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(incorporating the Cambs and Hunts Archaeological Society)

Volume LXXXIV

for 1995

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Erratum

In volume LXXXIII, p. 6, Journals exchanged with the *Proceedings of the Cambridge Antiquarian Society*:

Transactions of the Lancashire and Cheshire Antiquarian Society, Macclesfield, Cheshire
should read
Transactions of the Lancashire and Cheshire Antiquarian Society, Manchester

Wind Pumps in the Haddenham Level: an Archaeological Survey

J.B. Finney, S.M. Finney & N. James

Introduction

In the Fens, the eighteenth century was the age of the windmill. By the last quarter of the seventeenth century, within a generation of the main works of draining the peat for agriculture, wind pumps were introduced for raising water from the shrinking surfaces of the Black Fens into the rivers. Eventually, there were hundreds of them. Although superseded by steam machines during the nineteenth century, wind pumps were retained in a secondary role up to the early twentieth. They helped to maintain farming in much of the Fens during a period when many feared — or hoped — that Nature would reclaim them (see Appendix 1.1).

Following the chance discovery of the remains of a wind pump near Sutton Gault in 1991, we sought to assess preservation of others. To this end, we surveyed the Haddenham Level, identifying each of the eight sites known from documentary sources of the eighteenth and nineteenth centuries. Only at one or two has every trace gone, and at one there still stands a well preserved earthwork. Although surface remains of the rest are scant, there is evidence that some features do survive in the ground. The survey was completed in 1996.

Evidence

The distribution of wind pumps has been studied in parts of the southern Fens by R.L. Hills and K.S.G. Hinde, and by the Royal Commission on the Historical Monuments of England (RCHME). The principal sources of evidence are the records of drainage authorities, maps, notices in local newspapers, and earthworks, buildings and other archaeological remains (Appendix 1.2).

Little is known about the first pumps of the later seventeenth century. During most of the eighteenth century, the pumps used for field drainage were large; but smaller subsidiary ones were introduced later. The larger pumps were located at the outer edges of a fen in order to draw water from the middle and into a river or other main drain. The windmill preserved at Herringfleet, Suffolk, is probably a specimen of this type. Each drained about 1000 acres (400 ha). The typical site is next to a river flood bank, on the fen side. A pump comprised up to four features or sets of features: sail tower, water wheel or scoop wheel, intake channel and drains, and outlet culvert and ditch.

The sails that drove the pump were mounted on a wooden smock tower. It is thought that most towers sat on a base of brick on top of a low earthen mound and were supported by timber pilings. The pumps in the Swaffham and Bottisham fens stood as high as 18 m. Many towers provided rough accommodation for the 'millers'.

There were two alternative mechanisms for turning the sails into the breeze. In the nineteenth century, some towers were provided with fan tails which swung the sails into the breeze automatically. Before then and more commonly, they were pivoted by poles fastened to posts set around the tower. Connected by gears housed in the tower, the sails drove a wheel which raised water from the fen into the adjacent drain or river. The wheel was set at the side of the tower and scooped the water from an intake channel lined with brick.

Water from the fen was collected from smaller ditches and directed to the pump by a mill drain. Commonly, subsidiary drains or dykes converged with the mill drain from the edges of the fen behind the main drain or river. Usually,

Proceedings of the Cambridge Antiquarian Society LXXXIV pp. 155–65.

