DENDROCHRONOLOGICAL ANALYSIS OF OAK TIMBERS FROM 4 HIGH STREET, BADSEY, EVESHAM, WORCESTERSHIRE, ENGLAND.

Tree-Ring Services Report: EVHS/08/08

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SUMMARY

4 High Street consists of the northern half a large ornately panelled building, located on the main street of the village of Badsey, just outside Evesham. No detailed building analysis has been undertaken, but 4 High Street incorporates what appears to be a 3½ bay chimney house. The posts are without jowls. There are small square panels in the wall framing and straight down braces, the front has elaborate decorative paneling. The roof has been modified and raised to make another floor. There is large lateral chimney.

Of the thirteen samples taken from 4 High Street, seven are dated to form a 140-year chronology spanning AD 1447 to AD 1586. One other sample was individually dated and produced a sequence spanning AD 1400 to AD 1487. Four precise felling dates in the winter of AD 1586/7 and another in the spring of AD 1586, together with a probable felling date in AD 1583, indicate that construction occurred as a single phase in AD 1587 or soon after. A fifth timber with a precise felling date in the spring of AD 1573 may have been from a windthrown tree.

KEYWORDS

Dendrochronology, 16th Century, Standing building, Worcestershire, Evesham.

Figures

Tables

Photos

INTRODUCTION

There is an increasing interest in Britain's past as evinced by such television programmes as "Time Team" and "The House Detectives" which both promote and respond to this interest. Increasingly people wish to know precisely when ancient buildings were constructed in order to better understand the history of the land in which we live. However, although there is some ability to date a building on stylistic grounds, a precise date is rarely known except when there is a date-stone or documentary evidence.

The advent of dendrochronology (tree-ring dating) is changing this scenario, at least for buildings with timbers containing sufficient rings for analysis. The science is simple in concept. The width of a tree's growth rings varies from year to year, so that each sequence of years has a unique pattern of narrow and wide rings. We now know in detail the pattern of rings shown by oak trees in England for at least the last 2000 years, and there is some work in progress on other species. Small cores of wood taken from the structural timbers of a building show the pattern of rings laid down during the lifetime of the trees from which the timbers were cut. If this pattern is then compared with 'master chronologies' it is often possible to identify the felling date of the trees with astonishing accuracy. Where bark is present, it is possible to give a precise year, sometimes even the season of the year. We know that oak for building was almost always used 'green', (unseasoned, not having been felled and prepared until required), so construction dates can be determined in which we can place considerable confidence.

Recording Timber Framed Buildings

National trends in building activity inevitably conceal regional differences that can only be explained by detailed local studies. The Royal Commission on the Historical Monuments of England (RCHME) has analysed 53 medieval buildings in Kent (Pearson 1994). Hampshire County Council has analysed well over 100 buildings in the county (Roberts 2003). The Domestic Buildings Research Group (Surrey) is a voluntary group actively involved in the recording of domestic buildings and farm buildings, mainly in Surrey. For further information visit their website at: **www.dbrg.org.uk**. These projects utilise the specific dates provided by tree-ring analysis to refine the typological and stylistic dating of buildings.

Harris (1978) provides a useful introduction to the study of timber-framed buildings, while Brunskill (2000) details the study of vernacular architecture. Alcock's (1996) glossary provides illustrative drawings which are particularly useful in facilitating the naming of timbers in a building.

Figure 1: Area location map

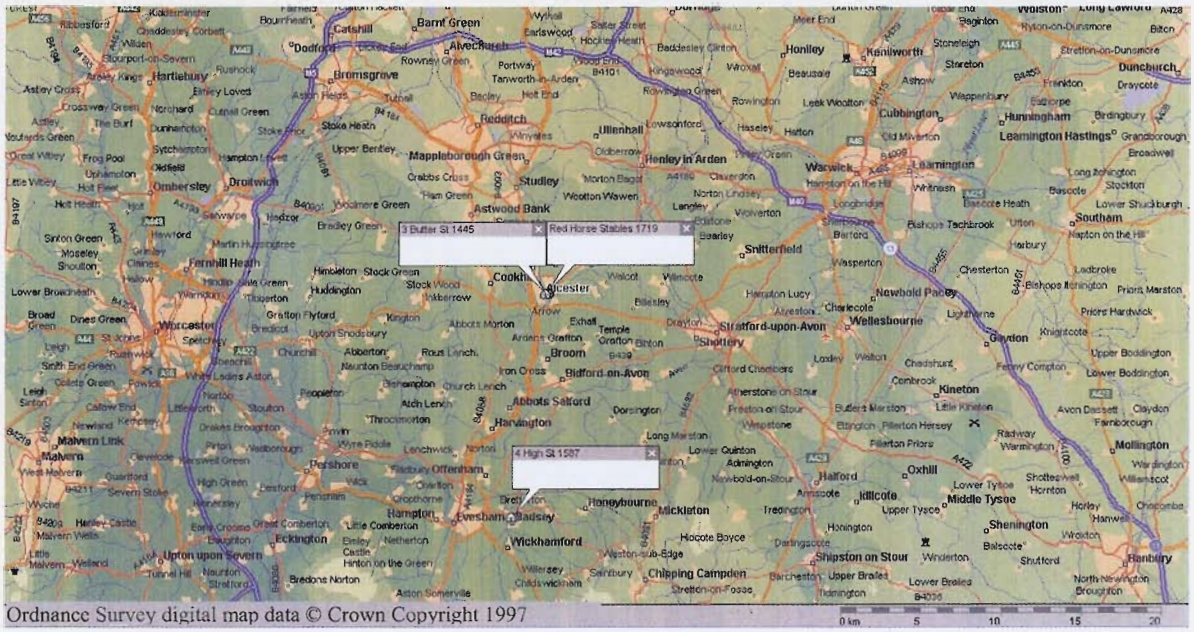
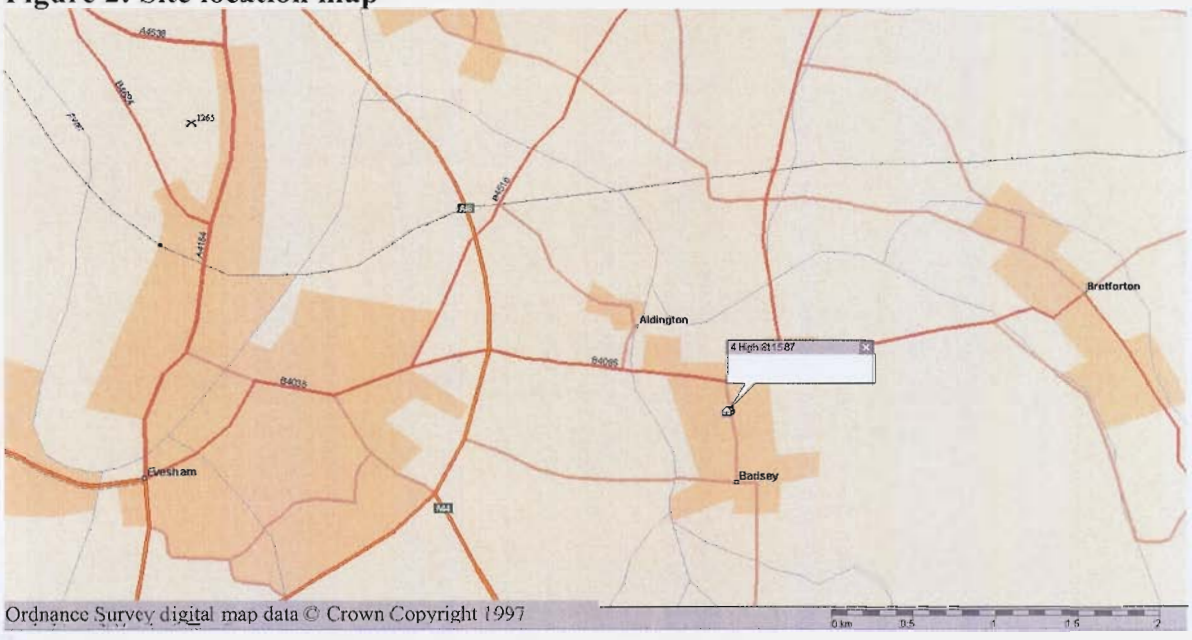


