



Kirk Mill, Chipping, Lancashire

Archaeological Building Investigation



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SUMMARY

Kirk Mill in Chipping (centred on SD 61975 43615) was established as a cotton-spinning mill in 1785, occupying the site of a medieval corn mill. The extant structure comprises a three-storey, 14 bay rectangular mill, with projecting wings at both ends, and a stair tower against the northern external wall. All external elevations are of roughly dressed and coursed local sandstone rubble, bonded in a pale lime mortar, with dressed quoins to the elevation returns. Internally, the walls are generally rendered but, where exposed, the wall face is of irregular random rubble, typical of stone mill buildings from all periods within the Ribble Valley.

The original mill measured approximately 33' (10.06m) wide, and around 69' (21.03m) long, with the original waterwheel probably being external to the mill. Internally, the building was of non-fireproof construction, and was sufficiently narrow for single large-scantling beams to span the entire floor; these were unsupported within the original construction. Although evidence for many line shafting positions survives within the mill, it is probable that deeply gouged scars placed to the north of the centre-line of the mill represents the position of the original shaft.

The mill was widened subsequently for the insertion of wider throstle frames, with the beams at the original north wall position being carried on slender cast-iron columns; a most unusual solution which avoided the need to re-roof the original part of the building. A steam engine was installed in the position of the original waterwheel, to provide power at times of water shortage, with an associated boiler house built to the east, and a free-standing chimney placed immediately to the south-west of the newly-formed engine house.

Cotton spinning ceased in 1866, and the building was reused for woodworking, predominantly chair-making, into the twenty-first century. Few alterations to the fabric were undertaken as a result of the conversion, with those of the twentieth century being typical of those of both industries, and including the insertion of a sprinkler system, external privies, and further offices above the boiler house.

Notwithstanding some remodelling, Kirk Mill represents a very rare and well-preserved example of an eighteenth-century, Arkwright-type water-powered cotton mill. Other examples of eighteenth-century water-powered cotton mills do survive in Lancashire, including Salmesbury Bottoms Mill, Houghton Bottoms Mill, Roach Bridge Mill, and Cleveley Mill near Scorton, although all of these have been subject to considerable remodelling and alterations with a resultant loss of original fabric. Kirk Mill is thus the most complete surviving example of an eighteenth-century cotton mill in Lancashire, affording it great significance within the textile industry in the county.

1. BACKGROUND

1.1 SETTING

- 1.1.1 Chipping is a rural village located in the Ribble Valley, lying 15km west of Clitheroe and 19km north-north-east of Preston (Fig 1). The village is located on the edge of the Trough of Bowland, and lies within the Forest of Bowland Area of Outstanding Natural Beauty. Notwithstanding the comparatively remote rural setting of the village, Chipping played a significant role in the initial stages of the industrialisation of textile manufacturing, and emerged as an important centre locally for the factory-based production of cotton yarn in the late eighteenth century.
- 1.1.2 Kirk Mill occupies a site on the western side of Malt Kiln Brow, on the north-western fringe of Chipping (centred on SD 61975 43615). The mill lies to the east of a bend in Chipping Brook, downstream of its confluence with Dobson's Brook. These watercourses supply the large mill pond that lies immediately to the north-west of the mill.



Plate 1: Recent aerial view, with arrow marking the position of Kirk Mill

1.2 SURVEY METHODOLOGY

- 1.2.1 The building investigation was carried out in July and August 2012. It aimed to provide an understanding of the historic fabric and key architectural features of the former mill complex, and to provide an archive record of the component structures. It has provided a drawn, photographic and textual record of the buildings to English Heritage (2006) Level III standard. Records were made of all principal structural elements, both internal and external, as well as any features of historical or architectural significance. Particular attention was paid to the relationship between the earliest and latest parts of the building, especially those that would show their development and any alterations.
- 1.2.2 **Photographic Survey:** a photographic archive of the buildings was compiled, consisting of both general and detailed interior photographs, which were captured using digital formats
- 1.2.3 **Instrument Survey:** floor plans of the buildings were surveyed by means of reflectorless total-station survey, to produce plans and a cross section through the main mill buildings. The drawings were used as a basis for annotation to illustrate the phasing and development of the buildings. Detail captured by the annotation included features such as window and door openings, and changes in building material and phasing. The final drawings are presented through an industry standard CAD package (AutoCAD 2004).
- 1.2.4 **Interpretation and Analysis:** a visual inspection of the buildings was undertaken, and a description maintained to English Heritage (2006) Level III. These records are essentially descriptive, and provide a systematic account of the origin, development and use of the mill complex.