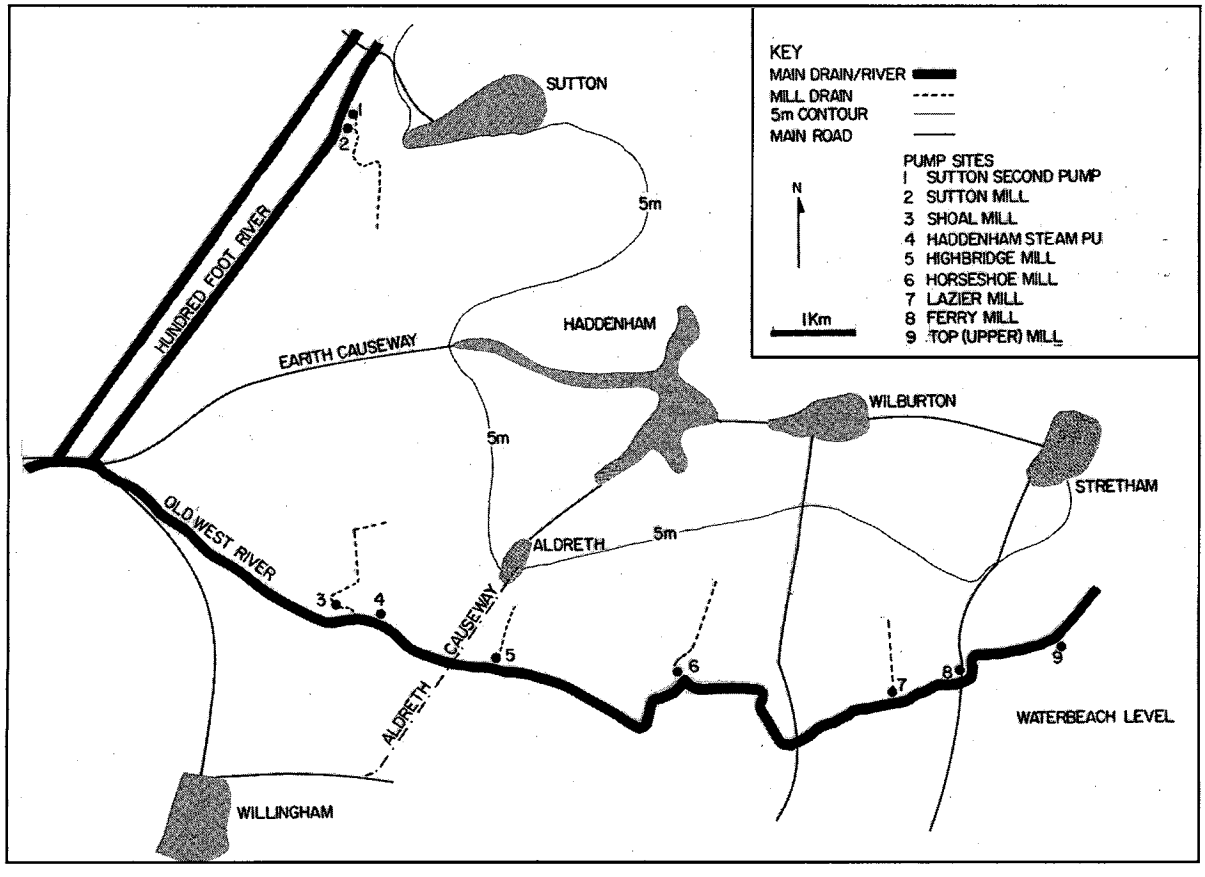

Figure 1. *The Haddenham Level.*

the water from these drains was gathered into a pond behind the scoop wheel. The wheel scooped the water into a culvert let through the flood bank of the main drain. The culvert was lined with timber or, like the intake channel, brick. The culvert emptied into an outlet channel which directed the water across the berm of the bank or the flood wash into the drain or river.

To boost drainage toward these pumps, smaller 'outliers' were set up within fens. Those in the southern Fens drained 30 to 50 acres (12–20 ha) and stood about 7 m high. Some were set upon low plinths of brick. They were supported by pilings or built directly upon the ground surface. The scoop wheel was mounted inside or partly inside the tower. The well-known pump preserved at Wicken Fen is a late example of the type. The prototypes of these pumps were probably developed by peat cutters.[1]

Many or most of the eighteenth-century pumps had complicated histories of maintenance and adaption. Once superseded entirely, some pumps were dismantled and the materials possibly re-used elsewhere. This usually left the feeder drains, intake pond, culvert and outlet intact around the mound, and perhaps some brick from the tower and channels. A hundred years ago, remains of wind pumps, including the towers, were not rare in the Fens; but preservation has deteriorated gravely since then. Four towers remain in Norfolk and Suffolk and a single late example in Huntingdonshire. Of these, the Pepperbox Mill, in Mildenhall Fen (Suffolk), is the best analogue for our survey in respect of chronology, topography and, presumably, technology.[2] In 1963, Hills reported, for the Waterbeach fens, that channels and bricks remained at the Top or Upper Mill while the twin Dollard pumps survived as scatters of brick, timber and nails. Yet, even as his article went to press, remains of the intake channel and foundations of the lower Dollard pump were to be ploughed up. The site of the Top Mill and its drains is still preserved as Hills saw it; but the remains of the Mere Mill have been further obscured recently by site development. Of the sites recorded by the RCHME northeast of Cambridge, in the years 1967–9, the two best preserved are now all but destroyed: the Swaffham Upper Mill's by dumping soil, concrete and other

materials, re-alignment of a drain and development of the river wash; and the remains of the Bottisham Mill and its cottage by facilities for moorings (see Appendix 1.3).

Haddenham Level

The drainage engineers of the seventeenth century divided the southern peat fens into three subregions, the North, Middle and South Levels.[3] The Haddenham Level lies at the western corner of the South Level. There is indirect evidence for a wind pump here as early as the sixteenth century but its site is not known. In 1727, following years of flooding, land owners in the Level were granted statutory authority to form an internal drainage board or commission. As defined by the legislation, the Level comprises some 6500 acres (2625 ha) between Sutton and the South Level Barrier Bank in the west and the Old West River and Stretham Ferry to south and east (Fig. 1; the Upper Delphs were excluded from provision). One of the Commission's principal purposes was to set up and run wind pumps. Subsequently, these provisions were emulated throughout the Black Fens.[4]

The first pumps in the Level may not have been built before 1732.[5] Most of the Commission's records for the years up to about 1950 have been lost.[6] However, a set of copies of the accounts for 1739–41 and 1743–5 have been preserved.[7] These name the pumps and show much about how they and the drains that fed them were maintained. Among the expenses were bricks and lime, timber (including oak, fir and deal), nails, brasses and ironwork, lubricants, line and thread, and time spent on mending sails. The ditches around the mill mounds were scoured and fenced. The millers were provided with turves for heating. Five pumps are listed, and they can be located more or less confidently on later maps.

Five maps are especially helpful for tracing the pumps' histories. The 'Map of Haddenham Level in the Isle of Ely' is thought to be that ordered by the Drainage Commission from William Custance in 1798. It shows the main drains and four wind pumps. In 1811, the Ordnance Survey recorded five pumps in the draft for its first map of the area but, by the time of publication, in 1836, three of them had been deleted. Baker's well known survey of 1816–20 and Lenny's of 1828–31 help to complete the story (see Appendix 2).

Failing the archive, the Drainage Commission's advertisements in the press, requesting tenders for various jobs, provide a few other glimpses of its activity. Like others, the Haddenham Commission tended to use the 'Cambridge Chronicle'. One notice in 1797 is especially interesting. It announced repairs to be carried out on four pumps in the Level.[8] This confirms the evidence of the 'Map of the Haddenham Level'.

Most of the wind pumps seem to have been decommissioned at about the time that the Haddenham steam plant was set up, in 1831.[9] The new machine drained the Level into the Old West River through Ewell Fen, west of the Aldreth Causeway. Again as elsewhere, the steam engine was replaced, in the present century, by oil-fired pumps. Two sets were installed: one by the steam station and the other at the end of the Rymermoor drain, draining into the Hundred Foot (New Bedford) River at Sutton Gault. The latter were dismantled in 1994, along with their elegant concrete house. For again as elsewhere in the Fens, the oil-fired pumps were replaced by electric machines, at both Sutton Gault and in the diesel house by the steam station.

Survey

The sites of the Haddenham Level wind pumps survive in various conditions (Fig. 1). Two have been quite obliterated. Three remain as dense scatters of brick; and sections cut into two of these show that more remains in the ground. One site is marked by bricks and the outlet channel. The other site is preserved as an earthwork, and this is in better condition than that of any other eighteenth-century wind pump recorded in the South Level during the last forty years. To help clarify the other sites, this well preserved earthwork is described first.