Figure 2: Site location map



4 High Street (NGR: SP 0695 4342).

4 High Street consists of the northern half a large ornately panelled building, located on the main street of the village of Badsey, just outside Evesham. No detailed building analysis has been undertaken, but 4 High Street incorporates what appears to be a 3½ bay chimney house.

The posts are without jowls. There are small square panels in the wall framing and straight down braces. The roof has been modified and raised to make another floor. There is large lateral chimney.

Photo 1: 4 High Street east aspect

Photo 2: 4 High Street north-west aspect

Objective of the analysis

The main objective of this analysis was to provide dendrochronological evidence to date the primary phase of construction of this building.

Dendrochronological Assessment

4 High Street was visited on the 26th March 2008 and a brief dendrochronological assessment conducted. The building timbers were assessed for their potential use in dendrochronological study. The main frame timbers and wall panels were identified to be oak with more than 50 rings. A number of these timbers also had traces of sapwood or bark remaining and were therefore assessed as likely the most suitable for sampling. The roof timbers were predominantly elm and considered unsuitable. The ground floor chimney bressumer was also included for sampling.

The building was later visted on the 11th August 2008. The purpose was to try establish whether the front decrative framing and rear end were co-eval with the construction of the rest of the building.

METHODOLOGY

Methods employed by Tree-Ring Services in general are those described in English Heritage guidelines (Hillam 1998a). Details of the methods employed for the analysis of this building are described below.

Sampling and Preparation

Photo 3: Extraction of a core in progress

Whenever possible, timbers with more than 50 annual growth rings were selected for sampling. This is necessary to provide a pattern of rings of sufficient length to be unique to the period of time when the parent tree was growing. Timbers were sampled using purpose-made 12mm and 15mm diameter corers attached to an electric drill. Sampling was located as discreetly as possible in what appeared to be original timbers and orientated in the most suitable direction to maximize the numbers of rings for subsequent analysis. Extracted core samples were immediately taped and glued onto wooden

laths on site and then labelled, ready for subsequent analysis.

Tree-ring sequences were revealed through sanding with progressively finer grits to a 600 abrasive grit finish to produce results suitable for measuring, see **Photo 4**. When required, for example where bands of narrow rings occurred, further preparation was performed manually. Where requested, extraction holes were "made good", employing pine dowelling, wood-glue, sawdust and wood stains to restore the timbers to their original appearance.

Photo 4: An example of the tree-ring sequences revealed through the sanding of cores.

Measuring and Cross-matching

Tree-ring sequences are measured under a x20 stereo microscope to an accuracy of 0.01mm using a microcomputer based travelling stage. All samples are measured from the centremost ring to the outermost. Samples considered unsuitable for dating purposes are then rejected. These include samples with disturbed ring sequences which cannot be measured due to knots or bands of extremely narrow rings, and those samples with less than 40 rings.

Samples of less than 50 rings are sometimes rejected from dendrochronological analysis because their ring patterns may not be unique (Hillam *et al.* 1987b). Although this is certainly true of all ring sequences of less than 30 rings which should not be used in dating (Mills 1988), samples with 30 to 50 rings may be dated in some circumstances (Hillam 1998b). Because samples taken by Tree-Ring Services are often from listed structures, it has been felt wise to maximise the recorded amount of data, and sequences of 40-50 rings are included in analysis and considered for dating, usually when they match well with a number of other sequences. Samples are measured twice and the two sets of measurements cross-matched and plotted visually as a check. Where sequences match satisfactorily they are averaged and the resulting sequence used in subsequent analysis. Sequences containing less than 50 rings are suffixed '-S', and sequences from managed trees '-M' to help indicate that additional caution must be exercised in dating.

Cross-correlation algorithms are then employed to search for the positions where tree-ring sequences correlate and therefore possibly match. All statistical correlations are reported as *t*-values derived from the original CROS73 algorithm (Baillie and Pilcher 1973). A value of 3.5 or over is usually indicative of a good match as it represents the value of '*t*' which should occur by chance only once in every 1000 mismatches (Baillie 1982), and the higher the *t*-value the closer to congruency in the cross-matching. However, due to the remaining small risk of high *t*-values being produced by chance, all indicated correlations are further checked to ensure that corroborative high results are obtained at the same relative position against a range of independent tree-ring sequences. Visual comparisons of sequences are also employed to support or reject possible cross-matches and serve as a means of identifying measuring errors.

