A SEVENTEENTH-CENTURY KID-WEIR AT DOVE BRIDGE, DERBYSHIRE

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INTRODUCTION (MAS)

During the construction of the dual carriageway Doveridge Bypass to replace the existing A50 trunk road (Fig. 1), an archaeological watching-brief was undertaken by Trent & Peak Archaeological Trust (T&PAT) on behalf of BBTA Construction Joint Venture. The aim of the watching brief was to observe the groundworks adjacent to known archaeological sites and to produce a salvage record of any hitherto unknown archaeological remains revealed by construction work.

The site under discussion lies on the alluvium of the low-lying floodplain, adjacent to the Tean-Dove confluence, where the present A50 crosses the River Dove (Fig. 1). A masonry bridge of 14th and 17th-century construction (Derbyshire Scheduled Ancient Monument 56) survives adjacent to the present road bridge. A bridge across the Dove, pre-dating the surviving structures, is documented in a number of Medieval sources, though the precise location is unclear. The Domesday Book of 1086 records the place-name *Dub Brycg*, 'Dove Bridge', suggesting the existence of a bridge across the Dove at this time (Cameron 1959), and a bridge across the Dove is described in the Cartulary of Tutbury Priory of 1258 (Br Mus Add 6714). To the north and south of the bridge are traces of ridge and furrow, later drainage ditches, floodbanks and causeways (Challis 1994; 1996).

In December 1996, as part of the construction of a new road bridge at Dove Bridge, Derbyshire (SK 106 344), interlocking sheet-metal pilings had been driven into the alluvium, immediately east of the river, in order to create two coffer-dams, *c.* 17.5m by 2.7m (01 and 02, Figs. 1 and 2). It was during this work that the surviving tops of wooden posts were observed protruding from the alluvium within the coffer-dams (Fig. 2). Further timber posts with cut-ends were observed amongst the spoil. The discovery of well preserved timbers within waterlogged alluvial deposits was recognised as being of significant archaeological interest, requiring salvage recording. As a result, a number of timber posts and brushwood piling were recorded, analysed and dendro-chronologically dated.