The chronology for our argument is summarised in Table 1, which also lists the locations of the sites. Small samples of the bricks were collected (Appendix 3).

Horseshoe

The Horseshoe pump and its mill drain lay along the parish boundary of Haddenham and Wilburton. An early map, the 'Generall Plotte' (see Appendix 2), shows that the mill drain was formerly a natural stream. The site was named, presumably, for the bend in the river, adjacent (Fig. 2.1).[10] The pump is one of the five listed in the accounts of 1739–45; and it is marked on the 'Map of Haddenham Level' and the Ordnance Survey's draft. Since Baker's and the other maps do not mark it, presumably the pump had been dismantled by 1821.

As at other wind pump sites, a couple of

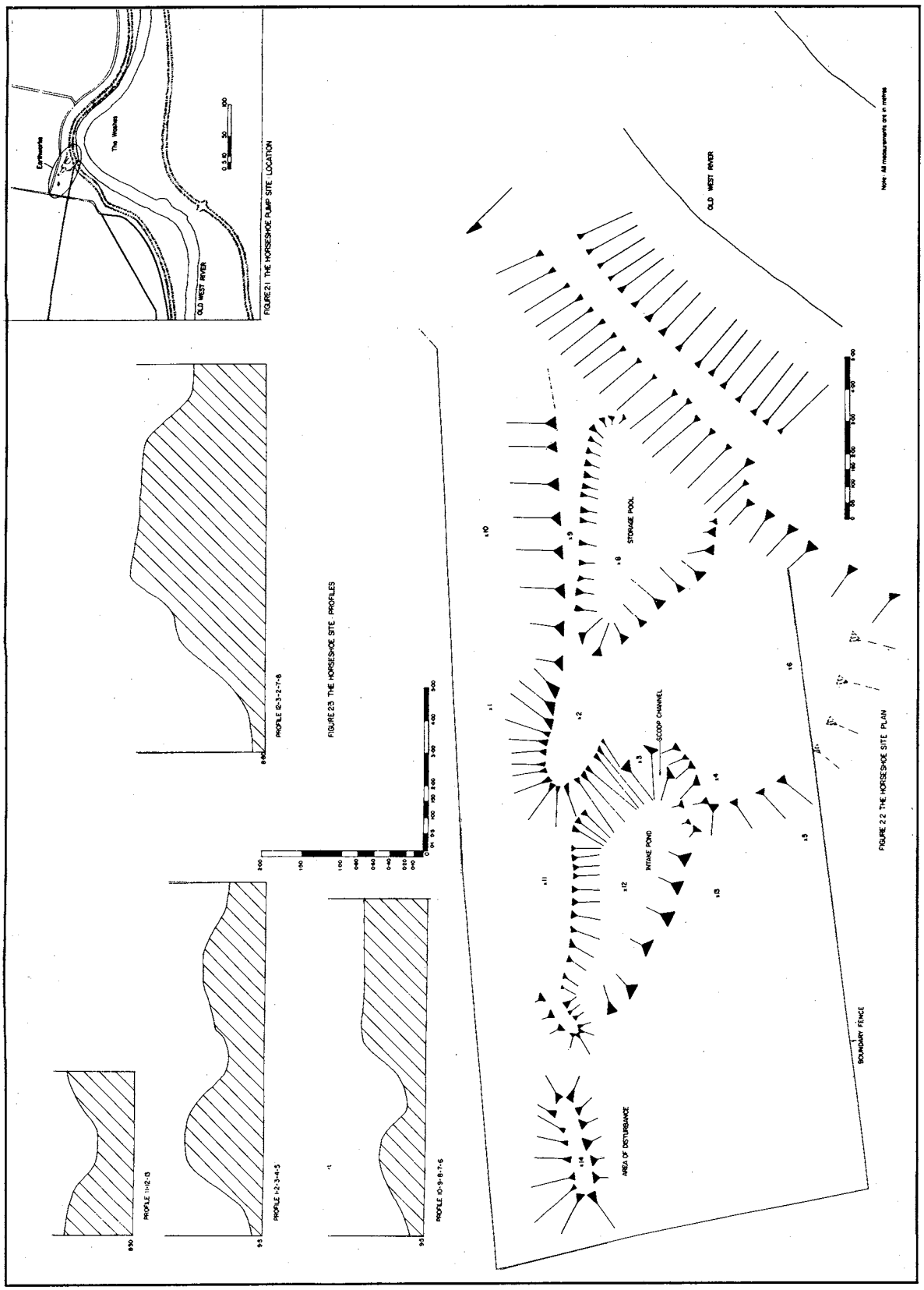

Figure 2. *The Horseshoe earthworks: 2.1) location; 2.2) plan; 2.3) profiles with data from 2.2 and Appendix 4.*

lateral ditches converge with the mill drain behind the flood bank of the river. The water was led up to the pump through an intake pond. No trace of a sluice between the feeder drains and the pond remains. The pond is now crossed by a path but most of it remains as a distinct depression — emphasised by the mound or mounds for the pump. We surveyed the site with alidade and plane table (Figs. 2.2–3, Appendix 4).

By the northeast corner of the pond is a mound measuring 4 m by 1.5 m. It is sharply defined but very small for supporting a sail tower. By the southeast corner is a lower, more diffuse mound, about 6 m in diameter. The latter is probably the site of the tower, on account of both the size of the mound and the orientation of a slight embayment adjacent, which must mark the mouth of the scoop wheel channel. Alternatively, the two mounds may represent successive phases of construction (see below).

There is no trace of either culvert or outlet drain. Since the river runs right up to the flood bank, there was no need for an outlet channel from the toe of the bank; and a new revetment may have disturbed former evidence of the culvert's mouth. However, a hand-moulded, unfrogged 'white' brick found lying on the bank may be from the culvert.

