Irrigation of Water Meadows in England

L'irrigation artificielle des prairies en Angleterre

Die Bewässerung von Riesselwiesen in England

Graham Brown

Introduction

The irrigation of land is usually regarded as the supply of water to an otherwise arid region in order that it can be fruitfully cultivated. In England, however, irrigation can perhaps be more appropriately described as supplementing the natural rainfall in order to improve grassland. In the low-lying meadows beside rivers and streams, irrigation was achieved either by the natural seasonal flooding of land, which resulted in a consequent deposition of fine alluvial silts, or artificially, by the controlled diversion of water through a system of sluices and leats. Elsewhere, on suitable valley slopes, meadows were irrigated by cutting contour leats and directing water from a source, through the leats, and allowing it to flow downhill in a controlled manner.

Although it is not entirely clear when these artificially flooded (also known as floated) meadows were first developed, it was in the early 17th century that there is documentary evidence of large-scale irrigation. They continued in use into the later-19th century and early 20th century when, with the introduction of artificial fertilisers and cheaper crops from abroad, they began to decline. Artificially irrigated meadows were especially successful on the chalk downland regions of Wiltshire, Hampshire, and Dorset, and in the West Country (particularly in Somerset and Devon). They were also enthusiastically adopted elsewhere in the country wherever possible. It is, however, in the chalk regions in the south of England and in the West Country that the earthwork evidence remains so prolific.

The aim of flooding meadows was to encourage an earlier growth of grass. This was achieved by allowing a thin sheet of continually flowing water to pass over the meadow, which had the effect of raising the ground temperature as well as depositing nutrients. This ensured an earlier growth of grass for the sheep flocks (and in some cases a hay crop for cattle and horses) in the Spring when there was a lack of fodder. Since sheep provided dung for the arable fields, there was a direct relationship between the number of sheep that could be kept and the amount of land that could be cultivated. Later in the summer, after further flooding, a hay crop would be cut. The artificial flooding of meadows was thus regarded as one of the most important agricultural innovations of the post-medieval period and their monetary value reflected this importance. On Brendon Farm on the Brendon Hills in Somerset, for example, the land was valued at 2s an acre in the 1840s, but when it was converted to a water meadow the value increased to 25s an acre (*Roals 1845*, 520). This increase appears excessive and may be an exaggeration, but nevertheless, similarly spectacular increases can be demonstrated elsewhere (*Bettey 1999*, 184).

Much has been written about the history and the advantages and disadvantages of flooded water meadows (*eg Kerridge 1953*; *Bowie 1987*; *Bettey 1999*). In contrast, however, with a few notable exceptions (*eg McOmish et al. 2002*, 132–36; *Wade-Martins – Williamson 1999*), relatively little detailed archaeological research has been undertaken. It is against this backdrop that this paper has been written. Using the evidence of field survey and investigation, coupled with aerial photographic interpretation from recent English Heritage research projects, this paper aims to analyse the main methods of artificially flooding meadows. It also questions the assumption that they were first used in the late 16th century and suggests that they probably evolved over a much longer period of time.

The Characteristics of Artificially Flooded Water Meadows

There are two main types of artificially irrigating meadows, which are classified as either 'catchwork' or 'bedwork' water meadows.

Catchwork Meadows

Catchwork meadows were mainly constructed on hill slopes, although examples on flatter ground near rivers and streams also occur (*Pusey 1849*, 469; *Acland 1893*). They are readily recognised by the series of water channels (also known as carriers or gutters) cut along the contours of a hill (*fig. 1*). Although commentators regarded them as relatively cheap to construct when compared to bedwork meadows they were, nevertheless, well engineered; for example, great care was taken to establish precise levels along the gutters (*Smith 1851*, 141). In addition, the downhill side of a gutter was invariably embanked to ensure an even flow of water along its full length. On occasions this bank may be breached at intervals to allow flooding of particular areas (*pers. comm.* Rob Wilson-North).

Fig. 1. *An example of a catchwork system on Exmoor. A series of contour leats are cut along the side of the hill, with a circular pond, possibly a manure pit, above (NMR 15306/54 © Crown Copyright. NMR).*

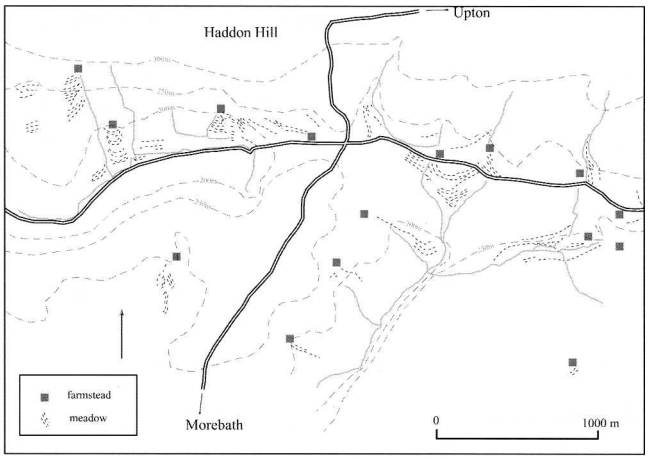

Fig. 2. *Catchwork meadows on the southern side of Haddon Hill, Exmoor to the east of the market town of Dulverton (© English Heritage).*