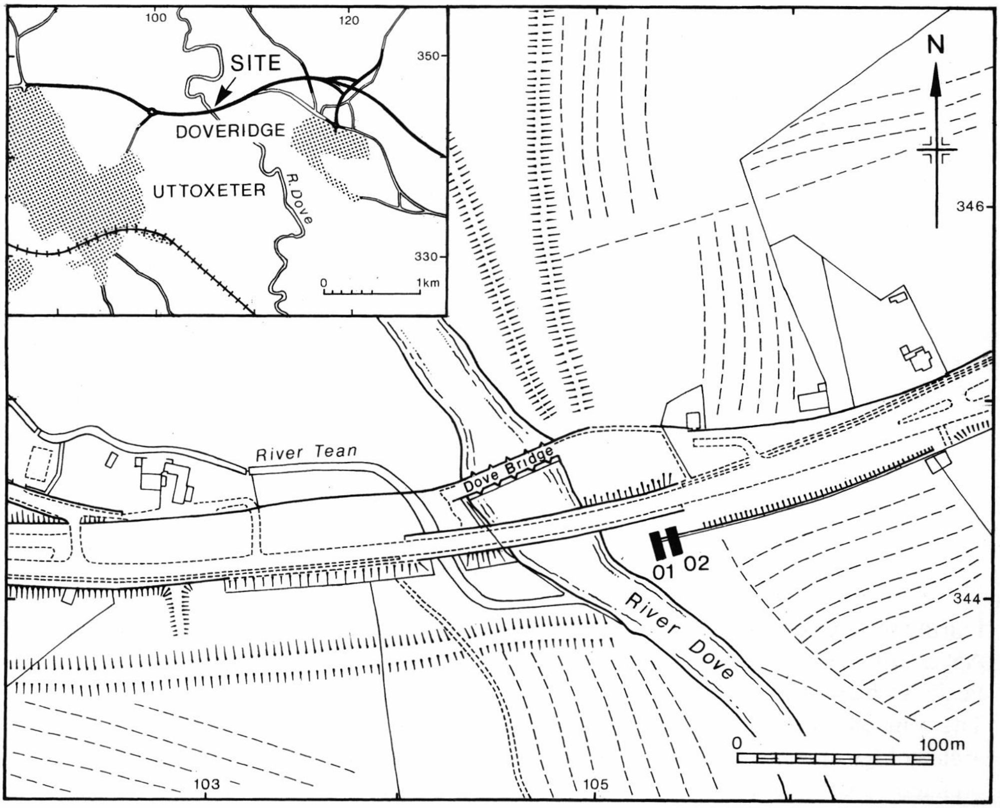

Fig. 1: Location map of the area investigated at Dove Bridge. 01 and 02 are the coffer-dams from within which the timbers were uncovered (Fig. 2).

The Salvage Recording Methodology

With a time limit of five working days, in difficult working conditions presented by the waterlogged deposits, it was decided that a section through the deposits in Coffer-dam 01 would provide the easiest and clearest indication of any possible surviving structure.

Since manual excavation was impractical, the section was machine excavated. The alluvium from the southern end of Coffer-dam 01 was removed down to the underlying gravel (A-B, Figs. 2 and 3). A photographic record of the excavation was made. The section was cleaned, photographed and recorded. Timbers recovered from the excavation were individually recorded; cleaned, measured and photographed, noting any structural evidence of joints, peg holes and cut-ends etc., and samples taken for dendrochronological dating. Prior to excavation, the *in situ* timbers were surveyed using an Electronic Distance Measurer (EDM).

Results

The EDM survey recorded two rows of upright timbers within Coffer-dam 01, with further isolated timbers along the edge of Coffer-dam 02 (Fig. 2). It was not possible to determine the extent of the timbers beyond the confines of the coffer-dams as no further

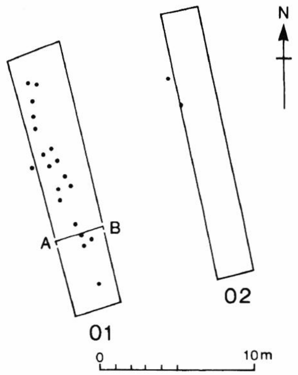

Fig. 2: Plan produced from the EDM survey showing the location of the upright timbers and the south-facing section A-B (Fig. 3).

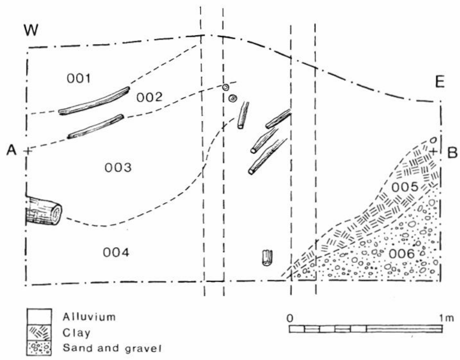

Fig. 3: South-facing section through the deposits within Coffer-dam 01, showing the approximate position of the upright timbers.

areas were disturbed by the groundworks. No timbers were visible in the exposed bank of the river, either up or downstream of the site, although timbers were uncovered during construction of the existing road bridge (K.Challis *pers. comm.*).

At the eastern edge of the south-facing section, beneath *c.* 1.6m of silts (001–004), a thick layer of clay (005) and a deposit of sand and gravel (006, Fig. 3) are interpreted as a remnant river bank. The steep slope of this bank implies that it was formed by fluvial erosion. The bank trended approximately north-south, parallel to the present river. Although a large quantity of twigs and brushwood were visible within the alluvium, no *in situ* timbers were contained in the exposed section (Fig. 3). However, from the EDM survey (Fig. 2) it is possible to show the approximate positions of timbers relative to the deposits (Section A-B, Fig. 3). The timbers appear to run along the edge of the remnant river bank, and at least 2m out into the channel fill (Fig. 3). Brushwood appeared more abundant in the immediate vicinity of the remnant river bank in section (Fig. 3), and was visible in plan amongst the upright timbers.

Timbers ABA — ABW were recovered during the excavation of the section. Once the section recording was complete the remaining *in situ* timbers (ABX-ACF) were recovered during the machine excavation of the coffer-dam. No further timbers were observed or recovered from Coffer-dam 02.