Timber Groups

A further element of the tree-ring analysis of buildings and archaeological assemblages is the grouping of timbers within the sampled material. Inspection of *in situ* timbers may indicate that samples derive from a common timber, while common arrangements of anatomical features (knots & branching) may also indicate samples are derived from a single tree.

Tree-ring analysis is used to support suggestions of same-tree groups between samples based on a combination of information. Timbers derived from the same tree are generally expected to have *t*-values over 10, although lower *t*-values may be produced when different radii measured from the same tree are compared. Tree-ring sequences producing *t*-values of 10 or above are examined to identify same-tree groups. Good comparisons of visual matching, growth rates, short and longer term growth patterns, are combined with pith information, sapwood boundaries, bark and anatomical anomalies, to help decide whether timbers are likely to come from the same tree. Where timbers are assessed to derive from the same tree, to avoid bias the sequences are averaged to produce a single tree-ring sequence before inclusion in the final site chronology, but inevitably some same-tree samples go undetected by dendrochronology.

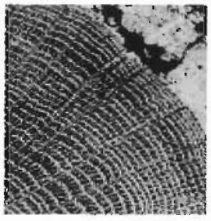
Chronology building and Cross-dating

The process of cross-matching compares all tree-ring sequences against one another and those found to cross-match satisfactorily together are combined to create an average sequence. The site mean(s) and individual ring sequences which remain unmatched with the site mean are then tested against a range of established reference sequences (reference chronologies). Significant *t*-values replicated against a range of sequences at the same position with satisfactory visual matching are similarly used to establish cross-matches with reference chronologies. Where cross-matching is established against dated reference chronologies, calendar dates can be assigned to the site sequences. The dates of the first and last ring of dated sequences are produced as date spans and these dates should not be confused with felling dates.

Felling Dates

Sequences dated by the cross-dating process provide calendar year dates for the final tree-ring present in the measured timber sample. The interpretation of these dates then relies upon the nature of the final rings in the sequence. Where bark survives intact on a sample a felling date is given as the date of the last ring measured on the tree-ring sequence. Based on the completeness of the final ring it is sometimes even possible to distinguish between spring, summer or winter fellings, corresponding to approximately March to May, June to September and October to February respectively. Where timbers were felled in either spring or summer and the final ring is incomplete and therefore not measured, allowance has to be made for the one-year discrepancy between the end of a measured sequence and the actual year of felling.

Sapwood Estimates

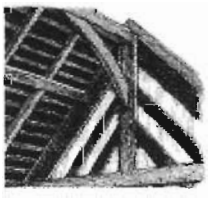


Where bark is missing from oak samples, as long as either sapwood or the heartwood/sapwood boundary have been identified, an estimated felling date range can be calculated using the maximum and minimum number of sapwood rings that were likely to have been present. Sapwood estimates have varied over time with different data sets, geographical location and researchers. A general trend identified is that the number of sapwood rings in oak decreases from north to south and from west to east across Europe.

However, simply not enough is yet understood about sapwood variations and the mechanisms responsible for them. A generally accepted sapwood estimate of between 10 and 55 rings for British and Irish oaks (at 95% confidence) was given in 1987 (Hillam *et al.* 1987a). Analysis of the increased data set available ten years later indicated a range of 10-46 rings to be more appropriate for England (Tyers 1998a). Currently as research in areas improves sapwood estimates are refined and new estimates applied. Therefore, when dendrochronological dates are produced, the reference to the sapwood estimate used in its calculation should always follow.

This report applies a minimum of 11 and maximum of 41 annual rings sapwood estimate, which means that 19 out of every 20 trees examined is expected have between 11 and 41 sapwood rings. This sapwood estimate is currently applied to Worcestershire and has been arrived at by Oxford Dendrochronology Laboratory (Haddon-Reece *et al.* 1990, Miles 1997). Felling date ranges have been calculated by adding the sapwood estimate of minimum and maximum missing rings to the date of the heartwood/sapwood boundary. Felling date ranges have been refined by the presence of surviving sapwood where appropriate, see **Table 4**. Where samples ending in heartwood were dated, "felled after dates" have been calculated by adding the minimum expected number of missing sapwood rings to the samples' final ring dates. These dates represent the earliest probable felling dates. However, the actual felling date of a tree may be decades later due to an unknown number of missing heartwood rings.

Felling Groups



It is common to find that timbers used in the construction or repair of smaller buildings, or identifiable parts of larger buildings, date into groups whose felling dates occur within a narrow range of years. These groups are called associated fellings. Where they are identified the average heartwood/sapwood boundary of the component timbers is used to calculate an overall estimated period of felling.

Close location association and a short (21 years at most) range of heartwood-sapwood boundary dates are normally used to define these groups. The estimates do not assume that trees within a group were felled at the same time, however evidence published by the Nottingham University Tree-Ring Dating Laboratory indicates that the range estimate encompasses the possible different individual felling dates (English Heritage 2001). Where bark is present within a group of timbers and other evidence does not dispute the date, it is assumed that all the trees within a felling group were felled in the same year.

Date of Construction

It is vitally important to understand that dendrochronological analysis provides dates for when trees were felled and not necessarily when their timbers were used. Green or freshly felled wood is however far easier to work and it is standard practice to assume that medieval timbers were felled as required and used green (Rackham 1990, Miles 1997). However, the use of previously felled timbers in vernacular construction was not uncommon, with short-term stockpiling usually of not more than 1 to 2 years (Miles 1997), and the use of leftovers or re-used timbers may certainly give rise to differences between felling dates and the date of construction where samples are analysed in isolation.

A number of samples having a close range of felling dates are required from varying elements of a building to either strongly indicate a single date of construction or to identify separate phases of construction. Where fewer than 3 samples with sapwood evidence or bark are dated the term "Spot date(s)" is applied to help identify that the dates are derived in isolation and therefore should not be used to indicate a period of construction. It is also usual to incorporate other specialist evidence before dendrochronological dates can be reliably interpreted as reflecting the date of construction.

Tree-Ring Services - Methods and Criteria

Tree-ring analysis and graphics are achieved via a dendrochronological programme suite developed by Ian Tyers of Sheffield University (Tyers 1999). Location maps are produced via - *Microsoft AutoRoute Express GB 98 Auto Street Navigator,* which uses Ordnance Survey digital map data © Crown Copyright 1997. Alcock's (1996) timber-framed building nomenclature has been adopted throughout to facilitate regional comparisons.