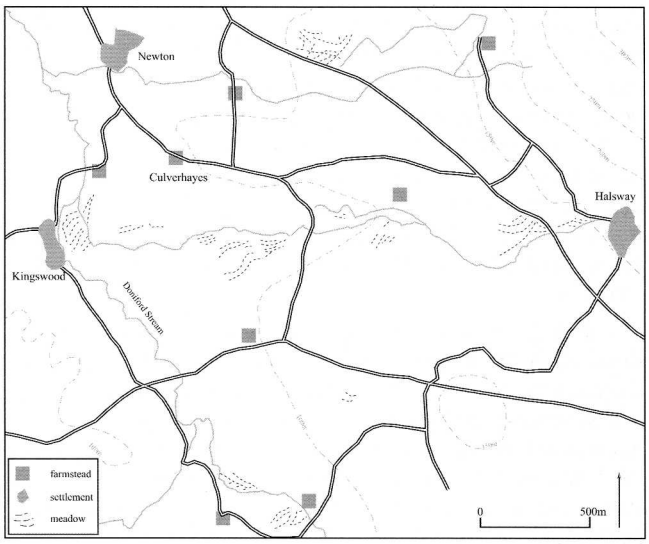

Fig. 3. *Catchwork meadows on western side of the Quantock Hills. Notice how some of the meadows are isolated from the farmsteads and they lie on lower ground to those on Haddon Hill (© English Heritage).*

The success of a catchwork meadow relied upon the availability of a suitable water supply. The most suitable water was from a spring although, as Pusey notes, not all springs were of the required quality (*Pusey 1849*, 465). Also springs on the south side of hills were much preferred to those elsewhere since the water tended to be warmer, and after all it was the warmth of the water acting on the soil that encouraged an earlier growth of grass (*Pusey 1849*, 463). On occasions, where the supply was insufficient or unsuitable, leats were cut to another source, which might be a considerable distance from the meadow. At Blackford Farm on Exmoor, for example, a leat was constructed from a spring nearly 2 km away (*Francis 1984*, 24). Wherever possible the water was further improved by 'mixing' it with the manure from a farm's stockyard. Although it is the case that catchworks were essentially for the benefit of sheep (*Pusey 1849*, 471–74; *Smith 1851*, 140), they were also constructed in order to provide a hay crop (*Roals 1845*, 519; *Taylor 2002*, 110).

From the stockyard or source, water would be channelled onto the upper part of the meadow where it was directed through a sluice and along a main gutter (also known as a carriage gutter). The end of the gutter would either taper to a point or have some form of 'stop' (such as turf), which ensured that it filled with water and overflowed, spilling a thin film over the meadow. Further gutters were cut down the hillside where they in turn would fill and overflow, thus watering the next section of meadow: in this way a controlled amount of flowing water covered the whole meadow. Eventually, any surplus water would be directed into a stream at the bottom of the slope. On some meadows, particularly those that extended over a number of fields, sluices and culverts through field boundaries were constructed to enable the farmer to direct the water to specific areas.

Catchwork meadows were used in many regions of England; however, it is in the West of England that they are particularly widespread and where the earthworks survive so well and where two systems are still in operation (at Wydon and East Nurcott /*pers. comm.* Rob Wilson-North/). Recent fieldwork and aerial photographic transcription by English Heritage on Exmoor, the Brendon Hills, and the Quantock Hills has highlighted the extent and nature of these meadows (*Dyer 1998*; *Riley – Wilson-North 2001*, 128–9; *Winton forthcoming*). On Exmoor and the Brendon Hills virtually all farms had catchworks near the farm buildings. Most lie at between 200–400 m OD with the farmsteads invariably located above a meadow but below, or on the same level as the source of water (*fig. 2*). In contrast, on the Quantock Hills the pattern differs slightly; here