A number of timbers were recovered from the spoil heap (AAA - AAY). Although these unstratified, *ex situ*, timbers could not be directly related to the *in situ* wood, it was likely that they were from the same ‘structure’. Dating of these samples could be compared with samples taken from the *in situ* wood. Because of the rescue nature of the excavation, it was not possible to achieve a plan of the exact location of the *in situ* timbers which were sampled.

EXAMINATION OF THE TIMBERS (CRS)

Methodology

Nineteen of the *in situ* piles were examined, of which twelve were selected for dendrochronology, and twenty-six *ex situ* piles or fragments were examined, of which

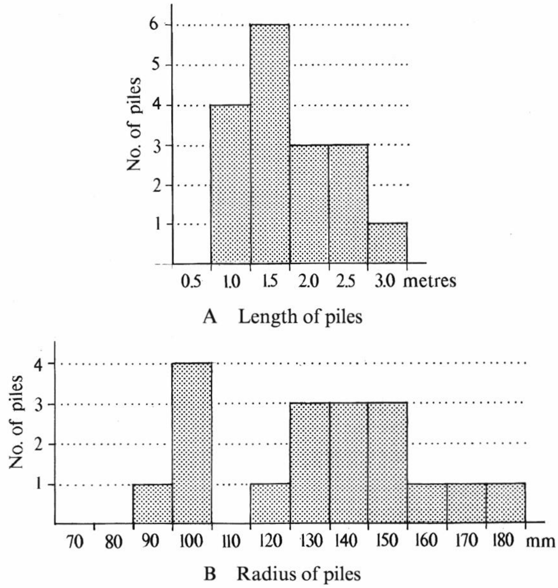

Fig. 4: Graphs showing (a) the length and (b) the radii of the recorded timber piles.

nine were selected for dendrochronology. All were of oak. Each of the twenty-one samples was prepared using surform and jack plane, and their cross-sections sketched. Approximate dimensions, shape, rays, line of rings and irregularities were recorded in this process. The presence of the heartwood/sapwood boundary and the existence of sapwood, either partial or complete, was also noted.

Results

Complete sapwood was present in nine of the twelve *in situ* piles and, although partly delignified, it retained its original ring widths allowing dendrochronological dating to within one year on these samples. Because the wood was below the water table, it was in an anaerobic environment ensuring excellent preservation. This applies particularly to the sapwood which normally shrinks and rots if allowed to dry. Such preservation of sapwood is usual only when wood is immersed while still green. Of the eleven piles that were found *ex situ*, seven retained partial sapwood, but the remainder probably lost their sapwood during their violent removal by machine.

Two piles (AAI and AAR), both *ex situ* had been made from whole round sectioned stems, but the rest of the *in* and *ex situ* piles were riven, i.e. made by splitting trunks with wedges into four to six segmental lengths. This is easily accomplished while the wood is still green. The length of the *in situ* piles varied between 0.6m and 2.5m (Fig. 4a), which probably relates to the depth of the river at various places, although some timbers were machine damaged. The longest *ex situ* pile which appeared to be intact was 2.79m (AAN).

The radii of these segments defines the size of the trunk and Figure 4b shows the wide range of tree sizes. The dendrochronological samples all lie at the right end of the graph (Fig. 4b), having been chosen for the maximum number of rings. These piles were riven from trees of *c.* 0.3–0.4m diameter, which would indicate a trunk height of *c.* 8–10m. With a maximum pile length of 2.79m it is likely that each trunk was cut into three lengths before splitting, so providing at least twelve piles. The split trunks were inverted for use as piles and their natural taper was accentuated with an axe (ABA: Fig. 5).

The smallest riven tree used was *c.* 0.18–0.2m in diameter and the round-sectioned piles (AAF and AAL) *c.* 0.13m and 0.2m in diameter, a range suggesting the trees were cut from naturally regenerated woodland with trees of all ages, rather than a plantation or coppice. Three other round-sectioned timbers (AAR, AAM and AAV), all *ex situ* were only 70mm, 80mm and 90mm in diameter and were probably brushwood. Nine pieces of brushwood were analysed. Eight were round-sectioned oak branches, with diameters of 50mm to 95mm; the ninth was a round-sectioned alder branch, 0.4m in diameter.

