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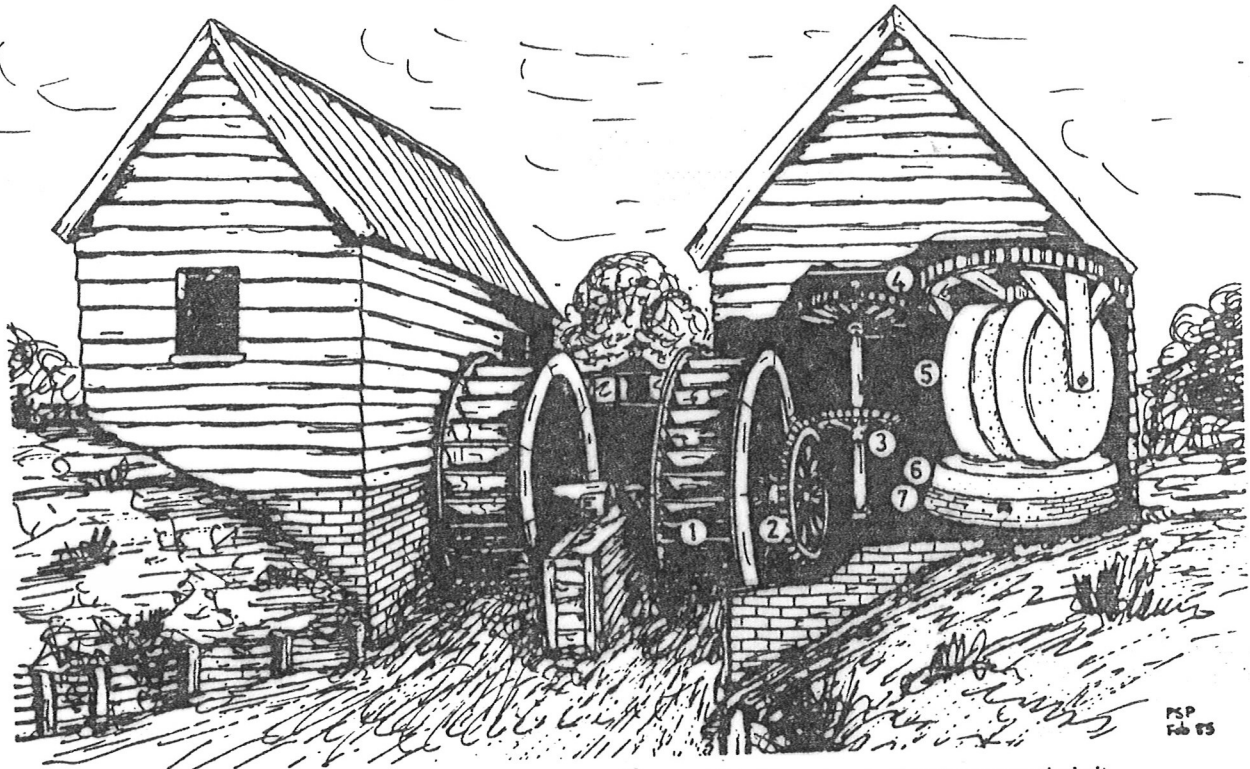


Fig. 1: Reconstruction drawing of the Lower Mills, about 1810. The waterwheel (1) drove a vertical pit wheel (2) inside the mill building. This turned a wallower (3) which powered a vertical shaft topped by a spur wheel (4). This spur wheel turned another spur wheel on top of a pair of edge runner stones (5) which revolved above a base stone (6) mounted on a brick base (7). The mixture of saltpetre, sulphur and charcoal was placed on the base stone, watered, and then the two edge runner stones made to revolve over the mixture to incorporate in into 'mill cake'.

## The Bedford Gunpowder Mills

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IN 1981 THE BEDFONT Research Group was formed to study the history of East Bedford. The writers became interested in the work of this group and have helped to coordinate documentary research and fieldwork on the Bedford Powder Mills. This has involved research sessions, particularly in the Muniment Room, Syon House, and exploratory excavations to assess the archaeological potential of the site. A long-term excavation programme is now in progress in collaboration with the West London Archaeological Field Group and the Greater London Industrial Archaeology Society. The results of the project so far are outlined here and the

information will contribute to a nationwide survey of such sites by the newly founded Gunpowder Mills Study Group.