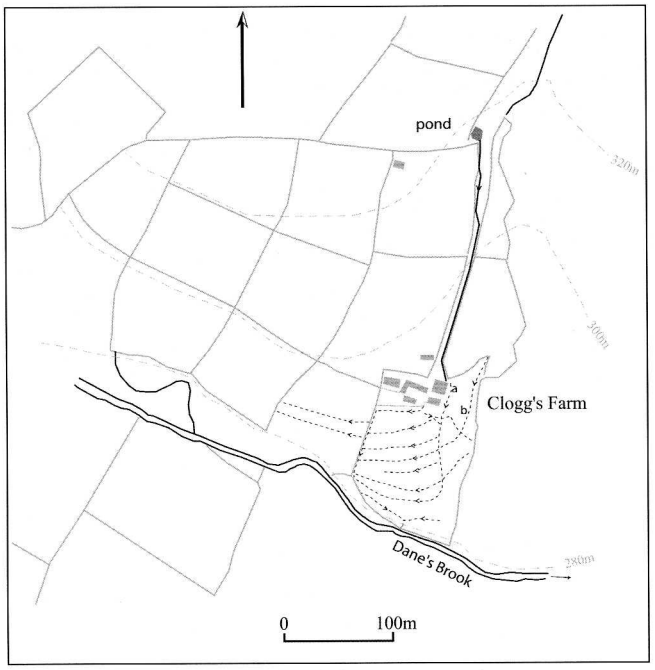

Fig. 4. *Cloggs Farm, Exmoor (© English Heritage. NMR).*

catchworks were not necessarily confined to the immediate vicinity of a farmstead but are sometimes detached (*fig. 3*). These detached meadows clearly would not have the benefit of farmyard manure unless it was carted to them.

Cloggs Farm is a small moorland-edge farm on Exmoor (*fig. 4*). It is situated on the south side of a relatively steep hill and above a small stream known as Dane's Brook. The farm, which lies at about 300 m OD, covers an area of 100 hectares with a meadow extending over two fields below the farmstead. The source of water for the meadow was a spring on higher ground to the north. From here the water flowed into a small 'collecting', or 'header' pond from where it was directed along a leat beside a track leading to the farmstead. In common with many of the Exmoor farms, water for the meadow was used for a variety of domestic and agricultural purposes. Here at Cloggs, the water was first routed to a barn where an overshot water wheel drove a small threshing machine, a grinder, chaff cutter, shearing machine, and a wood saw. Water was then directed from the barn into the stockyard where manure was washed through a culvert on the southern side of the yard. From the culvert the water/manure mix flowed either east or west along the main gutter on the upper part of the meadow. This gutter measures 0.3 m deep and is embanked to a height of 0.1 m on the downhill side in order to contain the water until a sufficient amount to flood the meadow was accumulated. Below the main gutter lie six further gutters, each less pronounced than the main gutter. Another main gutter (a) bypassed the barn and either provided water for the gutters on the lower slope, or directed it to the bottom of the hill when it was not required for irrigation. Some form of sluice would have been used to direct the water along the appropriate gutters. Additional water for the lower part of the meadow was also supplied from a third main gutter (b) that was fed by a tributary stream that flowed along the edge of the eastern field boundary. Finally, water was collected at the bottom of the hill and flowed along a drain and through a culvert into Dane's Brook.

The meadow to the south-west of the farmstead also has the remains of a catchwork system. Water was supplied from the first meadow through two culverts in the field boundary where it flowed along two gutters. Interestingly these two gutters are at a lower level than the corresponding gutters in the eastern meadow. This may have been necessary so that the water rate could be increased on the short downhill stretch before entering the western field, thus enabling the water to flow along the full length of the gutter at the required rate. Below the two gutters the ground is appreciably steeper and there is no evidence of gutters here. However, despite the lack of earthworks, it is probable that the upper part of the meadow was watered, but in this case from a drain bordering the northern field boundary.

The date of construction of the catchwork system at Cloggs is unknown; however, it is likely that it was either in existence by the 17th or early 18th century when the present farmstead was built, or it possibly post-dates this rebuild.

A further, but probably later, example is Larkbarrow Farm, which was one of a number of farms on Exmoor built by the Knight family in the mid-19th century (*Jamieson 2001*; *Riley – Wilson-North 2001*, 138). The now deserted farmstead is situated at about 400 m OD on a gentle south-facing slope overlooking a broad valley and is positioned almost centrally within its enclosed fields with meadowland to the south (*Jamieson 2003*, 22; *fig. 5*). Within the meadow are the remains of an extensive catchwork system that extended west beyond the depicted survey area. The source of water was a series of springs to the south-east of the farm. A leat (a) extends north from the springs along a field boundary and then turns northwest to the farmstead where its course is now unclear; however, given examples elsewhere on Exmoor, it is probable that some form of manure pit was located in this area. From the farmstead, the manure/water mix flowed along the main gutter (b) in a westerly direction and spilled over the meadow in a similar fashion to the one at Cloggs. Culverts were positioned in the earthen field banks to allow water to pass through onto adjoining fields.