For the analysis of a building an initial assessment is conducted with the owner and recommendations in line with English Heritage guidelines on sampling strategies made, (i.e., that a minimum of 8 to 10 samples are obtained per building or per phase). However, the final decision for the number of samples taken for analysis rests with the individuals who commission the analysis. Tree-Ring Services aims to follow English Heritage guidelines on methodology in producing and interpreting dendrochronological dates throughout its reports (Hillam 1998b). Part 2 of the Guidelines is designed for large projects in conjunction with other specialist disciplines and is not applicable to the type of privately commissioned dendrochronological analysis generally conducted by Tree-Ring Services and is therefore not used.

It is generally beyond the scope of an analysis to describe a building in detail or to undertake the production of detailed drawings. Without the benefit of other specialist disciplines there is always the danger that reused timbers can be inadvertently selected, and the conclusions presented in a report may be modified in the light of subsequent work.

RESULTS

On the 26th March 2008, eight core samples were taken. On the 11th August 2008 a further five cores were taken. What were considered the main trusses were labelled alphabetically from A in the north-east corner to E1 in the south-west corner. Sampling locations are indicated on a sketch plan of the building (see **Appendix I**).

Photo 5: Core EVHS01

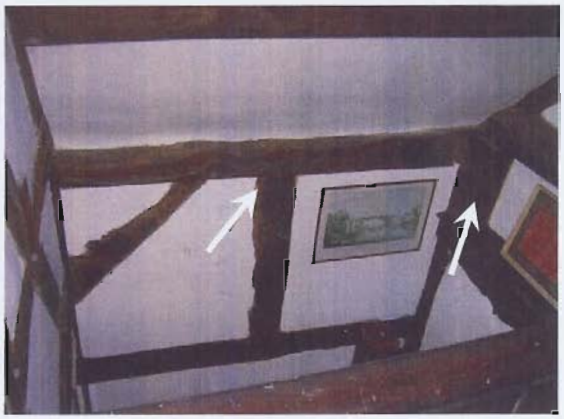


Photo 6: Cores EVHS02 (right) & EVHS03 (left)

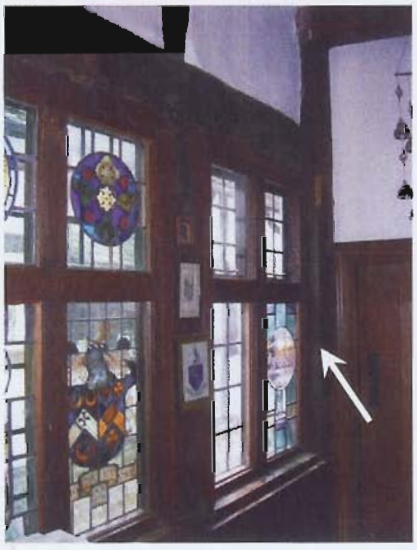


Photo 7: Core EVHS04

Photo 8: Cores EVHS05 (top), EVHS06 (right) & EVHS07 (left)

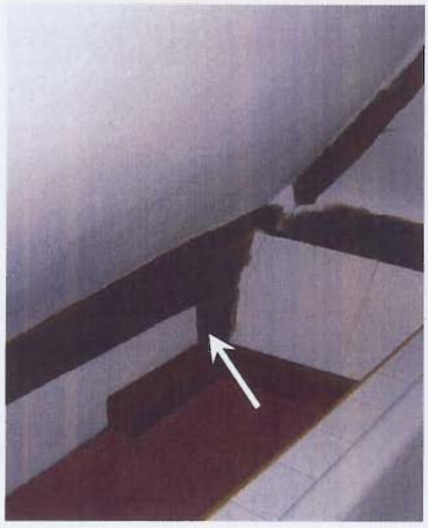


Photo 9: Core EVHS08

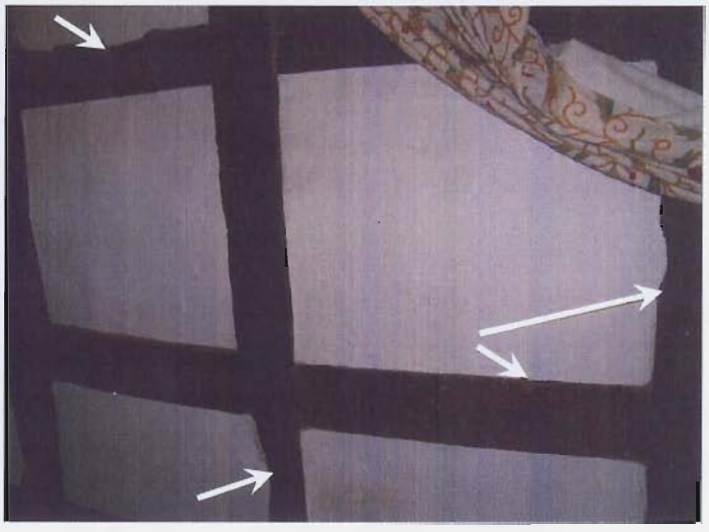


Photo 10: Cores EVHS09 (upper right), EVHS10 (middle) EVHS11 (top) & EVHS12 (lower right)

Photo 11: Core EVHS13

Two samples were elm and rejected from further analysis. All the other samples taken were confirmed as oak (Quercus spp) and of sufficient length to be considered for cross-matching. With the exceptions of EVHS07 and EVHS12, all the samples were successfully recovered from where sapwood appeared complete. Sample EVHS09 was oak but the rings were too narrow to be reliably measured. Two sequences contained less than 50 rings and were therefore identified by the suffix '-S', i.e., EVHS02-S and EVHS04-S. Five samples, which included EVHS02-S, contained sudden and sustained periods of ring width reduction characteristic of direct management, four of these were identified by the suffix 'M', i.e., EVHS01-M, EVHS03-M and EVHS08-M, EVHS13-M. Seven sample sequences were found to cross-match together (**Table 1**).

Table 1: Cross-matching between sequences from 4 High Street.