2. HISTORICAL BACKGROUND

2.1 HISTORICAL BACKGROUND

- 2.1.1 The earliest documented use of the site can be traced to 1544, by which date it was almost certainly occupied by a water-powered corn mill (LRO DDX 564/Box1). The date at which this corn mill was established remains uncertain, although there is some evidence to suggest that it was in operation during the 1400s (Aspin 2003). The mill was held by the Lords and Ladies of the Honour of Clitheroe, and was leased to copyhold tenants. Surviving deeds record the names of several corn millers who occupied the mill during the seventeenth and eighteenth centuries (LRO DDX 564/Box1).
- 2.1.2 The corn mill appears to have fallen into disuse by July 1785, when the building was purchased by the partnership of Hugh Stirrup, John Shakeshaft, Richard Salisbury and William Barrow. Stirrup, Shakeshaft and Barrow were all merchants, the former two based in London and the latter in Lancaster, whilst Richard Salisbury was a cotton manufacturer in Chipping. In addition to the mill buildings, the partnership also purchased an orchard adjacent to the site that was owned by the Stonyhurst Estate to enable the mill pond to be enlarged (LRO Stonyhurst Estate Rentals). The partners then erected a new four-storey mill on the site, which was based on the design and technology for spinning cotton patented by Richard Arkwright. The new mill measured 69 x 27ft, and housed 20 spinning frames with 1032 twist spindles, together with carding, roving, drawing and other ancillary machinery. The machinery was powered by a 19' 6" diameter and 5' 6" broad waterwheel with a 2ft square shaft (*General Evening Post*, 5 April 1788). The waterwheel was placed at the eastern end of the building, and may have been external (*Manchester Mercury*, 15 Apr 1788). William Carr, a clockmaker, had joined the partnership within a few years, presumably to lend his expertise with the gearing systems required to power the machinery in the mill.
- 2.1.3 The original partnership was short-lived and was declared bankrupt in June 1787 (*London Gazette*, 31 July 1787), reflecting the fluctuations in the emerging factory-based cotton industry. The mill, together with associated houses, a smithy, a barn and 14 acres of land, were put up for sale in 1788 and, by 1790, it had been taken over by Ellis Houlgrave and his father-in-law, Peter Atherton of Holywell. Houlgrave was a cotton spinner, whilst Atherton was an engineer and inventor and, notably, had been one of Richard Arkwright's first partners.
- 2.1.4 It is unclear whether the mill fell into disuse during the late 1780s, although Atherton and Houlgrave evidently experienced a shortage of labour as they placed an advertisement in local newspapers seeking additional workers (*Manchester Mercury*, 6 Apr 1790). It seems that Atherton and Houlgrave were responsible for installing a steam-powered beam engine in the mill, presumably as a supplementary source of power that could be utilised at times of low water flow in the Chipping Brook during dry months, although it was reported that the engine had 'very little use' (Sun Fire Office, 567253). The engine was supplied by the Coalbrookdale Company, and had 31" diameter cylinder.