### Gunpowder Manufacture

The first European description of the composition of gunpowder dates from the mid 13th century<sup>1</sup>. At first, natural sulphur and saltpetre had to be

1. A mixture of saltpetre, sulphur and charcoal, roughly in the proportions 75:10:15. See W. H. Hart, *A Short History of the Early Manufacture of Gunpowder in England*, London, 1855; J. R. Partington *A History of Greek Fire and Gunpowder*, Cambridge, 1960.

imported into England. By contrast, charcoal was usually made from timber coppiced in local woodlands. In the 16th century it was discovered that the main ingredient, saltpetre, could be made artificially from decomposed animal and vegetable matter found in stables and dovecotes. Saltpetre and sulphur were refined at gunpowder mills in purpose-built houses by various melting, filtering, evaporating and crystallising techniques. From the late 18th century charcoal was made in special ovens which were more efficient than open woodland camps and gave a finer charcoal. Early gunpowder was produced by making an intimate mixture of the ingredients using pestles and mortars, at first by hand and later in water-powered mills. By the late 18th century it had become general practice to use water-powered 'incorporating mills' for gunpowder manufacture in preference to pestles and mortars. A reconstruction drawing of the incorporating mills of the Lower Mills, Bedfont, as they might have looked

and worked about 1810 is shown and explained in Fig. 1. After several hours' incorporation, the damp 'mill cake' was pressed, broken into small grains, or 'corned', glazed to give the grains an even surface to regulate combustion and finally dried and packed in barrels<sup>2</sup>. Bedfont gunpowder was then taken in covered wagons through the streets of local villages to a wharf in Isleworth where it was loaded onto sailing barges to be taken down the River Thames to London, for distribution to either military or civil contractors.

#### Historical background

As firearms developed it became increasingly important to have easy access to the raw materials for making gunpowder. Successive governments attempted to make England independent of the foreign supply of raw materials, since this was very sensitive to changes in diplomatic relations, and encouraged the development of a gunpowder

2. See Major F. Baddeley, *The Manufacture of Gunpowder as carried on at the Government Factory, Waltham Abbey*, 1857; J. Braddock, *Memoir on Gunpowder*, 1832; W. G. Fitzgerald, 'How Explosives are made', *Strand Magazine* 9, 1895; Lieut. Col. H. W. L. Hime, *Gunpowder and Ammunition*, Long-

mans, 1904; R. A. Howard, 'Black Powder Manufacture', *Industrial Archaeol* 1, no. 1 (1975) 13-28; E. G. H. Marsh and M. McLaren, 'A Short History on gunpowder and the role of charcoal in its manufacture', *Journ Material Sci* 17 (1982) 3385-3400.

