom 1:1000. [© Crown Copyright and database right 2026. All rights reserved. Ordnance Survey Licence number 100024900].

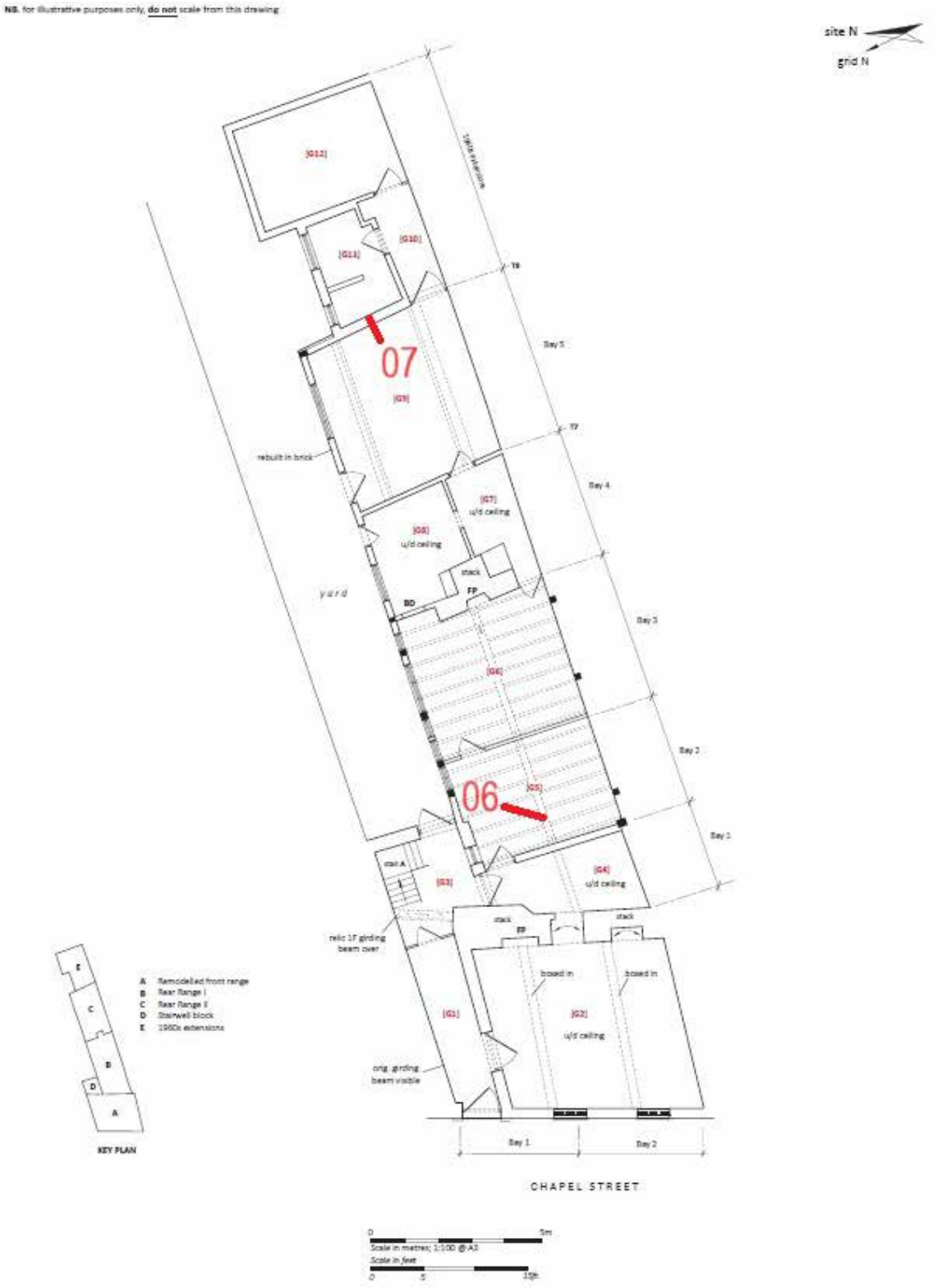

Figure 2: Plan of the ground floor of 21 Chapel Street, showing the locations of samples taken for dendrochronology. [drawing by Ric Tyler]