- 2.1.5 Atherton and Houlgrave were joined in partnership by another cotton spinner, John Rose, and James Budd, who was replaced subsequently by William Harrison, and the partnership became known subsequently as Harrison & Atherton. This company was responsible for considerable development of the mill building and the wider site, including the erection of Kirk House in 1793, which became the mill owner's residence. This may have been intended as a replacement for Grove House, which was used subsequently as the mill manager's residence. The detached building on the eastern side of Malt Kiln Brow, directly opposite the mill, was also built at this time. Fire insurance records of December 1795 state that this included a warehouse and stables with a reeling room on the first floor, with an arch bridging the road to provide direct access to the mill (Sun Fire Office, 649218).
- 2.1.6 A weft mill and an apprentice house intended to house 150 boys were also planned in 1793 (LRO DDX 785 4/3). Whilst surviving documents confirm that these were built during the 1790s, their precise location remains uncertain. However, it seems possible that the buildings occupied a site at Saunders Rake, to the north-west of Kirk Mill, where the company owned a few cottages to house mill workers. The buildings appear to have fallen into disuse following the death of Peter Atherton in 1799, and may have been incorporated in a new cotton mill that was established at Saunders Rake by William Bond in c 1800.
- 2.1.7 There is some documentary evidence to suggest that the mill was expanded during the 1790s to house additional machinery, which included spinning mules. In particular, a sale notice printed in a local newspaper in 1799 accredits the mill with housing 1120 spindles, together with a spinning mule of 336 spindles and an adjoining building capable of housing three additional spinning mules (*Blackburn Mail*, 19 Oct 1799). The 'adjoining building' that is referred to is likely to have been an extension to the west of the original mill block. A larger waterwheel may also have been installed at this time to provide the additional power required by the new machinery. Whilst there are no surviving documents that elucidate the size of the waterwheel at this date, a sale notice printed some years later stated that the mill was capable of working from 2000 to 3000 spindles (*Blackburn Mail*, 9 Nov 1808); an account written in 1843 gives the diameter of the waterwheel as 32ft (Pearson 1843).
- 2.1.8 Ellis Houlgrave died in 1794 and, following the death of Peter Atherton in 1799, the mill appears to have been continued by J Bury & Company. This important firm had interests in several textile mills in Lancashire, including Shaw Bridge Old Mill in Clitheroe. However, in 1811, Alexander Routh of Stockport bought Kirk Mill and continued business as Middleton, Routh & Company. Alexander Routh is listed as the owner of Kirk Mill in a factory inspectors' report of 1824, which also indicates that 74 persons were employed at the mill, which included several under the age of nine years old (LRO QSP 2841/29). Routh appears to have remained at Chipping until his death in the late 1830s, when Kirk Mill was taken over by John Evans and Cornelius Walmsley.

- 2.1.9 Evans and Walmsley were seemingly responsible for installing gas lighting at the mill, which necessitated the erection of ‘a complete and elegant apparatus adjoining the works’ (Pearson 1843). The use of gas was not without dangers, and a man was killed at Kirk Mill in 1839 due to a gas explosion (*Preston Chronicle*, 9 Feb 1839). Cornelius Walmsley left the partnership shortly after this date and started his own business at Hoghton Bottoms Factory, whilst John Evans continued at Kirk Mill.
- 2.1.10 The census returns for 1851 record John Evans as a cotton spinner and the resident of Kirk House. At that date, he employed ten men, seven boys and 24 women at the mill. However, the lower parts of the mill were damaged severely during that year by a flash flood on the Chipping Brook. This flooded the ground floor of the mill, described as the ‘throstle room’, together with the adjoining joiner's shop, to a height of 6ft, with the water rising 2ft over the top of the machines (*Preston Guardian*, 5 July 1851).
- 2.1.11 Evans was succeeded at Kirk Mill in 1853 by William Bond, who may have leased the mill as a tenant. This was a short-lived arrangement, as the mill was transferred to John Lowrey in 1854. John Lowrey died in c 1860, and his interests in Kirk Mill passed to his widow, Jane. The census returns for 1861 list Jane Lowrey as a cotton spinner, and indicate that she employed 54 men at the mill.
- 2.1.12 Cotton spinning at Kirk Mill finally ended in 1866, by which date the plant comprised 25 carding engines, 31 throstle frames, a 12hp beam engine, a 10hp high pressure horizontal engine, and a 32’ diameter waterwheel. Preliminary notification of the intended sale of machinery in the mill, referred to as Grove Mill and ‘late the property of Mrs Lowrey’, was posted in early September (*Preston Guardian*, 8 September 1866), with full details advertised the following week. The latter advertised for sale by auction on 20 and 21 September 1866, at Grove Mill in Chipping, ‘the whole of the valuable machinery and effects’. This comprised ‘a 12 horse power condensing beam engine, capital 10 horse high-pressure horizontal engine, double flued steam boiler, cotton opener, double-beater scutcher, lap machine, 25 carding engines, grinding machine, drawing frames, slubbing frames, drawing frames, 31 throstle frames, containing 5,428 spindles, 2inch lift, principally by J Elce & Co, winding frames, beaming frames and creels, cans, skips, driving straps, guide pulleys, counter shafting, mechanics’ tools, including double- and single-gearred lathes, upright drill, smithy bellows, anvil, wrought and cast scrap iron, office fixtures, and numerous other effects’ (*Preston Guardian*, 15 September 1866). Many auxiliary buildings were sold with the estate to Thomas Marsland, who rented it to chair makers.
- 2.1.13 The mill was taken over in the 1880s by the firm of HJ Berry, chair makers. From 1923, the waterwheel had also been used to generate electricity for lighting in the mill and adjacent properties. The mill continued to be entirely water powered until the 1932, when an oil-powered engine was installed to provide supplementary power. The mill was extended in 1943 to provide kitchen and canteen facilities and the waterwheel (the third known at the site) was partly removed to create a side entrance. Berrys remained at the mill and produced chairs until 2010, when the mill and its associated pond were afford statutory designation as Grade II listed buildings.