The remains of another catchwork lies further south (c) and was totally divorced from the farmstead. Later cultivation of this meadow has obscured some of the earthworks; nevertheless, a substantial main gutter can be traced extending west along the contour, with the fragmentary remains of another gutter further down the hillside.

The Bedwork System

The second principal method of artificially irrigating meadows is known as the bedwork system. This was far more costly to construct and maintain, but never-

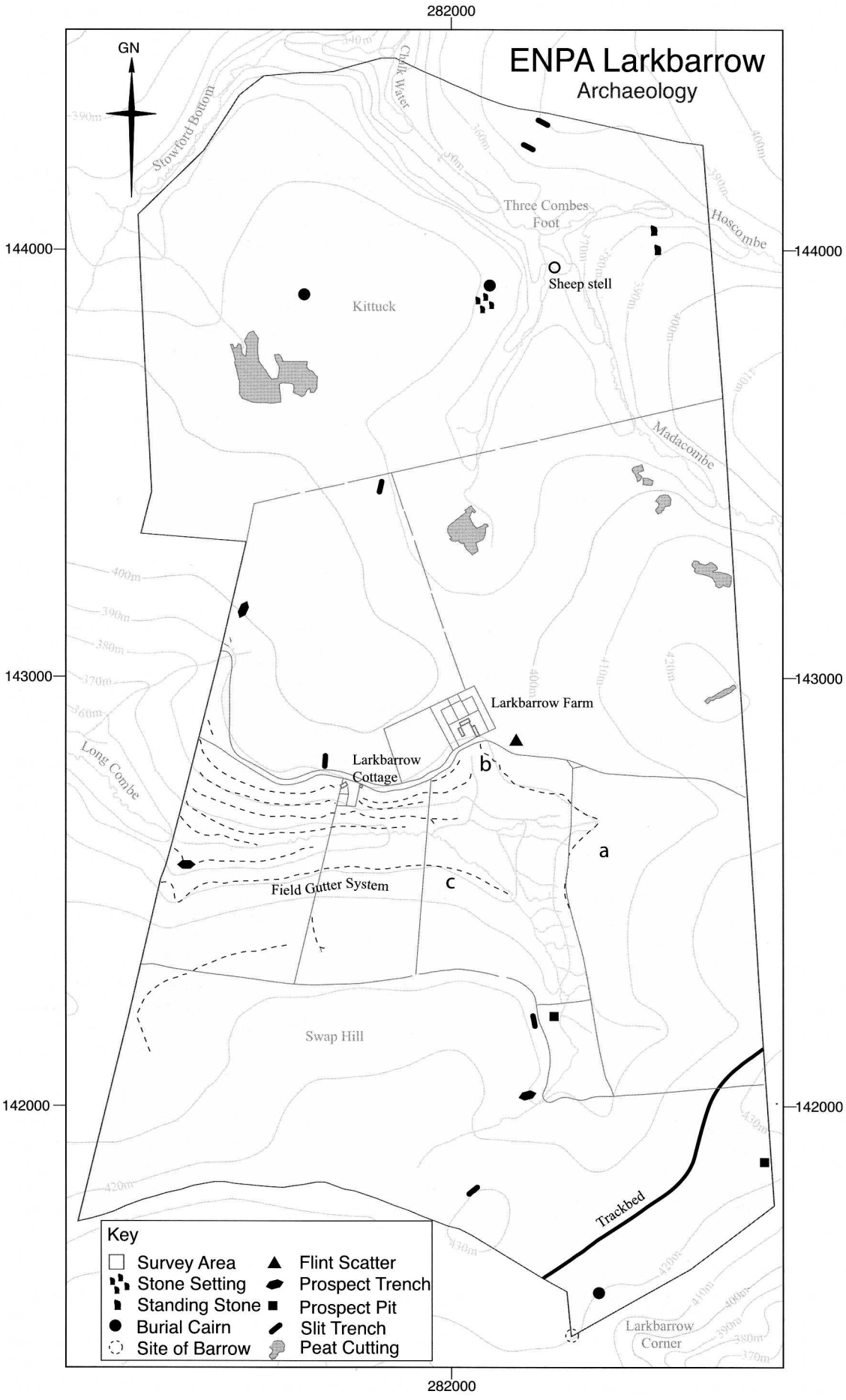

Fig. 5. *Larkbarrow Farm, Exmoor (after Jamieson 2003) (© English Heritage. NMR).*