There is a second depression between the mounds and the toe of the flood defence bank. This may have been a pond for storing water thrown up by the wheel. No such feature has been recorded in previous research, but the requirement for it is easy to imagine. There were complaints about peat scooped by wind pumps into main drains in both the South and Middle Levels. The pond could have served to hold water behind a sluice until there was enough to flush through the culvert without leaving peaty sediment.[11]

Perhaps the whole site was altered as the storage pond was made. The smaller, higher mound may be a remnant of an earlier platform for the sail tower, truncated in order to make room for the storage pond at the toe of the flood defence bank, and replaced by the platform on the opposite side of the scoop channel. This would account for the irregular form of the head of the intake pond. The scoop wheel and tower may have been set lower than before (and the intake pond recut) in response to falling water levels in the fen.

Shoal

The Haddenham Shoal pump (not to be confused with another of the same name on the opposite bank of this shallow stretch of the river) lay against the flood bank of the Old West. It was marked by the Ordnance Survey both on the draft and the published map of 1836. Both Baker and Lenny confirm the location.

There is no record of the pump during the eighteenth century; but an advertisement in 1807 referred to 'the new Mill Drain' (i.e. the North Fen Drain) north of the site. Mill and drain may date to 1801.[12] It follows that the Dam Bank bridge into Ewell Fen would have been built over the drain, but no material remains of that date can be seen here now. The ditch connecting the mill drain to the steam engine drain may have been cut in about 1830 enabling the wind pump to act as a subsidiary to the new engine. (In the Waterbeach Level, the Mere Mill was retained near the Stretham Engine for up to nine years.[13])

A secondary drain joins the mill drain from the side of the fen. An outlet leads across the river wash on the other side of the flood bank. The Ordnance Survey's draft shows that a channel of the river ran by the berm of the flood bank (a course preserved by the parish boundary); so the outlet channel may have been a modification following abandonment of this channel and using part of its former course.[14]

A sluiced brick-lined culvert runs through the bank. There is no earthwork to correspond to the pump; but coarsely moulded unfrogged 'white' bricks are scattered across the bank and to either side of it. Some of these are similar to those at the Horseshoe site. One of them has the brown-cream colour typical of bricks from the Haddenham area.[15] In common with the locations of other culverts, a track crosses the bank here, no doubt exploiting the structure below for support.

Lazier

The Lazier mill (various spellings or pronunciations) was one of the five recorded in the accounts of 1739–45. It is shown on the 'Map of Haddenham Level' and on the draft Ordnance Survey. Baker recorded it and Lenny also marked it, set a few yards back from the river flood bank. It is not on the Survey's publication of 1836; but their 25 Inch map, surveyed in 1887, does show a sluice and a couple of buildings just behind the flood bank of the river. The site and mill drain are on the parish boundary of Wilburton and Stretham.

The sluice is still intact, its brickwork in good condition. Three drains converge on it: the main one from the middle of the fen (marked 'Mill Drain' on the 'Map of Haddenham Level') and one each beside the upstream and downstream flood banks of the river. The 25 Inch map also

shows this drain and the eastward upstream drain. It does not mark the westward downstream drain but the revision of 1901 does so.

The buildings recorded in 1887 remain as a diffuse mound about 200 mm high and a scatter of bricks. There are more bricks and some nails on the fen side of the new westward drain; and here too the ground rises about 200 mm. Exposed in the section of this drain, at the fen side of the junction with the mill drain, are foundations of lime mortar and fragments of brick and fuel ash, possibly constituting hard core, about 250 mm deep. The bricks spread up to 15 m along the north or fen side of the westward drain. The site corresponds to that marked on both the 'Map of Haddenham Level' and Lenny's map; but Baker marked the pump on the opposite side of the mill drain. Assuming that this detail of Baker's was mistaken, these must be the foundations of the Lazier pump. They were probably exposed between 1887 and 1901 by the downstream drain. It is puzzling that the bricks in the side of the drain spread so far back from the junction with the mill drain.

The bricks at this site are of four types: reds of dense fabric, wire-cut and frogged; whites, wire-cut, some frogged; coarse whites of the type found at the Horseshoe and Shoal sites (and see below); and a few of whiter hue, notably lighter in weight. The first two types probably date to the later nineteenth century, remains, no doubt of the buildings shown on the 25 Inch map. By cross-dating and on typological grounds, the others can be assigned to the early nineteenth century or before.

The published Ordnance Survey and a local map of 1865 show that there was no building here in the mid nineteenth century, but the existence of mill drain and sluice would have favoured retention of the site for draining the fen. There is no trace of an intake pond, but it may have been disturbed when the wind pump was dismantled and again when the westward drain was cut. The map of 1865 does not show any other features.[16]

Highbridge

The Highbridge pump is one of the five covered by the accounts of 1739–45 and is marked on the 'Map of Haddenham Level'. On the Ordnance Survey's draft and their published map, it is recorded as the Bridge Fen mill. It is shown on Baker's map; but, contradicting the published Ordnance Survey, it is not shown on Lenny's map. Comparison between the maps shows that the mill drain was progressively modified until more or less superseded by the steam engine drain. The site and the fen are named after the bridge that carries the Causeway route between Aldreth and Willingham over the Old West River.

The site has been ploughed and all that remains is a scatter of hand-made white bricks at the typical junction of a drain from the middle of the fen with two others converging from behind the flood defence bank of the river. The bricks are the same as those found at the other sites. The local map of 1865 marks a small pond at the end of the adjacent drain, remains, perhaps, of the intake pond.

Ferry

The Ferry pump is also covered by the accounts of 1739–45. The 'Map of Haddenham Level' marks the other four covered by the accounts but not the Ferry site. By implication from the map and the advertisment of 1797,[8] this pump was decommissioned no later than 1797. The account for 27 May 1744 shows that it was tended together with the Lazier pump. Other entries confirm that pumps in the same neighbourhood were often tended by the same men. In 1798, the commissioners announced the sale of the Ferry pump, 'standing on the West River Bank, near Stretham Bridge'.[17]

We have no further information. However, Lenny's map shows an outlet flowing from the Haddenham Leam to the river near Stretham Bridge. This is a likely location for the Ferry pump; but the river flood bank here has been covered by the new bridge for the main road. The first published Ordnance Survey (1836) shows the same configuration of ditches as Lenny's. The 1882 25-Inch map shows that the ditch from the Leam had been removed by the late 1880s; but it marks a small ditch across the wash between the river and its flood bank. This latter may have been an outlet from the pump to the river.