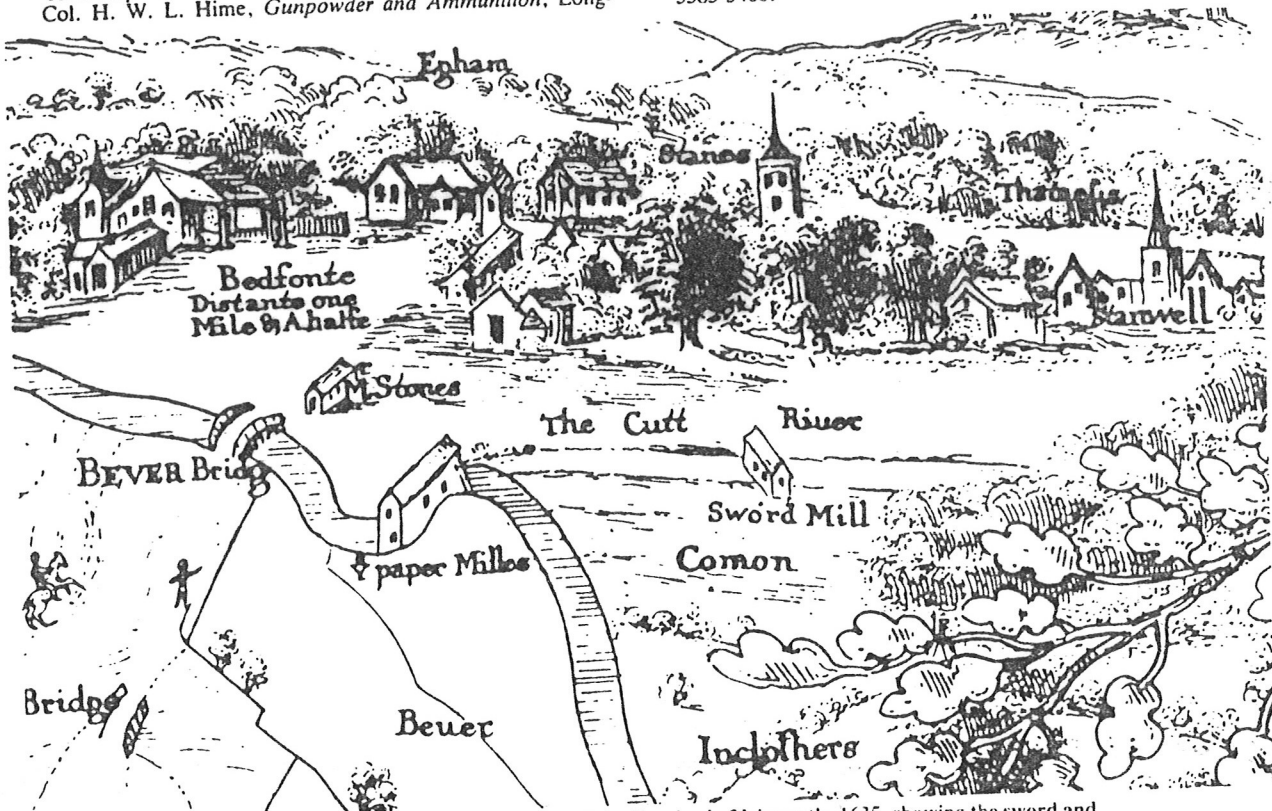


Fig. 2: Detail from Moses Glover's map of the Hundred of Isleworth, 1635, showing the sword and paper mills.

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industry in the south-east of England. Mills were set up at various sites, including Chilworth and Long Ditton, Surrey; Battle, Sussex; Faversham and Dartford, Kent; Waltham Abbey, Essex; and Hounslow Heath, Middlesex. The best known and later the most important mills in Middlesex were at Hounslow, the remains of which can be seen in Crane Park, Twickenham, but the earliest, by nearly a century, were established in the area of what became the site of the Bedfont Gunpowder Mills<sup>3</sup>.

Early antiquaries and historians claimed very ancient origins for the gunpowder mills on Hounslow Heath, but the first mills did not appear until the early 17th century. At that time Hounslow Heath was a much larger, more remote and often hostile place, notorious as a haunt for thieves and murderers. The area was well suited to the establishment of gunpowder mills. It was isolated from major settlements and so there was less risk of danger resulting from an accidental fire or explosion at a mill. Such a location also meant that a mill was largely hidden from public view. The Heath was well served by both natural and man-made watercourses, facilitating communications with the main markets of the South East via the River Thames. Water was also the principal source of power for the mill machinery and provided a means of transporting materials within the mill complex. In 1609 Sir Michael Stanhope, Lord of the Manor of East Bedfont, protested at the King's intention to allow the erection of powder mills and workmen's houses in the area. The appeal seems to have been unsuccessful since in 1619 James I excused the owners of the mills from their annual rent. The powder mills were probably based on an existing corn mill, the upper of two mills which stood on the Duke of Northumberland's River between Maultman's Bridge (Faggs Road) and the River Crane, on land to the north-west of Baber Bridge. The lower of the two mills was a paper mill under separate ownership. By 1630 the powder mills seem to have closed and the site was probably converted into a sword mill where blades marked with the "Hounslow" inscription were finished (see Fig. 2). Sword blades continued to be produced here until the mid-1650s<sup>4</sup>.

In 1655 Thomas Carter, a cooper of London, became leaseholder of the former sword mill and set up a gunpowder mill there. Twelve years later he had established a second powder mill to the south of