Filenames	Start date	End date	01-M	05	06	07	08-M	10	13-M	CROWLE3	OXON93
EVHS01-M	AD1520	AD1585		8.00	-	-	5.81	6.86	6.71	4.92	6.01
EVHS05	AD1447	AD1586			-	-	8.35	6.57	7.40	6.49	5.62
EVHS06	AD1462	AD1572				-	3.75	-	-	-	4.51
EVHS07	AD1497	AD1561					4.81	4.06	-	-	-
EVHS08-M	AD1472	AD1586						7.05	4.08	4.18	6.93
EVSH10	AD1470	AD1586						-	3.63	4.49	5.66
EVSH13-M	AD1447	AD1586								4.09	-
CROWLE3	AD1497	AD1589									7.63
oxon93	AD632	AD1987									

KEY: \ = overlap < 15 years, - = t-values less than 3.50. Note: OXON93 and CROWLES3 are references chronologies which are not included in the mean, but are shown as they help confirm the relative positions of some sequences.

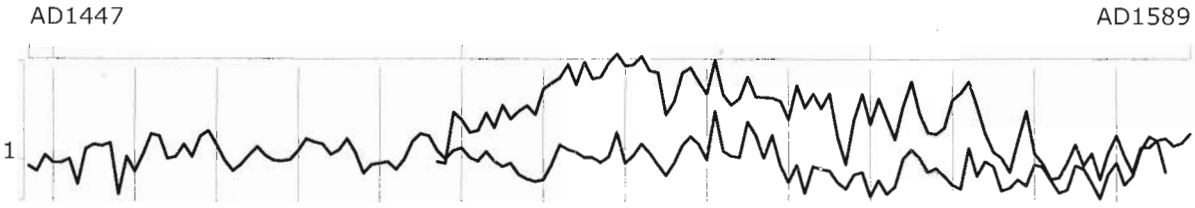
Sequences EVHS01-M, EVHS05, EVHS06, EVHS07, EVSH08-M, EVHS10 and EVHS13-M were combined to form a 140-year site chronology named EVSHM-HS. This site chronology was found to produce consistently high *t*-values (**Table 2**), and good visual matching with a reference chronology (see **Figure 3**), with the first ring of the sequence at AD 1447 and the final ring of the sequence at AD 1586.

Table 2: Dating evidence for site chronology EVSHM-HS against reference chronologies.

EVSHM-HS dated AD 1447 TO AD 1586					
File	Start Date	End Date	*t*-value	Overlap (yr.)	Reference chronology
OXON93	AD632	AD1987	7.10	140	OXFORDSHIRE MEAN CURVE (Haddon-Reece *et al* 1993 unpubl)
WNDS61	AD1494	AD1613	6.61	93	ROUND TOWER - WINDSOR CASTLE - BERKSHIRE (Miles and Haddon-Reece 2003)
CROWLE3	AD1497	AD1589	6.09	90	CROWLE COURT BARN 3 - WORCS (Hillam 1997)
HEREWORC	AD1341	AD1636	5.94	140	HEREFORD & WORCESTER - WEST MIDLANDS (Siebenlist-Kerner 1978)
HASLE-EG	AD1372	AD1594	5.80	140	EAST GARDEN - HASLEMERE - SURREY (Moir 2006)
BRIT3	AD1082	AD1912	5.63	140	BRITTANY THREE Unpublished but cited (Guibal 1987)
REIGATE	AD1401	AD1590	5.57	140	43 HIGH STREET - REIGATE - SURREY (Tyers 1990)
SENG18	AD1028	AD1591	5.25	140	SOUTHERN ENGLAND Update of (Bridge 1988) Pers com.
SINAI	AD1227	AD1750	5.22	140	SINAI PARK - STAFFORDSHIRE (Tyers 1997)
NUFFIEL	AD1404	AD1627	5.21	140	UPPER Ho FM Ho - NUFFIELD - OXFORDSHIRE {Haddonreece 1989}
EAST_MID	AD882	AD1981	5.01	140	EAST MIDLANDS (Laxton and Litton 1988)
WIMPOLE1	AD1469	AD1615	4.90	118	ST ANDREWS - WIMPOLE - CAMBRIDGESHIRE (Bridge 1998)

KEY: **Bold** = indicates a composite reference chronology consisting of multiple site chronologies.

Figure 3: Plot of tree ring chronologies for 4 High Street (bottom) and 3 Crowle Court Barn 3 (top) showing a good visual match (6.09 *t*-value).



Note: The ring width (mm) is plotted on a (y axis) logarithmic scale using common axis for both samples.

Sequences EVHS02-S, EVHS03-M and EVHS04-S which had failed to cross-match together were individually compared against our database of reference chronologies. Sequence EVHS03-M was found to produce consistently high *t*-values and good visual matching with the first ring of the sequence at AD 1400 and the final ring of the sequence at AD 1487 (**Table 3**).

Table 3: Dating evidence for sequence EVSH03 against reference chronologies.

EVSH03 dated AD 1400 TO AD 1487					
File	Start Date	End Date	*t*-value	Overlap (yr.)	Reference chronology
SENG18	AD1028	AD1591	7.18	88	SOUTHERN ENGLAND (Bridge 1988)
HIGHTOWN	AD1302	AD1489	6.73	88	BOOTH HALL - HIGHTOWN - HEREFORD (Boswijk and Tyers 1997)
WICK	AD1257	AD1496	6.71	88	ST CUTHBERTS - LOWER WICK - WORCESTERSHIRE (Bridge 1988)
CHKSPQO1	AD1200	AD1541	5.81	88	CHICKSANDS - BEDFORDSHIRE (Howard *et al.* 1998a)
HERE_CB2	AD1359	AD1491	5.79	88	CATHEDRAL BARN - HEREFORD (Tyers 1996)
CROWLE2	AD1412	AD1496	5.49	88	CROWLE COURT BARN - WORCS (Hillam 1997)
NOSTELL1	AD1263	AD1536	5.45	88	NOSTELL PRIORY - W. YORKS (Tyers 1998c)
LYDNEY	AD1360	AD1591	5.25	88	NASS HOUSE - LYDNEY - GLOUC (Howard *et al.* 1998b)
ENGLAND	AD404	AD1981	5.16	88	ENGLAND (Baillie and Pilcher 1982 unpubl)
WARNDON2	AD1391	AD1498	5.15	88	ST NICHOLAS - WARNDON - WORCHESTERSHIRE (Tyers 1998b)
BAYTON	AD1348	AD1525	5.11	88	BAYTON - HERE&WORC (Bridge 1996)
OHST	AD1244	AD1664	5.10	88	100 CHURCH ST - TEWKESBURY - GLOUSTERSHIRE (Nayling 2000)

KEY: **Bold** = indicates a composite reference chronology consisting of multiple site chronologies.