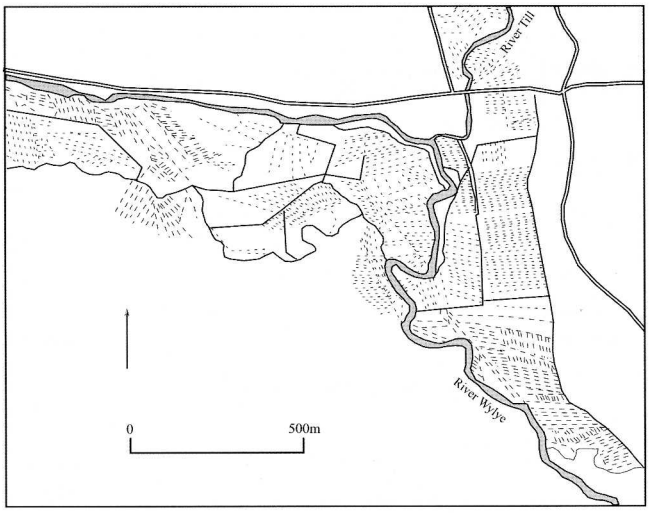

Fig. 6. *Water meadows at the confluence of the rivers Till and Wylye to the west of Salisbury (re-drawn from the Stonehenge World Heritage Site NMP aerial survey; © English Heritage. NMR).*

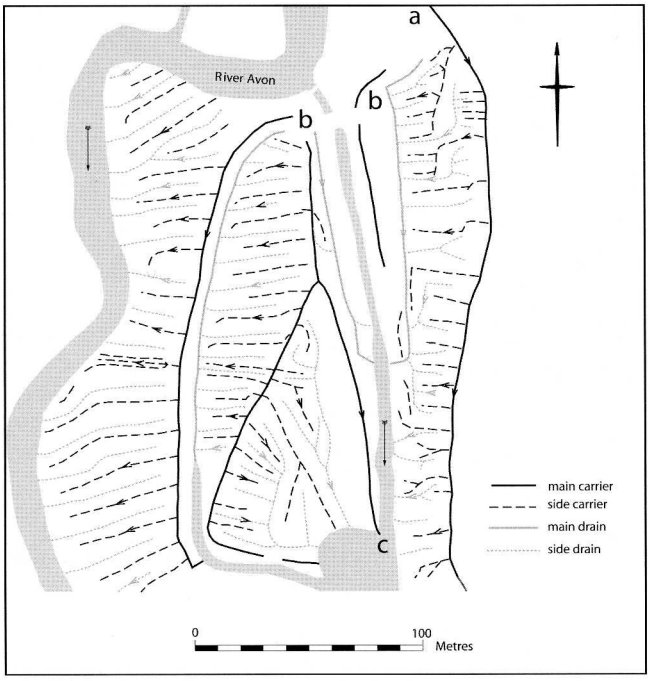

Fig. 7. *The bedwork water meadow at Hindurrington near Bulford (© English Heritage. NMR).*

theless the costs could be outweighed by the benefits. It was a system that was widely adopted in the chalk downlands of Wessex and has become the most distinctive and pervasive feature along the river and stream valleys of the region (*fig. 6*).

A bedwork system consists of a series of earthen ridges of varying length that are arranged in either parallel or 'herring-bone' blocks when observed in plan view. These ridges, known as carriers, carriages, or panes, have a narrow channel cut centrally along their length to carry the water (on most meadows, however, these channels are no longer visible). Between the carriers are the furrows, or 'side drains' that leads to a wider main drain, which in turn leads back to the river. Other features on the meadow may include hatches, sluices and aqueducts to direct and control the water to specific areas.

An example of a bedwork system is at Hindurrington, which is situated beside the River Avon to the north of Salisbury in Wiltshire, and was floated by at least 1660 (*Duke 1914*, 161; *McOmish et al. 2002*, 132–36; *fig. 7*). It covers an area of 5.7 hectares and extends both to the north and south of the depicted survey area. A main carrier (a) to the east, supplied water to three other carriers (b), which in turn fed the central channels along the side carriers. From each side carrier water flowed over the ridges and was collected in side drains. On the western side of the meadow these side drains empty directly into the river and not into a main drain as elsewhere. Interestingly, the main carriers have been carefully constructed at a lower level than the side carriers, and sluices would have been used to raise the water level sufficiently for it to flow along each side carrier. Small earthen mounds indicate the location of these sluices, although no brickwork is evident. This is unusual along the Avon since most have brickwork in the sluices and it may suggest that this particular meadow was an original layout whilst others may have been adapted and improved over the years.

Bedwork systems, like catchworks, are found in other parts of England. In Shropshire, for example, *Williams* (*1999*) has identified thirty-five flooded water meadows, either surviving as earthworks or from documentary sources (the county Sites and Monuments Record, however, lists only eleven examples). Perhaps the best preserved in the county is at Buildwas Abbey, which was surveyed by English Heritage (*Brown 2002*).