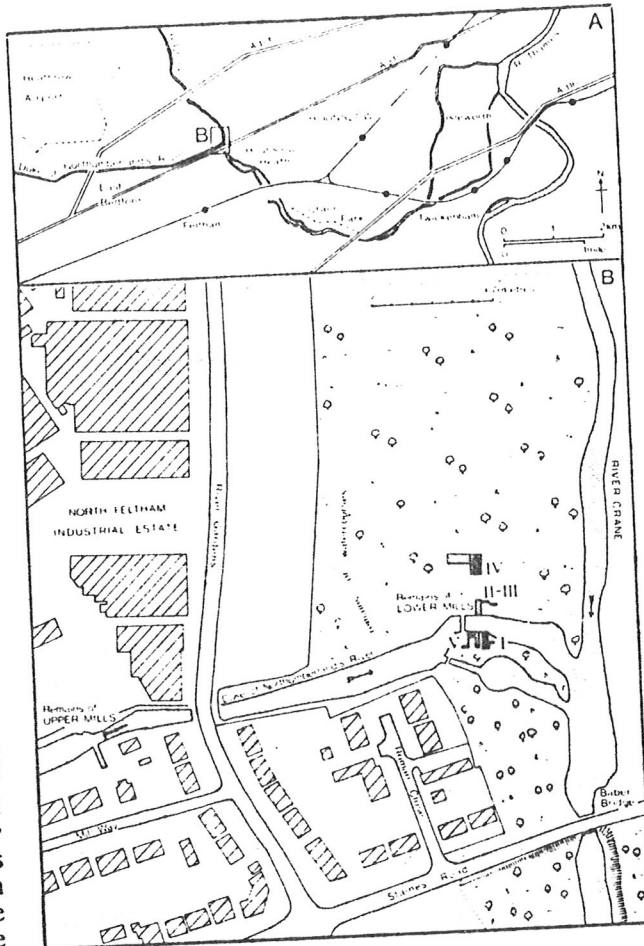


Fig. 3: Location map.

Baber Bridge, and a later owner of the sites, John Richardson, also added the paper mill to the holdings in 1690 and converted it to gunpowder. For the next 230 years the two mills (the original powder mills, now known as the Upper Mills, and the former paper mills, now known as the Lower Mills) were developed as a single unit. The mills to the south of Baber Bridge ceased production as powder mills about 1750 but were converted back to the manufacture of explosives in the late 19th century as the North Feltham Cartridge Factory. About 1800 considerable expansion of the Bedfont Mills took place. Large areas of land were enclosed from Hatton Common to the north, and the buildings

3. See G. Crocker, *Chilworth Gunpowder*, Surrey Industrial History Group, 1984; M. Maclaren, 'The Explosives Research and Development Establishment: its historical background', *Journ Nautical Sci* 1, no. 2 (1975); L. Over, *Gunpowder Mills on Hounslow Heath*, Richmond Friends of the Earth, 1983; A. Percival, *The Faversham Gunpowder Industry and its Development*, Faversham Society Paper No. 4, 1967; B. Philp, *The*

*Dartford Gunpowder Mills*, Kent Archaeological Rescue Unit, 1984; W. H. Simmons, *A Short History of the Royal Gunpowder Factory at Waltham Abbey*, London, 1963.

4. See J. Tofts White, 'The Hounslow Swordsmiths', *Hounslow Chronicle*, Winter 1980 and 'Benjamin Stone and Others', *ibid*, Spring 1983.

which had been burnt down in a series of accidents were rebuilt at greater distances from one another and away from the Staines Road. In 1820 the important firm of gunpowder manufacturers Curtis's & Harvey took over the nearby Hounslow Mills and soon after the Bedfont Mills. The latter were worked as an annexe to Hounslow and specialised in the manufacture of black powder for small arms, especially sporting weapons. After the First World War the gunpowder industry became depressed, Curtis's & Harvey were taken over by Imperial Chemical Industries (ICI) and the industry rationalised. As a result the Middlesex mills were closed down in the 1920s and the buildings dismantled. Although much of the Bedfont site has since been redeveloped for housing and industrial use, remains of some of the mill buildings, water courses and blast mounds still survive.

**Location (see Fig. 3)**

The remains of the Bedfont Gunpowder Mills are located in woodland to the north-west of Baber Bridge (TQ 112 746) on the Staines Road between Hounslow and East Bedfont. The site is bounded to the east by the River Crane flowing north-south and is bisected to the south by the Duke of Northumberland's River flowing west-east and joining the River Crane to the north of Baber Bridge. The western boundary is determined today by the edge of the North Feltham Trading Estate which covers a considerable area of the former site of mill ponds and buildings belonging to the later mills. Running north-south is River Gardens which links the Trading Estate with the Staines Road. The main entrance to the mill yard and the works was formerly at the point of this road junction, the Staines Road originally forming the southern boundary of the works. To the west of the bridge over the Duke of Northumberland's River in River Gardens are the remains of the Upper Mill races. A footpath leading east from this bridge along the north bank of the River runs through woodland past the remains of mill buildings, leets and fragments of incorporating mill edge runner stones to the Lower Mills. Further footpaths run north from Baber Bridge, across a bridge over the Duke of Northumberland's River, to the remains of further structures, water courses and blast mounds.