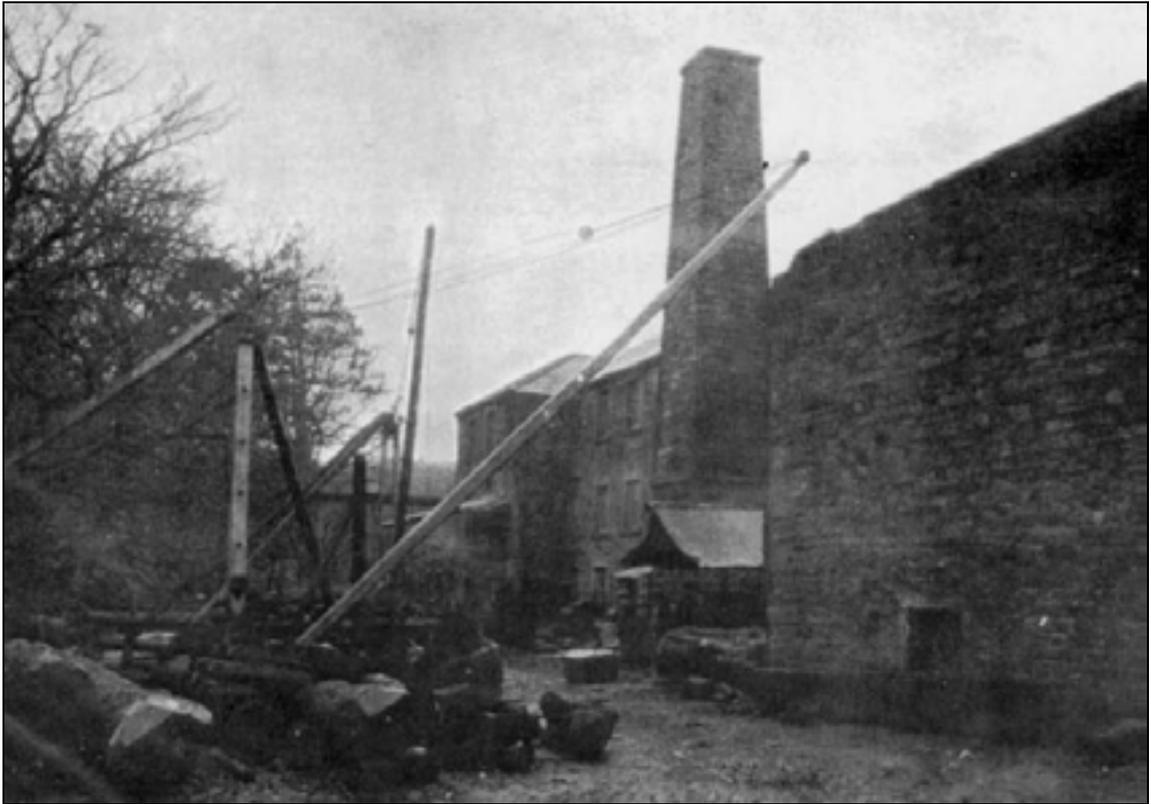


Plate 2: Kirk Mill from the south-east, 1924



Plate 3: Kirk Mill from the south-east, 1933

3. RESULTS

3.1 INTRODUCTION

- 3.1.1 Notwithstanding some remodelling, Kirk Mill represents a very rare and well-preserved example of an eighteenth-century, Arkwright-type water-powered cotton mill. Other examples of eighteenth-century water-powered cotton mills do survive in Lancashire, including Salmesbury Bottoms Mill, Houghton Bottoms Mill, Roach Bridge Mill, and Cleveley Mill near Scorton, although all of these have been subject to considerable remodelling and alterations with a resultant loss of original fabric. Kirk Mill is thus the most complete surviving example of an eighteenth-century cotton mill in Lancashire.
- 3.1.2 The extant structure comprises a three-storey, 14 bay rectangular mill, with projecting wings at either end, and a stair tower against the northern external wall (Fig 2). All external elevations are of roughly dressed and coursed local sandstone rubble, bonded in a pale lime mortar (Plate 4), with dressed quoins to the elevation returns, and often between phases (Plate 5). Internally, the walls are generally rendered (Plate 6) but, where exposed, the wall face is of irregular random rubble (Plate 7), typical of stone mill buildings from all periods within the Ribble Valley.



Plate 4: The south-facing elevation of Kirk Mill



Plate 5: Quoined returns of west wing and privy tower



Plate 6: General view of the ground floor



Plate 7: General view across the west wing of the second floor

3.2 EXTERIOR

- 3.2.1 The front, southern elevation represents the only surviving external wall of the original Arkwright-type mill (Plate 4), the eastern elevation now being an internal partition, and the western and northern walls having been removed in all but the wheel house, which was located in the eastern two bays, and projected beyond the north wall of the original structure. The wall is approximately 3' (0.91m) thick, diminishing to 2'6" (0.76m) at first-floor level, and 2'3" (0.68m) on the upper floor. The fenestration comprises vertical windows of 4' (1.21m) width, with dressed sandstone surrounds, flush with the wall face (Plate 4), and with slightly projecting plain sills. Several of these retain small-paned 25-light timber windows, which if not original, represent early replacements, whereas elsewhere nine-light timber-framed replacement windows of a probable late nineteenth-century date, make up the majority of the extant fenestration (Plate 4).