The meadow at Buildwas lies on the flood plain of the River Severn and at the eastern end of a long meander (*fig. 8*). The river is fast flowing, especially after periods of heavy rain, and as a consequence the meadow benefits from the seasonal inundation of water, which could sometimes last for several weeks. This natural flooding would result in the deposition of fine silts on the meadow; however, if the water remained for any length of time and it was static, it could stagnate and be harmful to the grass. Later in the year, artificial irrigation took place in order to provide a hay crop for the cattle.

The meadow covers an area of about 6 hectares and is bounded in the south by a higher terrace on the edge of which a railway line and roadway have been constructed. Rather than using the powerful river, the water source for the meadow was a stream that rises on a hill some 2 km to the south and discharges into the River Severn between the meadow and the nearby former Cistercian abbey. Brick culverts (a), on the side of a road and railway embankment directed the water from the stream to the hatch and 'collecting' pond (b). The hatch effectively controlled the supply of water to the meadow. When it was not in use the hatch would be closed and water directed back to the stream through a culvert. From the hatch, water was directed to a sluice (c) which, in common with another further

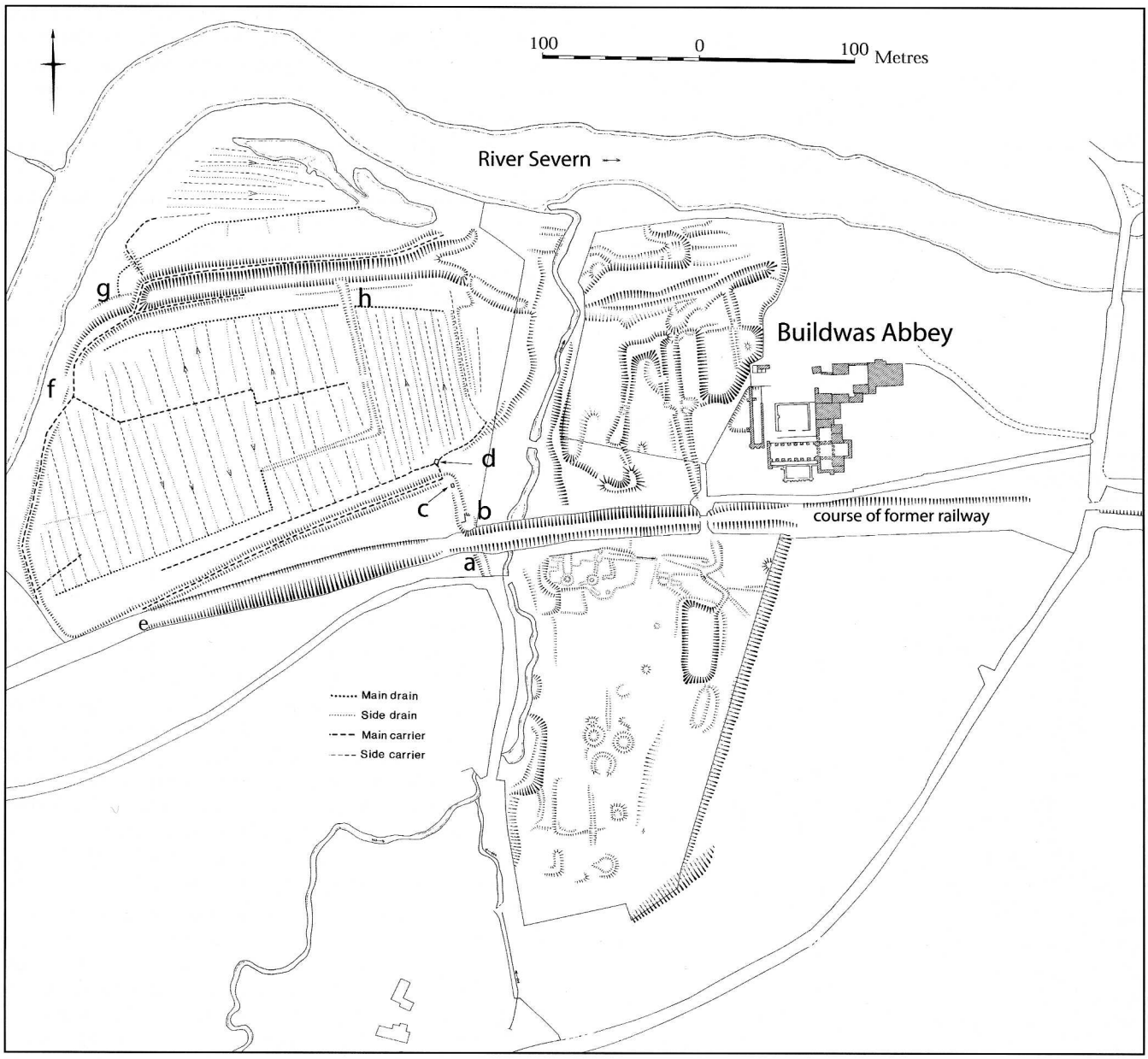

Fig. 8. *Water meadow at Buildwas Abbey, Shropshire (© English Heritage. NMR).*

north (d), is only partly visible, but is of brick construction and domed. From the sluice (c), water was directed either to the west or north. The main carrier to the west is cut into the natural north-facing slope and the difference in level from east to west is -0.6 m, which would allow a gradual flow of water. At (e) the railway line overlies the carrier but its course undoubtedly continued to the field corner. From this point it continues north along a curving embankment, which measures up to 0.5 m high and 3 m wide at the top. At (f) the main carrier divides, one branch following an easterly course in a doglegged fashion across the centre, slightly higher part of the meadow, whilst the other carrier continues further north along the embankment. At the south-western corner of a wide channel (g) it again divides and follows a course along both sides of the channel. The northern carrier again divides to water the northern part of the meadow.

From the sluice (c) the main carrier extends north to the sluice (d) where it divides; one branch flows west and provides water to a number of shorter side carriers, while the other curves east along an embankment to the present field boundary. This carrier provides water for the eastern side carriers.

From the main carriers the water flowed along the side carriers that extended at right angles to the main carriers: a 'stop' at the end would cause the water to overflow into the drains and discharge into the main drain (h) and ultimately to the river.

It is unclear when the meadow at Buildwas was first floated, but is likely to have been sometime in the mid-17th century or perhaps early 18th century when such systems are known to have been in operation elsewhere in the county (*Edwards 1989*, 153). The floating of the meadow probably continued until the railway was built during the early years of the 19th century.

Discussion