Sutton

The fifth pump covered by the accounts is the Sutton mill. In 1804, the Haddenham Level Commissioners advertised specifications for a large 'new WATER ENGINE near the Hundred Foot River'.[18] The 'Map of Haddenham Level' marks a mill near Sutton Gault and it is also recorded on another map of the same time.[19] Baker and Lenny also mark it (although the latter does not use the same clear convention for this site as he does for the others). It evidently drew water from the northern part of the Level into the Hundred Foot River. Both the location, at the foot of the South Level Barrier

Bank, and the mill drain correspond to those of the present electric pump and its oil-fired predecessor. Not that the wind pump survived so long: the site lay abandoned for many years. The published Ordnance Survey of 1836 marks no pump in this part of the Level but it does indicate that the last few yards of the mill drain were blocked up. Nor is there evidence of a wind pump now, presumably because construction of its twentieth-century successors destroyed any remains.

The pump is recorded on the Ordnance Survey's draft of 1811; but this shows another about 200 m down the line of the Hundred Foot River and South Level Barrier Bank; and Baker's map confirms that there were wind pumps at both sites. Since the second is marked neither by Lenny nor the published Ordnance Survey, it was evidently short-lived.

It was a common response to install a 'double lift' system of pumps as a solution to the increasing difficulty of drainage, brought about by peat shrinkage. An example of this was the installation of a second pump behind the Dowload Mill in the Waterbeach Level during the early 1800s. However, the second site at Sutton does not match the usual pattern for a 'double lift'. For, while the first seems to have drawn along the Rymermoor Drain, the second was located not upstream, lower into the fen, but, rather, downstream, and apparently not on the Rymermoor Drain at all.[20] Since it is clear that this second pump was not operating in tandem with the first, what purpose did it serve?

In 1797, the Haddenham Level (Amendment) Act confirmed the Commission's authority to set pumps up and also empowered it to drain 34 more acres a little to the north of this site (Section 31; the places are marked on the 'Map of Haddenham Level'). The additional discharge, close to the outlet, may have been considered excessive for the first pump alone so that the second was constructed as an auxiliary. The additional acreage was typical for the smaller type of pump.

At a location corresponding to the site marked by the draft Ordnance Survey and Baker, there is a scatter of bricks including some similar to those at the Horseshoe, Shoal, Lazier and Highbridge sites. It was disturbance of this site by drainage engineers in 1991 that alerted us to the survival of wind pump remains. Although neither Lenny's map nor the published Ordnance Survey mark the pump, both do record a ditch which continues the northward line of the Rymermoor Drain beyond its westward turn to the present pumping station. This ditch shows now as a soil mark and a very slight earthwork running through the peat straight toward the spread of bricks (Fig. 3). Although clearer in the southern part, the soil mark is continuous along the line shown on the two maps. The fill includes large fragments of lime mortar. No doubt, this was an outlet ditch from a former secondary pump to the mill drain of the pump at the Barrier Bank. Evidently, it was back filled with material brought from elsewhere, perhaps with the demolition

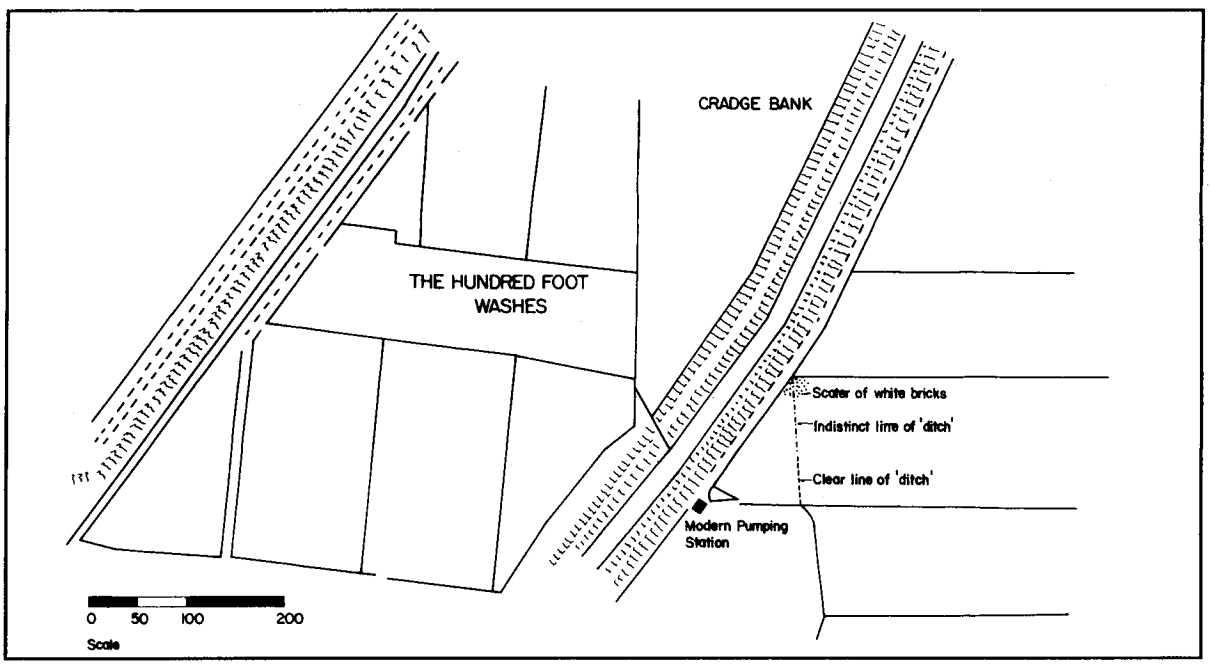

Figure 3. *Location of second Sutton pump.*

debris from the Sutton Mill. The 25-Inch Ordnance Survey shows that the ditch was filled by 1886 at latest.