However, no further cross-matching could be established, and therefore sequences EVHS02-S and EVHS04-S remain undated at this time.

Table 4: Summary of Dendrochronological Analysis

Sample	Timber and Position	Timber Conversion	Timber Dimensions (mm)	Species	Rings	Sapwood	Average Growth Rate (mm/yr)	Sequence Date Range	Felling Date	Rings to Pith		Age Estimate	Heartwood/ Sapwood Boundary
EVHS01-M	Bressumer	A2	440 x 400	Oak	140h+66	21+¼B	1.06	AD1520-AD1585	spring AD1586	>	15	226	1564
EVHS02-S	Post B	A2	0 x 0	Oak	41	12+Bw	3.09				10	**56**	
EVHS03-M	Mid Stud - B to C	C2	195 x 0	Oak	88	+?B	0.72	AD1400-AD1487	*c.* AD1583	>	15	108	1545
EVHS04-S	Post D1	A2	0 x 0	Oak	49	23+¼B	2.57				10	104	
EVHS05	Post B1	A2	180 x 0	Oak	140	31+Bw	1.00	AD1447-AD1586	winter AD1586/7	>	15	**160**	1555
EVHS06	Rail B1 to C1	C2	190 x 0	Oak	111	29+¼B	1.21	AD1462-AD1572	spring AD1573		10	126	1544
EVHS07	Rail - A1 to B1	C2	190 x 0	Oak	64	3+25	1.11	AD1498-AD1561	AD1586-99	>	15	84	
EVHS08-M	Post A	A2	0 x 0	Oak	115	34+Bw	0.74	AD1472-AD1586	winter AD1586/7	>	15	**135**	1552
EVHS09	Stud - truss A	C2	180 x 0	Oak									
EVHS10	Stud - truss A	C2	180 x 0	Oak	117	31+Bw	0.84	AD1470-AD1586	winter AD1586/7	>	15	137	1555
EVHS11	Upper rail - truss A	C2	190 x 0	Elm									
EVHS12	Lower rail - truss A	C2	190 x 0	Elm									
EVHS13-M	Tiebeam - truss E	C2	220 x 0	Oak	140	34+Bw	0.97	AD1447-AD1586	winter AD1586/7	>	15	**160**	1552

KEY	
+	= additional information not measured on the core
(+)	= unmeasured heartwood rings at the beginning or end of the core
HS	= heartwood/sapwood boundary
?B	= probable bark
Bw	= winter bark
¼B	= spring bark
A2	= boxed heartwood & trimmed
B2	= halved & trimmed
C2	= quartered & trimmed
E2	= tangential & trimmed
Bold	= main structural timbers used to calculate mean age

Note: Timber dimensions were generally taken at the core sample location and are not necessarily the maximum dimensions of the timber.

INTERPRETATION AND DISCUSSION

Felling Dates

The sapwood evidence used to calculate the felling dates now discussed is presented in **Table 4**, and the bar diagram (**Figure 4**) helps visually demonstrate the findings.

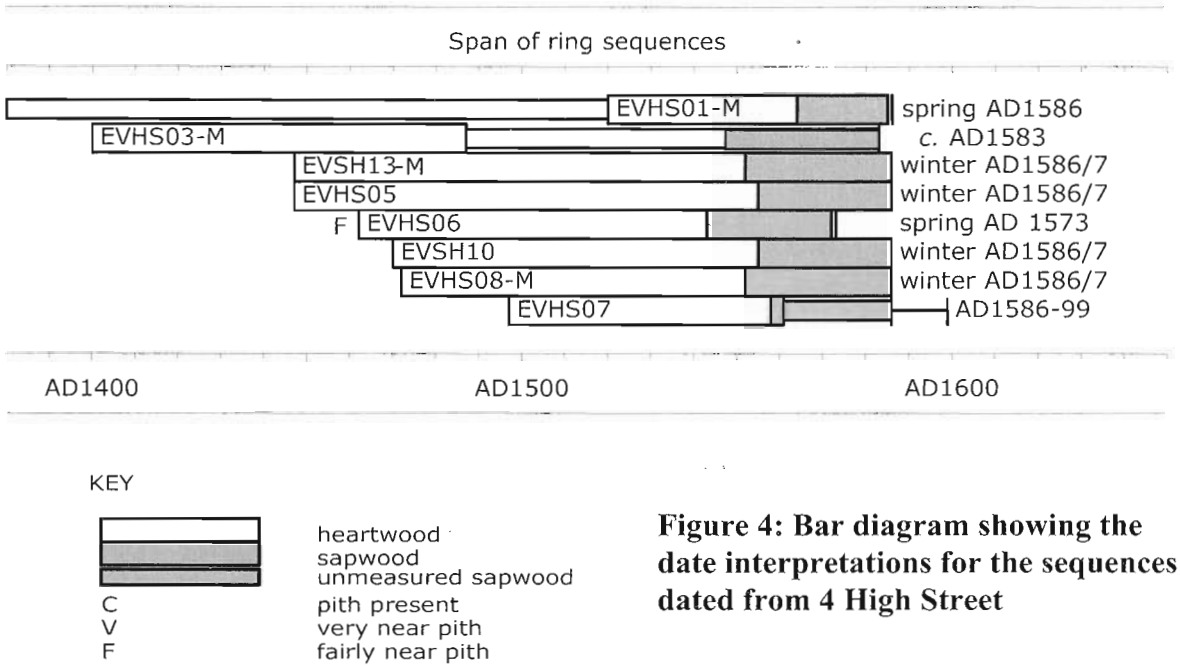


Figure 4: Bar diagram showing the date interpretations for the sequences dated from 4 High Street

4 High Street, Badsey, produces six precise felling dates. Under the microscope full sapwood on samples EVHS05, EVHS08-M, EVSH10 and EVSH13-M all occurs with the full development of the outermost ring, establishing that the source trees were felled in the winter of AD1586/7. On samples EVHS06 and EVHS01-M full sapwood occurs with the development of the spring sapwood vessels, identifying that the source trees were felled in the springs of AD 1573 and AD 1586 respectively. The end rings on sample EVHS03-M were too narrow to be reliably measured, however approximately 58 years of heartwood and 38 years of sapwood were counted to indicate that felling probably occurred in about AD1583. The felling date range produced by sample EVHS07 is consistent with felling having occurred in the winter AD 1586/7. The distribution of the samples taken from the building and the felling dates obtained, indicate that construction probably occurred as a single phase in AD 1587, or soon after.