Artificially irrigated meadows have a long pedigree in Europe. *Rackham* (*1986*, 338) notes what he calls the 'ancient' practice in Italy and the Alps, as well as along the Zermatt Valley in Switzerland. In addition 'artificially created grasslands' were established on the lower plains of Lombardy: this manipulation and management of the water resource began with the Benedictines and Cistercians in at least 1138 (*Braudel 1992*, 46). In England, however, it is in the 17th century that we have clear evidence of floated water meadows, not only in Wessex (*Bettey 1999*), but also elsewhere in the country. In Surrey, for example, Sir Richard Weston improved previously barren land on his estate at Sutton Park beside the River Wey in the early 17th century (*SHC* G 94). Work began in 1618 on constructing a channel about 5km long from the river to his estate where he floated an area of between 120–180 acres (50–75 hectares) (*Nash 1969*, 38). What was previously worthless was transformed into rich meadowland, which produced 150 loads of hay that sold for £3 a load (*Nash 1969*, 38). In addition to improving land on his estate, Sir Richard was a great agricultural innovator, who was later credited with introducing clover as a crop rotation in England (*Aubrey 1719*, 3; *Nash 1969*, 37).

In the West Country, John Hooker, a leading antiquarian, wrote about the agriculture of Devon in 1600. He noted how farmers on the higher grounds mixed water with dung and lime and directed it over the meadows (*Blake 1915*, 344): in other words the classic catchwork system. He seems to be writing about a well-established practice, but how much earlier is unclear. In Somerset, on the higher moorland of Exmoor, despite extensive fieldwork, there appears to be no evidence of catchworks on any of the deserted medieval settlements (see for example the plans in *Riley – Wilson-North 2001*). The settlement pattern here was mainly one of small hamlets of perhaps two or three farmsteads, many of which later amalgamated to form single units (*Riley – Wilson-North 2001*, 93, 122). It is possible that it was during this process of amalgamation that water meadows were introduced. Their creation would not necessarily leave any documentary evidence since they were essentially individual enterprises (unlike bedworks that invariably entailed negotiation with other people or involvement of the manor courts).

It was, however, Rowland Vaughan who has been attributed as having 'invented' the system of artificially irrigating meadows sometime in the 1580s on his farm at Turnastone Court, Vowchurch, which lies beside the River Dore in Herefordshire (*Kerridge 1973*, 110). Vaughan published an account of his work in 1610; however, his book was written eighty-seven years after one written by J. Fitzherbert in which he alluded to the principle of irrigating meadows (*Rackham 1986*, 338). It has also been suggested that it was Vaughan's connections with the Earl of Pembroke, one of the leading landowners in Wiltshire, which initiated the spread of water meadows to Wessex (*Bettey 1999*, 180). However, despite this link, this seems unlikely since Vaughan's meadow is more akin to a catchwork system on flat ground and quite unlike the water meadows in Wessex. It is perhaps worth re-emphasising that catchworks were not confined to hill-slopes, but were also constructed on low-lying, sometimes virtually flat ground, thus allowing the water to flow gradually, and very thinly, over the meadow (*Pusey 1849*, 469–77).