Summary and Discussion

Beginning, probably, in the early 1730s, the Haddenham Commissioners concentrated four pumps along the Old West River, with a single one in the north of the Level. Presumably, the Ferry mill was removed following its sale in 1798. Then, like their colleagues elsewhere in the South Level, facing that testing time of rising water, rising prices and expanding markets, the Commissioners mustered fresh resolve, setting a new pump up at the Shoal and a second one at Sutton.[21] Barely a generation later, the strategy was completely revised with the introduction of steam power. The Shoal pump and perhaps the Highbridge pump may have been retained for a while alongside the new engine but they had certainly been removed by 1865. Today, the only substantial remains are those of the Horseshoe mill.

Our interpretations rest upon certain assumptions and raise certain implications in turn. It remains to assess three methodological difficulties with them.

There are problems in using the maps. Working with maps of small scale and not tied to a national grid, it is difficult to interpret details on the ground — hence doubts about locating the Lazier pump and the second Sutton pump. Further, we have assumed that if a map marks one pump then it must mark each of them. This poses a quandary about the later years of the Highbridge pump, where the Ordnance Survey contradicts Lenny. If a map is lacking, the problems are yet worse — hence doubt about the Ferry site.

The second problem concerns the bricks (see Appendix 4). There are hand-made bricks of much the same fabric at the site of every pump except the Ferry Mill and that presumed to lie beneath the modern site at Sutton. Since comparison of the maps allows us to distinguish the five sites corresponding to the accounts of 1739–45 from the two later ones, the uniformity of the finds implies that the remains at the older sites are from later phases of repair or rebuilding such as the works advertised in 1797.[8] The light bricks at the Lazier site may therefore be an earlier type. The account for 4 October 1740 specifies white bricks. How distinct, though, were the bricks made in different kilns and at different times?

Does uniformity among the bricks from different sites reflect the integrated organisation recorded in the accounts? The entry for 4 October 1740 is for a batch of 3500 bricks. As the Commissioners were responsible for many other structures, the bricks were not necessarily for the construction or maintenance of wind pumps. Any archaeological interpretation of the pattern would have to be tested both by increasing the sample of bricks and by comparing them with those from other drainage districts. Brief inspection at the Top Mill and the upper Dollard site, in the Waterbeach Level, revealed much the same material. Nor was it possible to distinguish between most of the bricks from the pumps and the earlier bricks scattered over the nineteenth-century site of Lockspit Hall (near the Horseshoe site).

Thirdly, it is difficult to tally the scant archaeological evidence for the pumps with the documented specifications. The accounts show that each wind pump was run by two men (except, perhaps, the main Sutton mill). It does not follow that every mill in the Level was of the same size, but neither the accounts nor the 'Map of Haddenham Level' indicate variation. The dimensions advertised for the 'engine near the Hundred Foot River' were larger than the Horningsea Mill's, and the specifications for another (perhaps the Shoal pump) imply an even larger structure.[22] Yet two of the mounds and intake ponds measured by the RCHME in the Swaffham and Bottisham fens were larger than those of the Horseshoe pump; and the base of the Pepperbox Mill, in Mildenhall Fen, has almost twice the diameter of the larger Horseshoe mound.

It is not to be expected that the archaeology of wind pumps would be simple, modest though they were. Since the Commission redistributed them so often, would it not have altered them yet more *in situ*? The accounts for 1739–45 and advertisements in the press record continual tasks of maintenance and alteration. We are, at the time of writing, carrying out more detailed investigations at two of the sites, on which we expect to report elsewhere, along with further observations on the second site near Sutton Gault.

Conclusions

Our field-work has confirmed and illustrated the documentary evidence. The succession and distribution of wind pumps shows that the drainage Commission was engaged in constant calculation and adjustment (see Table 1). Owing to the greater number of mills in the Haddenham Level, we can learn more clearly than from previous studies that deployment of wind pumps was a strategic engagement of limited resources against the elements. The technology of pumping by windmills was more diverse than

recognised before. If our interpretation is correct, discovery of the outlet pond at the Horseshoe site amplifies what is known of how the engineers adapted to the problems of draining peat.

Dr Hills showed how to identify the sites of wind pumps by archaeological survey (see note 13). Our discoveries of brick scatters confirm the presence of a distinct local type of site. No doubt there are many other examples elsewhere in the Fens.

However, in the Haddenham Level as elsewhere, substantial remains of wind pumps are now very rare. Conversion to houses has saved a precious few, including the Pepperbox but no others in the South Level. Some were replaced by later machines adapted to the existing drains. Such seems to have been the fate of the older pump at Sutton.[23] Reinforcements of flood defence banks and modifications of adjacent ditches may have disturbed some remains. The Shoal site may have been affected by enhancements of the north flood bank of the Old West River between 1960 and 1964.[24] The footings of the Lazier pump and the second pump at Sutton were disturbed by ditching. Other remains have been ploughed: the Highbridge site and the second site at Sutton have been damaged just as were the Dowload mills in the Waterbeach Level. Various forms of redevelopment and change of site use account for the loss of yet other remains, as at the Ferry site and the sites of the Bottisham and Mere mills.

Survival of the Horseshoe earthworks is therefore all the more remarkable. May the present report help to ensure preservation of this little monument representing a critical phase in the grand, tragic project of draining the Black Fens.

Endnotes

[1] Royal Commission on the Historical Monuments of England (RCHME), *An Inventory of the Historical Monuments in the County of Cambridge* 2 (London, HMSO 1972: lxiv); Lawrence Gibbs, Pumping machinery in the fenland and by Trentside, *Minutes of the Proceedings of the Institution of Civil Engineers* 94 (1888): 267.

[2] K.S.G. Hinde, Windpump remains in the Fens, in N.A. Smith (ed.), *Cambridge Industrial Archaeology* 1973 (Cambridge, Cambridge Society for Industrial Archaeology 1974: 19–20).