**Excavation of the Lower Mills (see Fig. 3)**

Work on a detailed survey of the site started at the Lower Mills and has involved the recording of above-ground remains and archaeological excavation, the latter to assess the archaeological potential of the site, to find the remains of earlier structures and evidence for the Mills' development. This has taken place mainly on selected weekends. On the

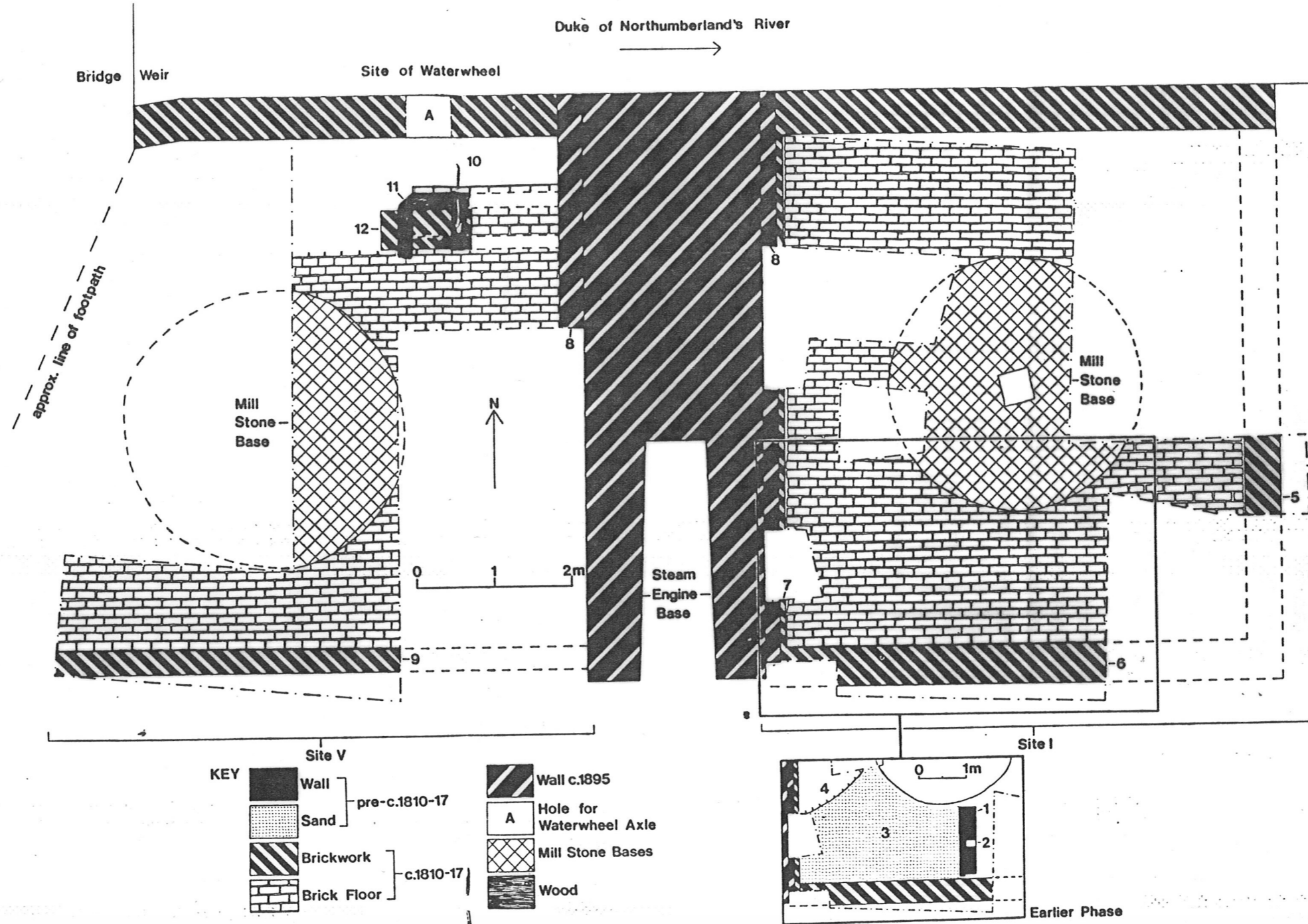
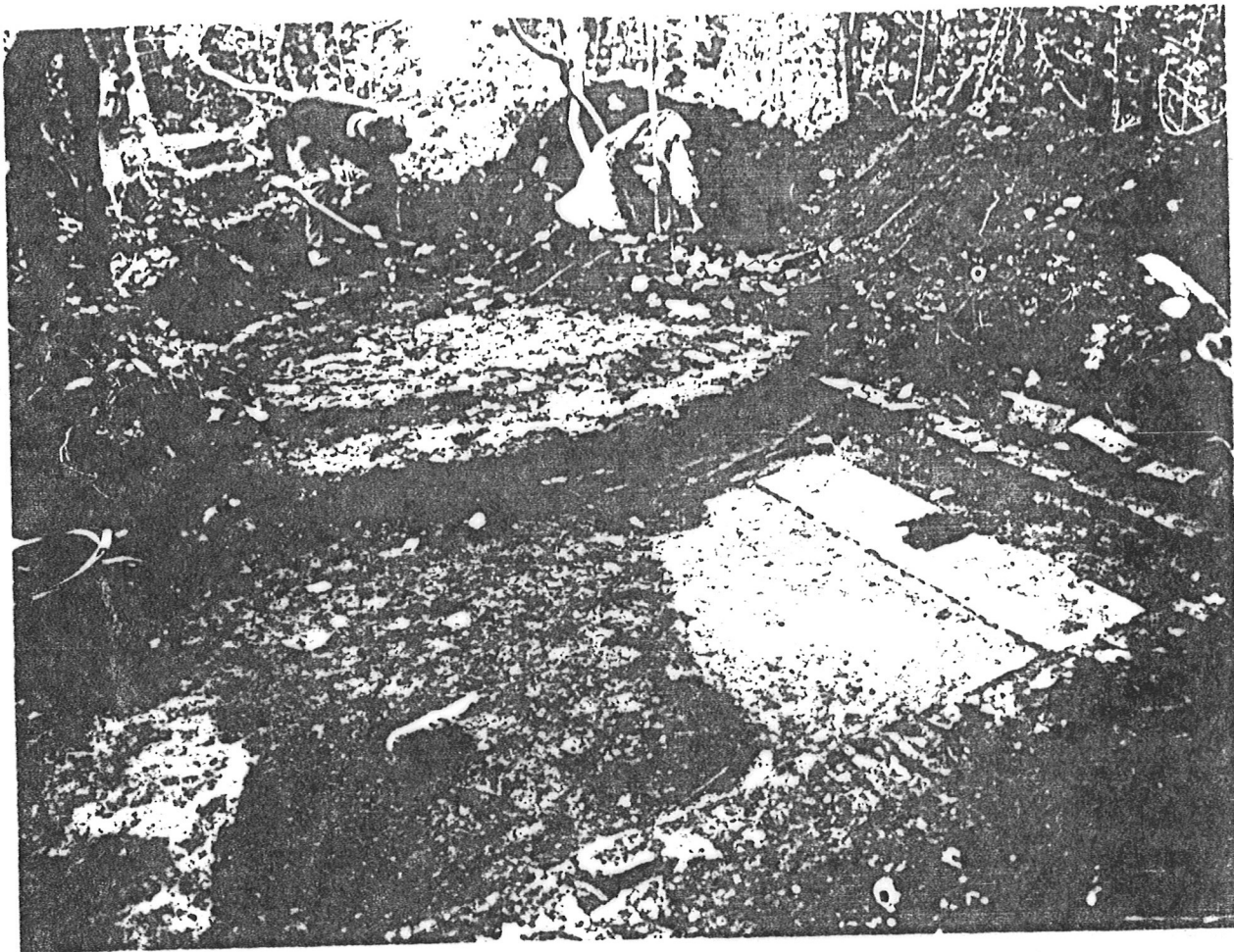