Although catchworks and bedworks are the most widely recognised floated water meadows, other variants undoubtedly existed. *Kerridge* (*1967*, 253) describes what is termed a 'floating upwards' system, whereby a river was dammed and water allowed to flow on to the adjoining meadow. Another variant can be seen at Avebury in Wiltshire, where a long narrow ditch, which was probably a water 'carrier', extends from the river in the north along the western side of a bank. This ditch marks the eastern side of the meadow. Cuttings along the 'carrier' enabled water to flow onto the meadow (*McOmish et al. forthcoming*). A similar meadow lies at Binknoll to the south of Avebury (*Brown forthcoming*). Here a wide bank, which was probably a 'carrier', curves from a stream around a meadow. At the point where the stream and bank meet there is a constriction in the stream, which is where a sluice or dam was probably located. The level of the water would be raised when the sluice was closed allowing water to flow along a channel in the bank and onto the meadow.

Whether there is any chronological difference between these meadows and the more common types is unclear. However, on the chalklands at least, it is probable that some of the classic bedworks, with their highly planned, corrugated lines of ridges and furrows, had simpler, less sophisticated origins. These were perhaps similar to those at Avebury or Binknoll and are now obscured by the more elaborate meadows that we see today.

A medieval date for artificially flooding meadows is also alluded to in some documentary sources. *Moorhouse* (*1981*, 697–8) for example, has suggested that artificially flooding meadows was occurring in Yorkshire in the 14th and 15th centuries. Accounts for Bolton Abbey in 1311 refer to the diversion of water from a river onto the fields. At Allerton Bywater in the same county, the accounts for 1420/1 refer to wages for making weirs in the flood banks, and for 'flooding and raising the ditch near the king's highway for safe-keeping of the king's meadow there' (*Moorhouse 1981*, 697).

A more explicit example is provided from Westminster Abbey's manor of Pyrford, Surrey. In 1331–2, meadow was highly valued: at 3s an acre, it was nine times more valuable than its arable land. The importance of meadow is illustrated in the manor's customal where work that was to be undertaken on the meadow is the first entry. One of the services of the customary tenants was damming (or stopping) the water, to overflow the lord's meadow once a year. While some tenants appear to be stopping the river, others were stopping the millstream (*SHC* G 97/4/9).

While these examples from Yorkshire and Surrey do not necessarily imply a floated water meadow of the sort that is so familiar with today, they do suggest that the principles and advantages of flooding were probably understood in the medieval period, although the actual form they took is unknown. *Cook et al.* (*2003*, 159–62)

have also recently pointed out the lack of documentary evidence for floated meadows in England during the medieval period, but go on to highlight a number of examples from monastic houses where meadows may have been irrigated.

It seems wholly plausible, therefore, that floated water meadows evolved over a long period of time and, although reaching prominence in the 17th to 19th centuries, they had an earlier, simpler origin. It will only be through further detailed archaeological investigation and targeted survey, coupled with documentary evidence, that a clearer understanding of these meadows will be obtained.

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Summary

In England, the artificial irrigation of meadows was one of the most important agricultural innovations of the post-medieval period. The process entailed the diversion of water from a spring, river or stream, using a system of leats to ensure a shallow film of constantly flowing water over the meadows. This had the effect of encouraging an earlier growth of grass that was used mainly to feed sheep and provide additional nutrition for ewes suckling lambs during the early spring when fodder was relatively scarce. As a consequence larger flocks could be kept and more land cultivated.

Using the evidence from field investigation, earthwork survey and aerial photographic interpretation, coupled with map and documentary evidence, this paper examines and compares the principal methods of artificially irrigating meadows. It also questions the view that they were first flooded during the latter stages of the 16th century and suggests that they may have developed earlier, possibly during the medieval period.

Résumé

L'irrigation artificielle des prairies en Angleterre a été une des plus importantes innovations agricoles de la période post-médiévale. Le procédé nécessitait la déviation d'une eau de source, de rivière ou d'un ruisseau, par le biais d' un système de canaux qui déversait en continue une mince couche d'eau sur les prairies. Cela avait pour effet d'accélérer la pousse de l'herbe et permettait donc de nourrir les moutons au printemps quand le fourrage était relativement peu abondant. Par conséquent, il devenait possible de cultiver davantage de terrain tout en ayant de plus gros troupeaux.

Utilisant les témoignages récoltés durant les enquêtes de terrain, les études de travaux de terrassement, l'interprétation de photographies aériennes, ainsi que certaines informations tirées de plans et de sources documentaires, cet article examine et compare les méthodes principales de l'irrigation artificielle. Il met en cause le fait que ce fût pendant la dernière partie du 16ème siècle qu'aurait débuté la pratique de l'inondation des prairies et suggère qu'elle aurait été développée plus tôt, peut-être même pendant la période mediévale.

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