Piles AAB, AAD, and ABK were pierced by peg holes 0.18m, 0.12m and 0.18m from their upper ends, with respective diameters of 35mm, 40mm and 25mm (Fig. 5). Pile AAB had a second peg hole 0.42m from the top and 40mm in diameter. Part of a possible peg, *c.* 90mm long and 20mm in diameter, with a single cut to the end, was also recovered (ABT: Fig. 5).

TREE-RING ANALYSIS OF THE TIMBERS (REH, RRL and CDL)

Sample Analysis and Dating Methodology

Samples were provided from twelve different *in situ* oak piles and nine *ex situ* oak timbers. Details of the tree-ring samples are shown below (Table 1).

Each of the 21 waterlogged samples was initially prepared by C. R. Salisbury then frozen and their surfaces then further prepared using scalpel and blade. The widths of the growth-ring sequence of all twenty-one samples were measured and compared with each other by the Litton/Zainodin grouping procedure (Laxton and Litton 1988). At a value of $t=4.5$ two groups of samples were formed (Figs. 6 and 7). The t-value is a measure of the correlation between two sequences of ring-widths at each relative position of one to the other (offsets). The better the correlation at an offset, the higher the t-value. A t-value of at least 4.5 is usually adequate for the dating to be accepted with reasonable confidence (Laxton and Litton 1988).

Results

The twelve samples of the first group cross-matched with each other at the offsets shown in Figure 6. Because of this satisfactory cross-matching the ring-widths from these twelve samples were combined at these relative offset positions to form DOVBSQ01 (Fig. 6), a site chronology of 116 rings. Site chronology DOVBSQ01 was successfully cross-matched with a series of relevant reference chronologies for oak (Table 2), giving a first ring date of 1502 and a last measured ring date of 1617. Evidence for this dating is given by the t-values of Table 2.

Seven dated samples in site chronology DOVBSQ01 (Fig. 6) retain complete sapwood, that is, the last measured ring date of such samples is the felling date of the timber represented. One sample, ABP, has near complete sapwood and was felled in 1608–11. Three samples have either the heartwood/sapwood boundary or partial sapwood (AAJ, ABQ and AAH, Table 1). The felling date range of these can be estimated using 15–50 sapwood rings as the 95% confidence limit. Timber AAK does not have any sapwood and its felling date range cannot be calculated.

Sample No.	Timber	Total rings	Sapwood rings	First measured ring date	Last Heartwood ring date	Last measured ring date	Felling date or range
DOV-BO1	AAD	51	8	–	–	–	–
DOV-BO2	AAH	70 + 7–10nm	20 + 7–10nm	1548	1597	1617	1624–27
DOV-BO3	AAA	104	16c	1510	1597	1613	1613
DOV-BO4	AAN	33	8	–	–	–	–
DOV-BO5	AAK	82	none	1502	–	1583	–
DOV-BO6	AAC	63	h/s	–	–	–	–
DOV-BO7	ABV	52	h/s	–	–	–	–
DOV-BO8	ABM	83	18c	1528	1592	1610	1610
DOV-B09	ABB	68	h/s	–	–	–	–
DOV-B10	ABG	82	18c	1528	1591	1609	1609
DOV-B11	ABJ	91	17c	–	–	–	–
DOV-B12	ABP	71	14	1538	1594	1608	1608–11
DOV-B13	ABA	73	18c	1538	1592	1610	1610
DOV-B14	ABH	74	19c	1537	1591	1610	1610
DOV-B15	AAG	54	none	–	–	–	–
DOV-B16	AAF	38	10	–	–	–	–
DOV-B17	AAJ	56	6	1524	1573	1579	1588–1623
DOV-B18	ABQ	60	h/s	1522	1581	1581	1596–1631
DOV-B19	ABD	60	h/s	–	–	–	–
DOV-B2O	ABU	82	20c	1528	1589	1609	1609
DOV-B21	ABK	78	15c	1531	1593	1608	1608

h/s — heartwood/sapwood boundary
nm — not measured
c — complete sapwood on sample, last measured ring date is felling date of timber

Table 1: Details of tree-ring samples taken from the timbers recovered at Dove Bridge.