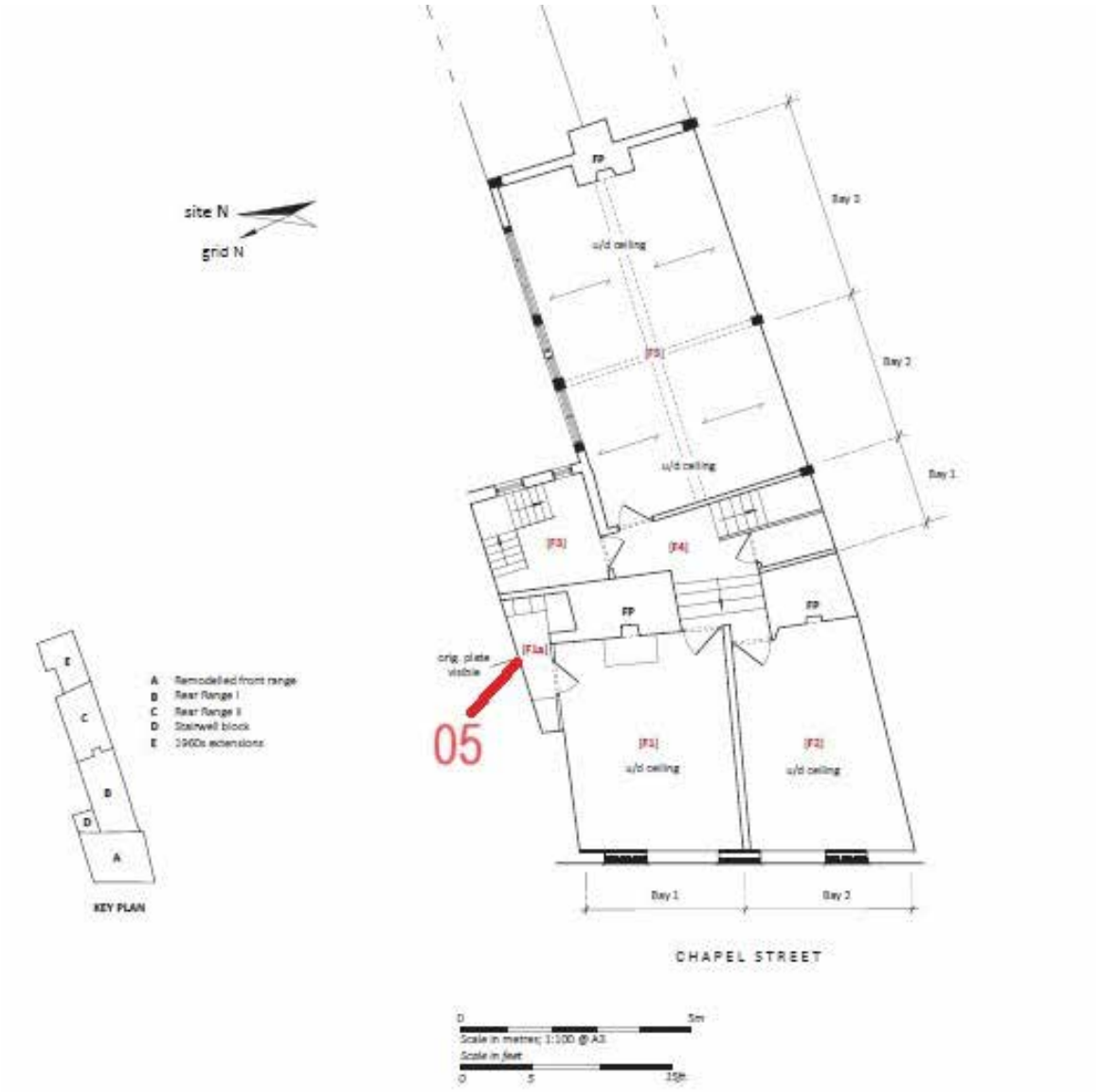

Figure 3: Plan of the first floor of 21 Chapel Street, showing the locations of samples taken for dendrochronology. [drawing by Ric Tyler]