[3] H.C. Darby, *The Draining of the Fens* (2nd ed.) (Cambridge, CUP 1956: 70–72).

[4] *Ibid.*: 119–21. For the early pump, *cf.* H.B.Wells, Haddenham, in R.B. Pugh (ed.), *Victoria History of the County of Cambridge and the Isle of Ely* 4 (London, OUP 1953: 143).

[5] According to local expert, C.N. Cole, up to about 1732 there was only one wind pump in the southern fens ('Bedford Level petition, presented to the House of Comons, The 10 February 1777' (1777): 95, misquoted in *Journal of the House of Commons* (1777) 36: 300 (24 March)) — at Upware, presumably (RCHME 172: 132). There were others, but unlicensed, perhaps (P. Filby pers. comm. 1995).

[6] G. Chandler pers. comm. 1993. On 15 February 1962, the Clerk to the Great Ouse River Board asked the Haddenham Level Drainage Board about documents — by implication, back to 1931 or before (National Rivers Authority Anglian Region archive, ref. 6/E/P.425). Came reply: no information. We thank R. Tinkler for bringing this correspondence to our attention.

[7] 'Account of the Haddenham Level Receiver & Expenditor', Ely - Diocesan Records, Cambridge University Library (A8.46–7); S.H. Miller, *Fenland Notes and Queries* 2(330) (1894): 137; R.L. Hills, *Mills, Machines and Uncountable Costly Necessities* 29 (Norwich, Goose 1967: 125). Biennial accounts were required by the founding statute, with copies for Haddenham church and the Isle of Ely Sessions court.

[8] *Cambridge Chronicle and Journal* 1797, 5 August.

[9] Drainage engines, *Cambridge Chronicle and Journal* 1831, 4th February (P. Filby pointed this notice out to us); and *cf.* Lenny's map.

[10] Hereabouts lies a natural watershed: Gordon Fowler, Fenland waterways past and present: South Level district (part 1), *Proc. Camb. Ant. Soc.* (1933) 33: 117–19, 123–4; S.C.A. Holmes, Outline geology of the Roman fenland and stratigraphy of the Holocene deposits near the Old West River, Cambridgeshire, in C.W. Phillips (ed.), *The Fenland in Roman Times* (RGS Research Series 5.) (London, Royal Geographical Society 1970: 131); cp. Charles Nalson Cole, *Extracts from the Report of a View of the South Level.* (London, Bedford Level Corporation 1784: 61, 65, 117). The 'Map of Haddenham Level' calls the Old West River 'Old Cutt'.

[11] Complaints: *Journal of the House of Commons loc. cit.*; Samuel Wells, *The History of the Drainage of the Great Level of the Fens. called Bedford Level.* (London, Samuel Wells 1830: 433).

[12] *Cambridge Chronicle and Journal* 1807, 25 April; *ibid.* 1801, 25 April. Landscape history of this part of

Table 1. *Locations and dates.*

Site	Map Ref. (TL47/57)	1739	1798	1811	1816–20	1828–31	1836
Sutton	42617904			+	+		
Sutton	42507891	+	+	+	+	+	
Shoal	42447286			+	+	+	+
Highbridge	44257219	+	+	+	+		?
Horseshoe	46547190	+	+	+			
Lazier	49117169	+	+	+	+	+	
Ferry	50057225	+					

the Level is the subject of continuing research by one of us.

[13] R.L. Hills, Drainage by windmills in the Waterbeach Level, *Proc. Camb. Ant. Soc.* (1964) 56/7: 122; J.R. Stubbings & K.S.G Hinde, *Waterbeach Level* (1991): 14 (unpublished pamphlet).

[14] Wells 1953: 142; for the Willingham Shoal pump, *cf.* K.S.G. Hinde, Meres and mills in Willingham and Stretham, *Proc. Camb. Ant. Soc.* (1971) 66: 166ff.

[15] M. Dowdy pers. comm. 1995. These bricks were from a foot bridge that stood here (J. Darby pers. comm. 1993) — and, no doubt, the pump before that.

[16] The local map: 'Haddenham 1865' National Rivers Authority Anglian Region archive.

[17] *Cambridge Chronicle and Journal* 1798, 14th April (P. Filby pointed this notice out to us).

[18] *Ibid.* 1804, 30th June.

[19] 'A plan of the Sutton and Mepal fields' (1795) Cambridge University Library Ms. Plans 156.

[20] Hills 1964: 120. For the general pattern of double lifts, *cf.* Darby 1956: 121, 220. The accounts show that the Rymermoor Drain was maintained by the drainage Commission.

[21] Darby 1956: 160ff.; Dorothy Summers, *The Great Level* (Newton Abbot, David & Charles 1976: 193); Vancouver, 'General View of the Agriculture in the County of Cambridge' (1794): 148; W. Gooch, *General View of the Agriculture of the County of Cambridge.* (London, Richard Phillips 1811: 32–5); B.A. Holderness, Agriculture 1770–1860, in Charles H. Feinstein & Sidney Pollard (ed.), *Studies in Capital Formation in the United Kingdom 1750–1920* (Oxford, OUP 1988: 21–2); Richard Perren, Markets and marketing, in Joan Thirsk (ed.), *The Agrarian History of England and Wales* 6 (Cambridge, CUP 1989): 200–202.

[22] *Cf.* Notes 12, 17 above, RCHME 1972: lxiv, 84.

[23] Cp. *Ibid.*: 132–3 and K.S.G. Hinde, *Willingham (West Fen) Pumping Station* (n.p., Feoffees of Willingham Pumping Station 1977: 5).

[24] Letter of Chief Engineer to Estates Surveyor, Great Ouse River Board 31 January 1962 (ref. M/A/76), National Rivers Authority Anglian Region archive.

Acknowledgements

Thanks are due to the respective owners of and agents for the sites for their cooperation, especially the trustees of B.S. Pell's 1985 Settlement. The County Archaeology Field Office kindly lent surveying equipment. The County Record Office, Cambridge University Library, National Rivers Authority and esp-ecially the Cambridgeshire Collection helped with documentary sources. M. Dowdy assessed our samples of brick. We are grateful too to P. Filby, Rev. Dr R. Hills and K. Hinde for sharing their knowledge of wind pump technology and its local history and for commenting on earlier draft of this report; and to the Editor for her guidance.