Reference Chronology	Span of Chronology	*t*-value	
East Midlands	882–1981	7.6	(Litton and Laxton 1988)
MGB-E01	401–1981	6.7	(Baillie *et al.* 1982)
Wales and West Midlands	1341–1636	4.3	(Siebedlist-Kerner 1978)
MC10-H	1386–1585	5.4	(Fletcher 1978, *pers. comm.*)
Blakesley Hall, West Midlands	1514–84	6.8	(Esling *et al.* 1989)
Stoke-on-Trent	1436–1623	5.8	(Howard *et al.* 1992)
Brampton, Derbyshire	1480–1602	8.0	(Howard *et al.* 1993)
Kirk Ireton Church	1512–1601	6.0	(Howard *et al.* 1995)

Table 2: Results of the cross-matching of site chronology DOVBSQ01 and reference chronologies when first ring date is 1502 and last ring date is 1617.

The timbers in DOVBSQ01 (Fig. 6) do not appear to have been cut in a single felling programme. Rather, there is a spread of felling dates (Table 1). The earliest is seen in timber ABK, which was felled in 1608; the latest is possibly represented by sample ABQ

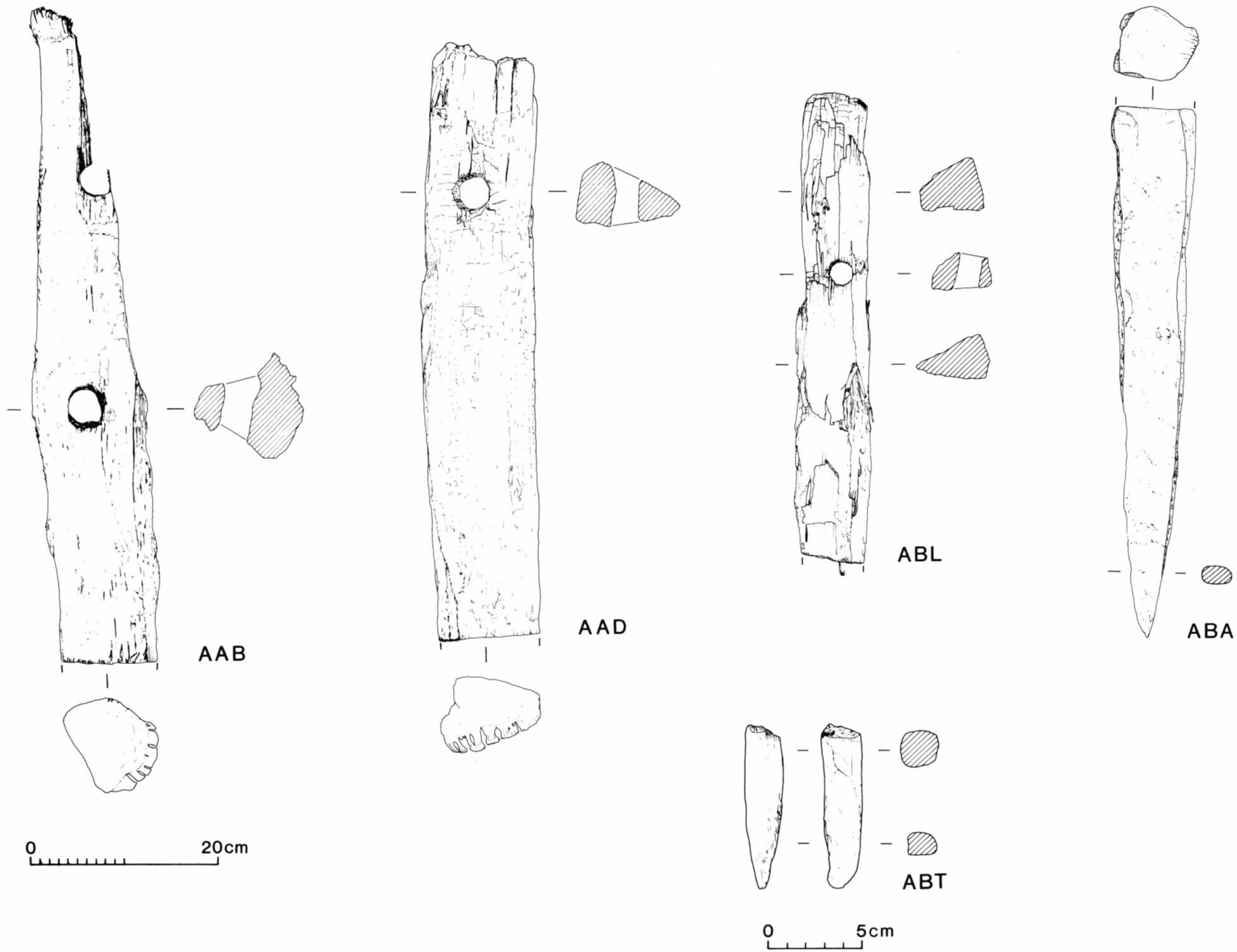

Fig. 5: Timber piles AAB, AAD and ABL pierced by peg holes; axe-accentuated taper to pile end ABA and a possible wooden peg ABT.

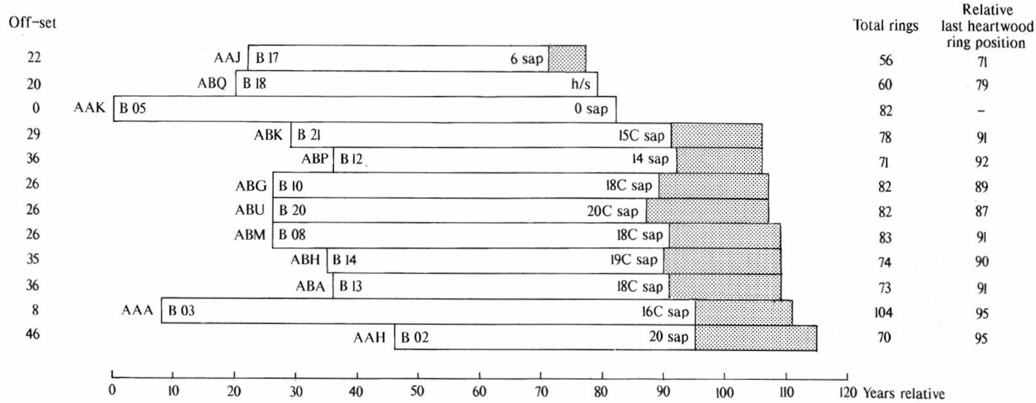

Fig. 6: Bar diagram of samples in site chronology DOVBSQ01.

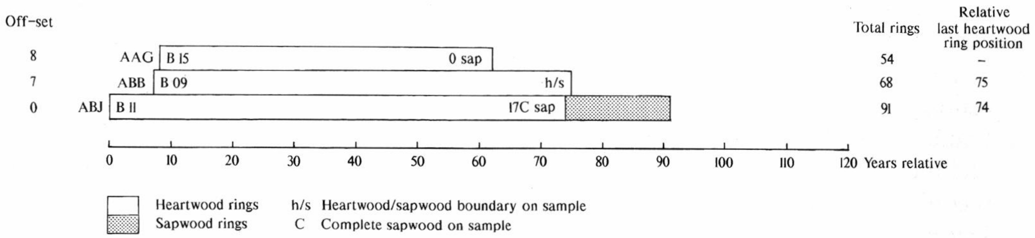

Fig. 7: Bar diagram of samples in site chronology DOVBSQ02.

which could have been felled as late as 1631. The latest certain felling date is represented by AAH, which was felled between 1624 and 1627.

The three samples of the second group (AAG, ABB and ABJ) cross-matched with each other to form DOVBSQ02 (Fig. 7), a site chronology of 91 rings. This site chronology did not cross-match with the reference chronologies (Table 2) or with the dated site chronology (DOVBSQ01), and must therefore remain undated. It will be seen from Table 1 that five of these samples (AAD, AAF, AAG, AAN and ABV) have less than the minimum of 55 rings considered preferable for satisfactory analysis. There is however, no obvious reason why the three longer samples, ABB, ABJ and AAG (DOVBSQ02, Fig. 7), should not date. The ring widths show no compaction, distortion or complacent growth which would cause difficulties. It is possible that the trees represented were growing at a time and/or a place for which there is little reference material against which to compare. This is in contrast to the final undated sample, ABD, which does show a series of compacted and distorted rings in its middle section.