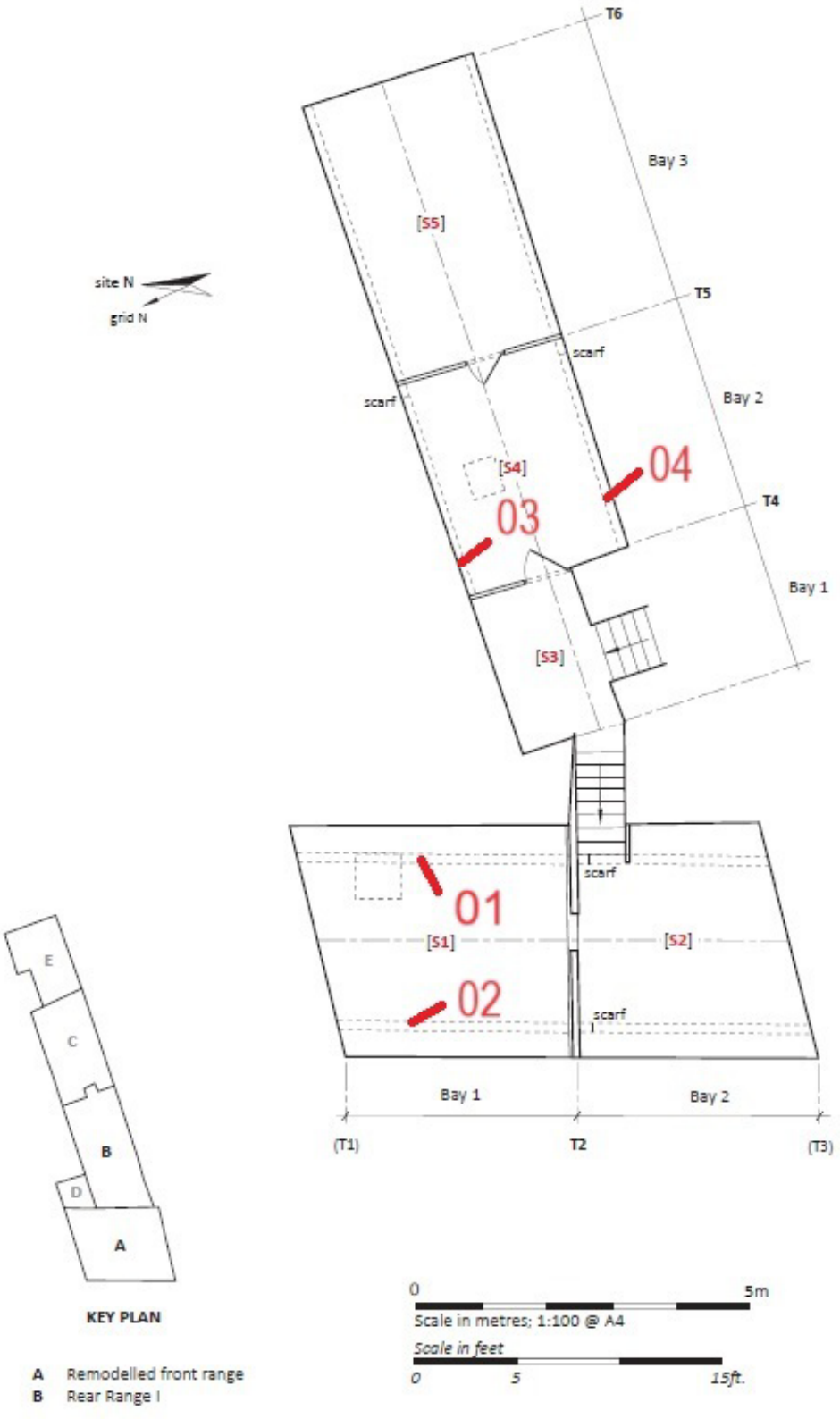

Figure 4: Plan of the second floor of 21 Chapel Street, showing the location of samples taken for dendrochronology. [drawing by Ric Tyler]