Figure 5: Great Tangley Manor House, Surrey (T. Allom. Engraved for Brayley's History of Surrey. Flemming)

Interestingly, the elaborately decorative panelling to the front of 4 High Street is similarly evident in the 4th quarter of the 16th century in Surrey. Great Tangley Manor, Nr Guildford (**Figure 5**), has 1582 inscribed on one of the corbels. Also, similar type panelling is to be found at No 4 Malthouse Cottages (**Photo**) and 1 Church Street (**Photo**) which have been dendrochronologically dated to 1581 (Moir 2004) and 1571 (Moir 2005) respectively.

Photo12: North-east aspect of N°4 Malthouse Cottages, Gomshall, Surrey

Photo13: East aspect of 1 Church Street, Godalming, Surrey.

Timber analysis

The timbers sampled were all oak except for two which were elm and therefore discarded. Using just the largest structural timbers, (i.e., three posts), the average age of the source trees used in the construction is 128? years. The posts and bressumer all appear to be boxed heartwood converted, and the wall panelling quartered.

There are insufficient local reference chronologies to indicate whether the timbers came from a relatively local source, although this is considered likely to be the case. A form of periodic disturbance (probably management) is identified in three of the timbers dated, and this is likely to have reduced their cross-matching. However, these growth reductions were not sufficiently distinct to identify periodicity.

Two samples were taken from rails at the front of the building and identified to be elm. These timbers appear coeval with the oak samples and suggest both species of tree were used at the building's time of construction. Two to three sharp periods of growth reduction are evident in both samples, and these are indicative of management. The reductions occur approximate on a 10 year cycle.

CONCLUSIONS

Of the thirteen samples taken from 4 High Street, Badsey, seven are dated to form a 140-year chronology spanning AD 1447 to AD 1586. One other sample was individually dated and produced a sequence spanning AD 1400 to AD 1487. Four precise felling dates in the winter of AD 1586/7 and another in the spring of AD 1586, together with a probable felling date in AD 1583 and a consistent felling date range, indicate that construction occurred as a single phase in AD 1587 or soon after. A seventh timber with a precise felling date in the spring of AD 1573 may have been from a windthrown tree.

ACKNOWLEDGEMENTS

I would like to thank the owners, Mr & Mrs Phillips, whose interest in the archaeology of their building led to the commissioning of this report. I am also grateful to those dendrochronologists who enable their chronologies to be used in dating.

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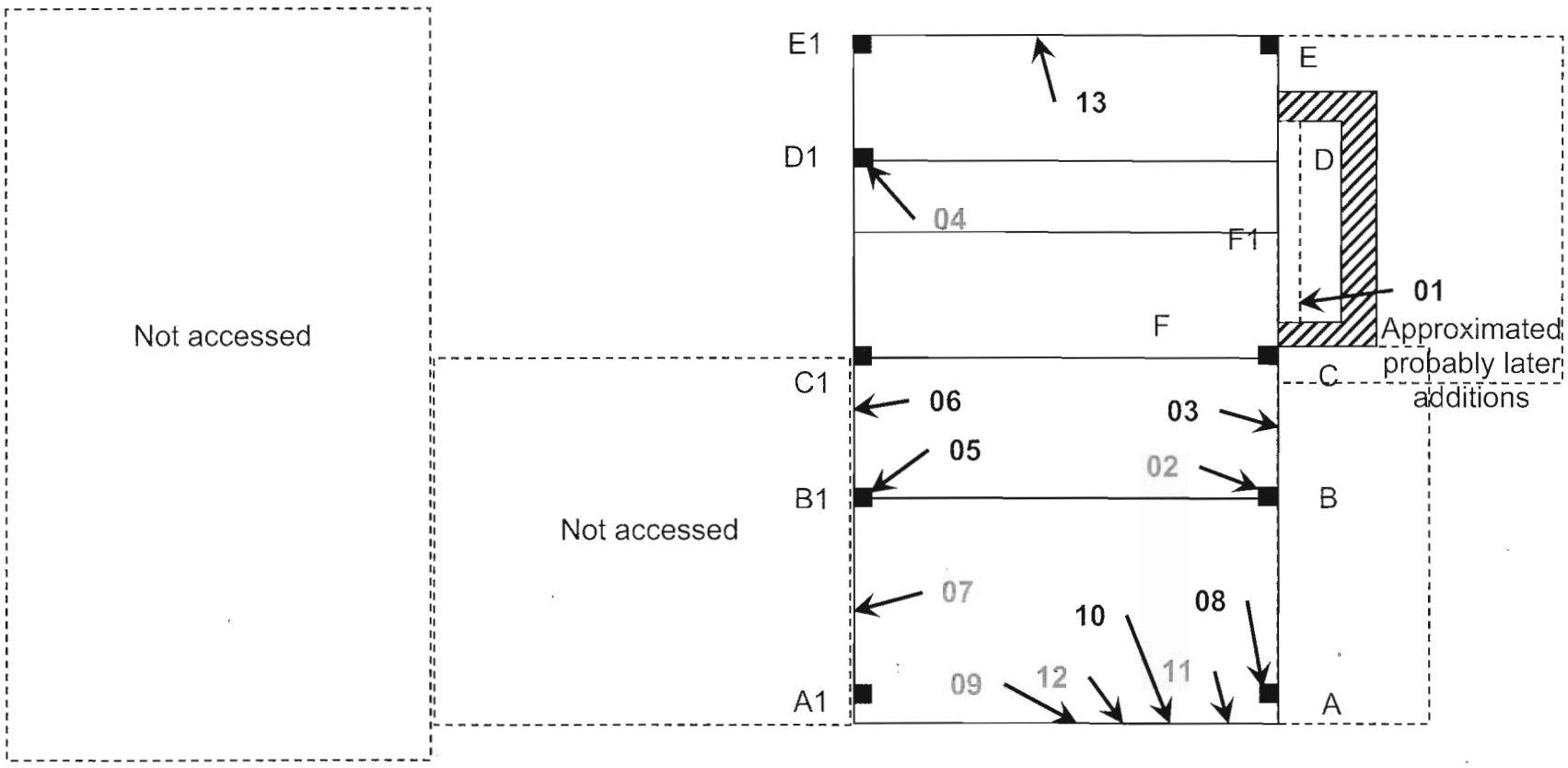
APPENDIX I: Floor Plan of 4 High St and the rest of the building

Approximate Scale: 1 cm = 1 m.