Some caution might be expressed with the representatives of the samples. It is possible that some of the timbers sampled come from the same tree. This might be indicated by the high t-values of the cross-match between some of the samples, and is supported by close similarities in the shape of some of the cross sections. This is the case for example with timbers ABM, ABA and ABH with values in excess of $t = 10.0$; they have a similar cross-sectional form, all have complete sapwood and each has a last measured ring date of 1610 (Table 1). Timbers ABB and ABJ might also be from the same tree. These match each other with a value of $t = 10.0$ and have a similar, though not identical shape. The other samples cross-match with values ranging between $t = 5.0$ to 6.0. This would suggest that all the timbers came from trees growing fairly close to each other, but probably not from the same stand of woodland.

DISCUSSION (CRS, REH and MAS)

The lay-out of the piles from Dove Bridge (Figs. 2 and 3) suggests they were a bank revetment, perhaps placed to repair a wash-out of the river bank caused by severe flooding. It would appear from the analysis and dendrochronological dating that the timbers were felled over a period of time. Dendro-analysis of all the *in situ* piles with complete sapwood (ABA, ABG, ABH, ABK, ABM and ABU) represents the earliest felling dates of AD 1608–10. Timber ABQ, with a heart/sap date of 1581 would only need 16 rings of sapwood to make the same felling date. Similarly, piles AAJ and AAK could also belong to this group. It seems likely that the felling straddles the winters of 1608–10.

Several centuries of global cooling, known as the Little Ice Age, started in the 15th century and increasing snow fall in the Peak District would have resulted in severe spring flooding. The first Frost Fair was staged on the River Thames in the winter of 1607–08, and the exceptionally heavy snow fall followed by flooding in the winter of 1614–15 was recorded in the Youlgreave Churchwardens' and Constable's Accounts (1604–1722, Derby Record Office).

The preservation of the sapwood suggests that the timbers were used whilst the wood was still green, it therefore seems probable that the timbers were felled and inserted as and when needed. The later felling dates may well represent insertion of timber into the structure as repairs and additions, until possibly as late as 1631 (ABQ: Table 2).

It is unlikely that these timber piles are related to the 17th-century repairs and rebuilding of the two middle arches of the 14th-century bridge. A stone on the parapet is inscribed with the date 1691, possibly recording the rebuilding work, as between the years 1689 and 1691 the Staffordshire Quarter Sessions allowed £350 for work on the bridge (Jervoise 1932), at least sixty years later than the last dated timber (Table 1).

The structural evidence surviving from the timbers recovered at Dove Bridge, would seem to fit the method of construction typical of river bank revetments and sea defences before the modern use of sheet-metal piling. These barriers, using poles with peg holes near their upper end supporting horizontal brushwood, are known as *brush-weirs* or *kid-weirs*. Kid-weirs are discussed by Lord and Salisbury (1997, 57–60), where the authors cite a description of the sea defences at Romney Marsh, Kent, in a manuscript dated to just before 1624 (Beck):

> . . .there are some appointed to laye the faggots (kidds or bundles of brushwood) in courses. . . on the earth. . . then there are others which set the needles (piles with peg holes). . . driving them through the faggots about half the length of the needles. Then come others and edder the same that is wreath the edders (withies) about the said needles. There are others. . . which putte wodden pynnes (pegs) about ten or eleven inches long through the eye of the needles and then others drive down the needles very close to the worke as hard as the pynnes will suffer without breaking (Fig. 8)