Methodology

An initial assessment of the timbers for dendrochronological potential sought accessible timbers, preferably with more than 50 rings and, where possible, traces of sapwood, 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 tree-ring 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 combination of visual matching and a process of qualified statistical comparison by computer. 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 series. 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*-values 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 felling 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 (i.e. if it has only the spring vessels or early wood formed, or

the late wood 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

Only limited sampling was undertaken, as unfortunately, during the assessment of potential, it was found that the only accessible timbers of the front range (A) were those of the roof, and these could be seen to be of elm (*Ulmus spp*). Similarly, the majority of exposed timbers within the rear range (B) were also of elm, with the exception of some small, re-used oak (*Quercus spp*) joists which were deemed too fast grown or of too small scantling, thus containing far too few rings for secure dating purposes. Timbers of the rear extension (C), although a mixture of elm and oak, were generally fast grown and/or mostly inaccessible. However, a single suitable oak wallplate was identified in the stairwell block (D). Due to these premises operating as a bookshop, with much of the space occupied by books, it was not possible to obtain clear photographs of the timbers to illustrate this report.

As most of the main structural elements were of elm, which has been found to be generally unsuitable for conventional dendrochronology (Bridge 2020), sampling was limited to a few major components in the main areas of interest to provide material for possible future analysis by different complementary scientific dating methods. The oak wallplate, accessible from the stairwell block, embedded in the north wall was also sampled. Details of the samples taken are given in Table 1 with locations of these shown in Figures 2, 3, and 4. The ring-width measurements of the samples with more than 20 rings are given in the Appendix.

Only two of the elm samples, sa21chs01 and sa21chs06, contained more than 20 growth rings. These were measured, along with the oak sample, sa21chs05. Comparison of the three series with each other and with the database of oak reference chronologies produced no consistent matching and hence all remain undated by ring-width dendrochronology. The lack of secure dating evidence for the elm series is unsurprising given the known challenges of dating elm through ring-width dendrochronology (Bridge 2020). The inability to date the 66 ring oak series is most likely due to it being a single sample, the dating of which are somewhat more challenging than when dealing with a group of coeval timbers.

Table 1: Details of samples taken at 21 Chapel Street, Stratford-upon-Avon. Samples are elm unless otherwise stated

Sample number	Location	Number of rings	Sapwood	Mean ring width (mm)	Mean sensitivity
Front range (A)					
SA21CHS01	Room S1, Second floor, east purlin	37	h/s	2.33	0.27
SA21CHS02	Room S1, Second floor, west purlin	<20	?C	NM	-
Rear range (B)					
SA21CHS03	Room S4, north purlin	<20	h/s	NM	-
SA21CHS04	Room S4, south purlin	<20	?C	NM	-
SA21CHS06	Room G5, Ground floor, main spine beam	80	?C	1.61	0.27
Stair well (D)					
SA21CHS05	Room F1a lower wallplate beam (oak)	66	?h/s	1.89	0.18
Rear extension (C)					
SA21CHS07	Central stud in east wall	<20	h/s	NM	-

Key: h/s = heartwood/sapwood boundary; C = complete sapwood; NM = not measured

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Appendix

Ring width values (0.01mm) for the sequences measured

sa21chs01

130	235	333	213	249	225	419	481	361	267
185	191	216	369	294	254	288	273	330	218
201	283	209	269	214	225	250	128	101	108
71	48 207	203	205	164	199				

sa21chs05

226	220	283	272	195	213	216	177	204	200
173	151	252	218	238	302	405	360	354	149
203	194	261	187	217	229	199	201	251	269
193	143	194	257	320	227	326	200	186	171
187	213	198	205	188	151	102	119	116	106
110	116	91	90	68	107	98	98	73	126
124	89 96	100	113	139					

sa21chs06

112	198	222	302	238	205	139	187	135	132
70	201	162	220	137	181	204	221	320	84
77	205	241	250	314	193	169	243	191	211
281	337	242	145	267	208	315	340	100	73
93	144	145	164	210	246	237	236	122	104
111	173	162	173	142	166	163	145	118	117
125	158	132	175	160	131	60	62	64	57
58	61 58	54	67	49	70	33	48	51	

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ISSN 2398-3841 (Print)
ISSN 2059-4453 (Online)