Fig. 4: Plan of Sites I and V.



**Fig. 5: The excavations on Site I, looking north-east and showing the mill stone base and the southern wall of the Tail Mill (bottom right).  
The eastern wall of the earlier building with its post cavity is to the right.**  
(Photo: K. B. Fleming)

first weekend (April 1984) four trenches were dug: Sites II and III in the area of the exposed mill stone base of the north-east incorporating mill established the position of the eastern brick foundation wall of the building but due to severe undercutting and erosion by the river the internal features of the building were badly disturbed and of little value; Site IV to the north of the Lower Mills revealed the internal layout of a mid 19th century structure tentatively interpreted as a housing for a steam boiler. This supplied power for the steam engines which were installed to supplement the water powering of the incorporating mills. The most productive site was Site I to the south of the Duke of Northumberland's River in the area of one of the incorporating mills of the Lower Mills. As a result, all subsequent work (on two weekends in Autumn

1984) has been concentrated in the area of the southern two incorporating mills on Sites I and V.

**Sites I and V** (see Fig. 4)

In the 1830s the Lower Mills consisted of a "Head Mill near the cooper's shop" with its "Tail Mill on the north side of the River" (Sites II and III) and a "Head Mill Lawn side" (Site V) with its "Tail Mill ... near the glazing mill" (Site I) to the south of the River. Today the mills of each pair (and therefore Sites I and V) are separated by large brick and concrete structures aligned north-south, which were built in the mid 19th century as beds for steam engines. On Sites I and V the northern walls of the two mills formed the southern retaining wall for the Duke of Northumberland's River. Observation of the dried-up River bed to the north of this wall in the

summer of 1984 revealed traces of a pier located centrally within the River. This divided the River into two mill races, each with a set of paddles and gates allowing the water over a weir to power a breast-shot waterwheel. The two waterwheels were about 16ft (5m) in diameter and 8ft (2½m) wide. The axles of the wheels were supported in mid-River by the central pier, and their other ends taken through the walls of the Head Mills to power the machinery within. From the bridge to the north-west of Site V it is possible to see the now-blocked circles of brick in the River walls where the axles entered the Head Mills.

The earliest structural remains revealed to date lie on Site I (see Fig. 5). These consisted of a narrow north-south brick wall (1) with an integral post cavity (2). Associated with the wall was a thin layer of sand which had once been the bedding layer for a brick floor (3) lying to the west of wall (1). The wall and floor seem to have formed part of a brick and timber structure, probably an earlier mill building. At the western edge of Site I part of a robbed-out, apparently circular, brick structure (4) has been tentatively interpreted as the remains of a base for an incorporating mill base stone within this building. These early features on Site I, perhaps along with some of the early features on Site V still awaiting more detailed analysis, appear to represent the 18th/early 19th century remains of a Lower Mill complex. According to a lease of 1767 this consisted of "two mills under one roof", a structure shown on maps of pre-1810 as having spanned the width of the Duke of Northumberland's River.

By 1810-17 this early mill building had been replaced by matching pairs of mill buildings lying either side of the River (see Fig. 6). On Site I the early brick floor (3) and circular brick base (4) were robbed out and wall (1) was razed to ground level. The area to the east of the former building was made up and the levelling layer contained by the eastern wall (5) and southern wall (6) of the new building, the Tail Mill. The other walls of this building are represented by the River wall to the north and a north-south wall (7) underlying the eastern edge and plinth (8) to the later steam engine bed. Within the walls (5, 6, 7) of the Tail Mill a new and substantial circular base for an incorporating mill base stone and a brick floor were constructed, probably in a single episode of building.

On Site V the contemporary Head Mill was built with a gap of about 1m (3ft 3in) between its eastern wall, which lies under the brick plinth (8) on the western side of the steam engine bed, and the western wall (7) of the Tail Mill. The other walls of the Head Mill are represented by the east-west wall (9), the parallel wall to the north on the River's edge

and the as-yet unexcavated western wall, presumed to lie approximately beneath the edge of the footpath. As on Site I, a brick floor was laid down within the walls of the new building respecting the base for the incorporating mill base stone. The floor also respected to the north the edge of a brick-lined wheel pit (10) and a large jointed timber structure (11) resting on a substantial brick base (12) and the edge of the wheel pit. The rotted arms of this timber structure were once secured into slots in the eastern wall of the Head Mill, probably to act as a brace.

The hollow square formed by the timbers was on an alignment with the hole in the River wall (A) where the axle of the waterwheel entered the building and terminated in a pit wheel. The timbers (11) appear to represent the support for a vertical axle for a wallower wheel (driven by the pit wheel) which supplied the drive for the edge runner stones via spur wheels (see Fig. 1). A system of gearings and axles probably transferred power from the waterwheel to a similar set of edge runner stones within the Tail Mill.

By 1895 the power from the waterwheels had been supplemented by the installation of two steam engines positioned on brick beds between the Head and Tail Mills of the matching pairs of mill buildings either side of the River. Between Sites I and V a brick plinth (8) was built over the adjacent walls of the Head and Tail Mills. On top of this a steam engine bed 7.3m (24ft) long, 2.25m (7ft 5in) wide and about 3.0m (9ft 10in) high was constructed. The long, vertical-threaded steel pins which secured the steam engine on top of the bed are still *in situ*. As yet it is not known what type of engine was mounted on top of the bed nor how it worked the mill machinery; it was probably provided with power from a steam boiler housed to the north on the opposite side of the River (Site IV). The disuse of the buildings on Sites I and V is represented by a layer of black cinders immediately underlying the leaf-mould of the present woodland. This layer can probably be dated to the mid-1920s when the mills were dismantled and presumably fired to render them inoperable and to remove any potentially dangerous accumulations of gunpowder.