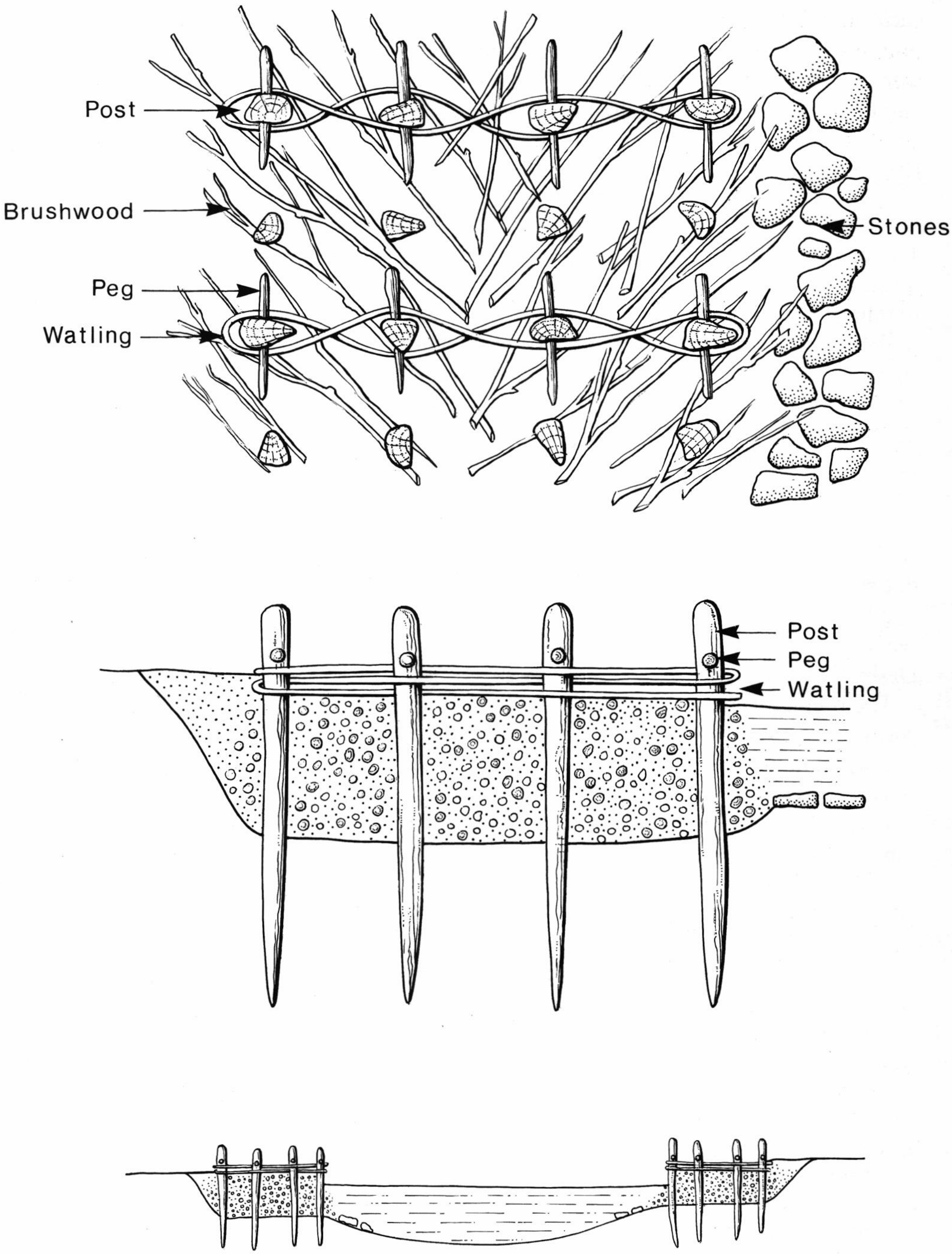

Fig. 8: Reconstruction drawings of a kid-weir (after Lord and Salisbury 1997).

Lord and Salisbury (1997, 57–60) describe many other kid-weirs in the Trent Valley, dating from the 13th century. The piles were placed in rows and only a limited number were wattled with withies (Fig. 8). Although oak was the preferred wood, piles can be of any river valley species. Although no horizontal wattling was found at Dove Bridge, this would have been at the top of the weir, at or about the level of the water table, and would have rotted away.

ACKNOWLEDGMENTS

Thanks go to BBTA Construction Joint Venture for their assistance and funding during this project. The work on site was supervised by Mark Southgate, assisted by Howard Jones and Rob Sussum, and managed by Keith Challis, thanks also go to Keith and Daryl Garton for commenting upon the text. The surveying was conducted by Andy Howard and Vicki Priest. The Figures for this paper were drawn by Jane Goddard and the timbers illustrated by Caroline Wickham and Jane Goddard.

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Note: All the unpublished reports above are available in the Derbyshire Sites and Monuments Record.

The Society gratefully acknowledges the financial support of BBTA in the publication of this report.