KEY:
Numbers identify location of the cores taken.
Blue = dated to AD 1587
Grey = Undated cores

APPENDIX III: Raw ring-width data

Ring widths (0.01mm), starting with innermost measured ring

EVHS01-M

32	29	40	43	50	38	62	80	124	124
89	307	151	115	84	190	146	101	204	98
63	79	46	79	74	74	57	37	43	60
26	48	26	36	73	167	135	113	143	79
68	72	241	123	140	170	87	75	90	61
165	131	85	74	91	168	160	108	64	125
180	94	118	226	287	260				

EVHS02-S

613	546	252	229	247	263	345	317	335	256
115	87	50	79	260	438	530	634	689	583
418	314	334	497	451	490	516	408	224	292
143	78	80	101	134	177	231	161	155	343
271									

EVHS03-M

236	408	112	139	178	115	174	146	136	194
106	111	99	110	64	114	98	87	132	38
75	46	39	59	40	28	26	35	49	42
34	31	92	44	39	79	39	34	98	57
28	90	40	31	50	33	42	43	40	39
38	73	78	53	32	48	41	47	37	24
60	31	32	36	40	33	36	42	58	60
85	48	41	42	80	112	40	53	36	88
78	88	73	54	48	60	88	85		

EVHS04-S

333	386	411	493	442	365	349	323	350	265
283	261	269	219	315	246	279	244	244	214
192	228	202	206	231	271	241	157	167	196
226	253	253	423	372	306	320	365	179	146
174	144	194	137	92	89	135	231	194	

EVHS05

90	83	107	95	95	101	67	118	127	124
130	57	104	82	108	120	87	103	82	101
68	130	183	150	89	88	88	167	116	119
94	111	96	146	126	145	122	97	142	161
69	52	57	71	60	64	106	123	185	124
121	113	153	131	118	95	137	78	83	92
64	42	31	57	82	124	94	90	87	108
77	91	136	111	151	143	128	101	79	102
207	254	233	162	346	152	136	154	283	204
126	175	82	67	118	56	107	91	122	84
59	78	73	33	57	33	50	74	104	100
60	52	69	60	53	105	61	95	65	52
53	66	57	74	74	49	54	50	55	54
53	49	64	61	59	55	54	64	72	86

EVHS06

180	204	100	126	153	140	160	133	103	107
89	109	85	157	121	101	101	103	95	145
124	115	100	94	110	119	98	140	124	152
117	110	159	137	147	128	103	96	91	91
87	113	99	120	121	108	128	142	123	139

184	194	179	160	137	148	146	198	148	151
215	187	149	142	153	109	99	78	82	104
88	103	88	127	125	105	114	127	106	106
100	113	122	99	97	123	156	153	140	145
147	139	202	135	113	99	97	100	84	65
66	75	91	69	62	73	83	102	80	87
88									

EVHS07

104	108	109	133	117	109	101	141	85	84
81	64	53	54	71	87	96	116	87	113
79	109	165	134	194	178	141	50	75	92
127	110	158	148	123	185	150	132	153	255
187	179	113	72	111	64	89	89	86	105
66	90	72	52	88	67	72	106	109	122
95	103	95	97	96					

EVHS08-M

74	79	69	94	80	101	80	100	105	148
127	149	129	113	148	150	90	79	88	76
75	86	121	131	169	98	89	96	139	100
111	90	115	64	69	63	50	38	38	55
71	64	69	64	66	60	75	130	87	96
114	87	69	50	62	103	101	78	64	109
67	69	89	129	115	79	98	58	41	61
31	57	54	38	40	31	38	41	21	37
25	33	52	61	60	53	53	57	54	60
67	48	61	53	41	53	51	42	48	61
63	47	44	49	42	44	48	46	43	45
55	63	78	71	77					

EVHS10

121	91	59	72	59	128	65	93	72	85
94	100	88	79	93	80	111	131	55	61
81	74	84	86	100	119	98	71	77	84
70	68	70	70	99	73	72	66	73	65
65	58	80	109	85	97	110	84	97	147
122	134	138	89	76	55	51	89	115	159
113	192	131	125	113	164	178	132	141	74
62	115	65	92	85	62	78	56	69	88
61	86	62	70	111	129	87	28	35	45
45	29	64	50	47	58	30	34	41	46
84	96	57	57	48	66	81	57	62	72
98	64	59	71	87	57	117			

EVHS13-M

73	65	65	92	89	104	75	130	132	150
190	90	178	111	132	165	126	134	108	125
143	144	174	158	114	128	97	138	118	121
110	155	111	162	134	133	122	162	172	174
47	61	55	49	56	61	71	71	86	97
93	92	85	97	77	70	69	86	57	61
61	87	61	72	101	71	83	77	85	86
86	78	112	95	100	116	111	105	73	72
123	143	157	143	172	112	147	115	134	143
94	116	85	61	91	57	78	72	72	71
54	74	70	51	65	52	57	61	66	59
67	68	60	60	56	98	77	88	93	63
54	78	82	91	111	101	64	63	88	108

APPENDIX IV: Mean ring-width data

Title : 4 High St - Evesham - Worc [EVSHM-HS]
Ring-width QUSP data of 140 years length
Dated AD1447 to AD1586
Unit of Measurement 0.01mm
7 timbers raw data mean
Average ring width 98.84 Sensitivity 0.18

AD1447							81	74	86	93
AD1451	92	102	71	124	129	137	160	73	141	96
	120	155	139	112	105	126	117	144	163	133
	100	87	89	103	122	101	99	103	99	120
	130	123	117	116	120	140	103	71	78	82
	83	80	91	114	131	127	102	97	103	110
AD1501	95	90	96	103	80	83	73	74	65	68
	84	102	106	102	96	103	89	99	148	104
	122	134	112	85	73	84	119	135	141	114
	193	126	120	110	168	166	117	146	91	67
	97	59	87	83	79	76	60	78	79	54
AD1551	75	58	65	97	110	96	73	78	72	66
	61	106	72	87	84	55	57	68	65	90
	93	73	59	59	85	89	69	57	73	91
	67	75	108	126	116	113				