### Conclusions

The excavations at the Bedfont Gunpowder Mills have provided information relating to the development of the Lower Mills from about the late 18th century to their closure in the 1920s. Sites I and V in particular have shown that there is a surprising number of surviving structures and features which demonstrate the evolution of the site. Very few such industrial sites have been analysed in detail and it important to use the surviving archaeological evidence in conjunction with documentary sources:

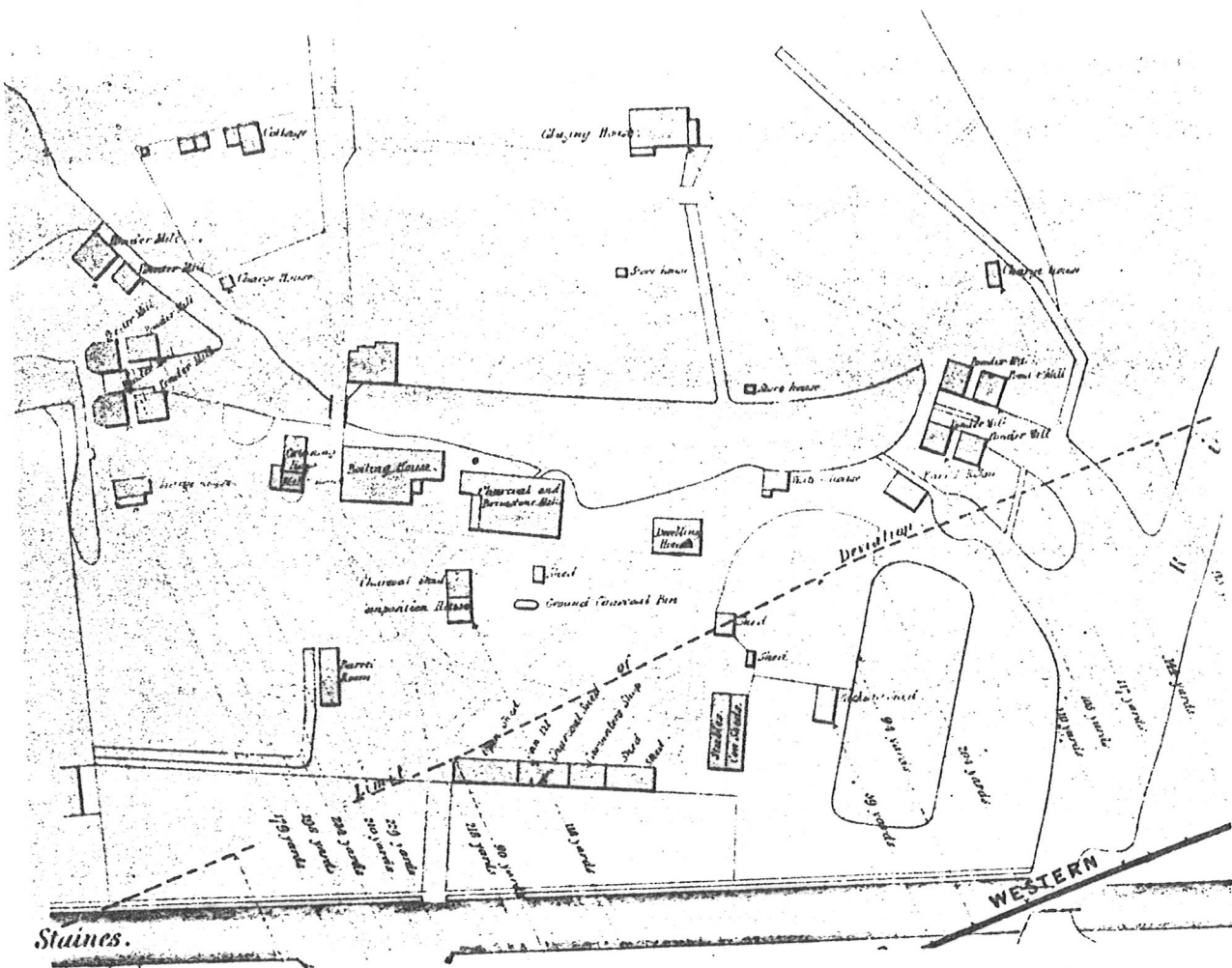


Fig. 6: Detail from an 1846 map of the Bedfont Mills, showing the Upper Mills (left) and the four mills of the Lower Mills (right) above the confluence of the Duke of Northumberland's River and the River Crane.

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These can demonstrate the enhancement of traditional methods of water power by the application of new technology, such as steam. The excavations have not yet located sufficient evidence of early structures to enable detailed reconstruction of the form of the 17th/early 18th century buildings and their working. It is hoped, however, that further excavation of the Lower Mills, and perhaps even an extension of the site to the Upper Mills, will provide evidence to help show the full extent of the earlier mill complex.

#### Acknowledgements

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