Appendix 1. Historical and archaeological background.

1.1 History

The 'age of the windmill' is H.C. Darby's phrase: H.C. Darby, *The Draining of the Fens* C.4 (Cambridge, CUP 1940); *ibid.* (2nd ed.) (Cambridge, CUP 1956); and *cf. idem, The Changing Fenland* C.5 (Cambridge, CUP 1983). For the general technological succession of which wind pumps were part, *cf. idem* (1956): 113ff., (1983): 107ff.; for the total number, *cf. idem* (1956): 225; and, for the economics in general, cp. Dorothy Summers, *The Great Level* (Newton Abbot, David & Charles 1976). Succinctly covering administration and technology is Peter Filby, Fenland drainage windmills of Cambridgeshire and Huntingdonshire, in Duncan Breckels (ed.), *Proceedings of the Twelfth Mill Research Conference* (Mistley, Mills Research Group 1995: 31–43, 43–4).

1.2 Archaeology and Topography

For areas near by, see the following: Royal Commission on the Historical Monuments of England (RCHME), *An Inventory of the Historical Monuments in the County of Cambridge* 2 (London, HMSO 1972: lix ff.); R.L. Hills, Drainage by windmills in the Waterbeach Level, *Proc. Camb. Ant. Soc.* (1964) 56/7: 115–22; R.L. Hills, *Mills, Machines and Uncountable Costly Necessities* 29 (Norwich, Goose 1967: 125); K.S.G. Hinde, Meres and mills in Willingham and Stretham, *Proc. Camb. Ant. Soc.* (1971) 66: 165–73. Summing some of these findings up are Christopher Taylor, *The Cambridgeshire Landscape* (London, Hodder & Stoughton 1973: 201–2) and *idem Fenland Pumping Engines* (Cambridge, Cambridge Society for Industrial Archaeology n.d.: 2–4). Reviewing the surviving buildings in Norfolk, Suffolk and Huntingdonshire is K.S.G. Hinde, Windpump remains in the Fens, in N.A.Smith (ed.), *Cambridge Industrial Archaeology 1973* (Cambridge, Cambridge Society for Industrial Archaeology 1974: 18–21). On acreage drained, *cf.* RCHME 1972: lxiv; Hills 1967: 32.

1.3 Preservation

For the decline of the wind pumps in general, *cf.* Darby 1983 and several of the photographs; and, for the local examples, RCHM 1972: 131–2, 84, Hills 1964: 122, and H.C. Hughes, Windmills in Cambridgeshire and the Isle of Ely, *Proc. Camb. Ant. Soc.* 31 (1931): *passim.* At the Dollard site remain a slight mound and a few bricks behind the river bank but crop growth prevented assessment of the second pump when we visited the site. See also Hinde 1974.

Appendix 2. Maps.

The 'Map of the Haddenham Level' is in the County Record Office (515/P). It is probably the work advertised in *Cambridge Chronicle and Journal* 2 June 1798. The survey log is thought to be in the collection of Peterbrough Museum Library but cannot be traced at present (Ms E. Davis pers. comm. 1995).

For the Ordnance Survey's chronology, *cf.* J.B. Harley, Introductory essay, *The Old Series Ordnance Survey Maps of England and Wales* 5 (Lympne Castle, Harry Margary 1987: xxi, xxvii–xxviii). For Baker's, *cf.* R.G. Baker, *Map of the County of Cambridge and Isle of Ely* (Bluntisham, R.G. Baker 1821); For Lenny's, *cf.* J.G. Lenny, *Particulars Referring to a Plan of Part of the Bedford Level, and Lands Adjacent, Subject to Eau Brink Tax* (Halesworth, Roper 1844). Since Lenny's sheet for the area of our study marks the Swaffham steam pump but not the Stretham or Haddenham engines, this part of the survey must have been done before 1832 (*cf.* K.G.S. Hinde, Swaffham fen engine, *Proc. Camb. Ant. Soc.* (1971) 63: 87–9; Taylor 1973: 206 (Appendix 1.2 above) gives the correct date for the start of the Stretham engine; and *cf.* our 9.). Considering contradictions between the Greenwood map of Cambridgeshire (1834) and Lenny's of the fen drainage, we have not relied on the former, *pace* Herbert George Fordham, Cambridgeshire maps. II. Maps of the Nineteenth Century, *Proc. Camb. Ant. Soc.* (1908) 12: 183.

Helpful for understanding the natural drainage is the 'Generall Plotte and description of the Fenns' (British Library, Cotton. Augustus. 1.i.78). It is thought to be an early copy of Hayward's survey of *c.* 1604 (R.J. Silvester, William Haiwarde and the Fens, *Fenland Research* (1989) 6: 40–41).

Appendix 3. Bricks.

Samples of brick were collected from five sites. They will be deposited with the Cambridge Museum of Technology. The following chart summarises their attributes.

Site	Dimensions (mm)			Colour	Note
	Length	Width	Depth		
Sutton	212	100	59	white	TL42627913
Shoal	Fragment	107	47	light cream	
Highbridge	Fragment	109	49	light cream	
Horseshoe	Fragment	105	50	yellow white	
Lazier	Fragment	107	44	buff cream	

Appendix 4. Horseshoe site heights.

The temporary bench mark on the site was tied to the bench mark on the river bank sluice at the south end of the dyke running along the east side of Hoghill Drove. The following locations are those marked on Figure 2.3.

Location	m above sea level
1	2.09
2	2.94
3	2.45
4	2.70
5	2.02
6	2.73
7	2.76
8	2.19
9	2.53
10	2.13
11	1.77
12	1.42
13	1.79
14	2.31

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Articles: K.R. Dark, 'Archaeological survey at Sidney Sussex College, Cambridge, 1984', *Proceedings of the Cambridge Antiquarian Society* 74 (1985) pp.81–4.
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