- 3.2.2 At ground-floor level, two windows were remodelled into a large loading doorway, with only their lintels surviving above, whilst a narrow window to the east represents a later insertion (Plate 4). This has an I-section steel beam lintel, extending beyond the window, and having a 'FRODINGHAM IRON & STEEL CO LTD' rolling stamp, suggesting a date of insertion in the early twentieth century. The wider wall space to the right denotes the position of a free-standing, square-section tapering chimney, depicted on a photograph of 1924 (Plate 2), which would have partly blocked the light into the windows of the eastern two bays.
- 3.2.3 The bay to the east of the former chimney almost certainly represents the position of the original waterwheel, and has a large vertical window in the south elevation (Plates 4 and 8). This relates to the insertion of a steam engine in the late eighteenth century (*Section 2.1.4 above*), and was placed directly above a doorway affording access to the engine bed, which was remodelled subsequently to form a further window (Plate 8). The window of the second floor matches those to the west, suggesting that the waterwheel house was of the same height as the mill to the west, and that the wheel was of only two-storey height. The front (south) elevation of the wheel house was probably devoid of fenestration within its original construction.
- 3.2.4 The eastern bay of the main façade houses the present waterwheel, and has similar windows to those elsewhere, at first- and second-floor level, that on the first floor having been reduced in height subsequently (Plate 8). It has a wider dressed doorway at ground-floor level, which afforded access directly to the waterwheel, presumably to allow maintenance of the buckets. This doorway was blocked with brick subsequently (Plate 8).



Plate 8: Façade of engine and wheel houses

3.2.5 The earliest surviving element of the rear (northern) wall of the mill is in the position of the engine and wheel houses. This wall is of similar sandstone rubble, roughly-coursed construction, with windows at second-floor level, similar to those of the southern façade (Plate 9). At first-floor level, the headrace for the waterwheel entered the eastern bay, and comprised coursed sandstone side walls above a concrete base, with steel stirrups above a sandstone sill in the wall face (Plate 10). This was flanked by similar rubble walls, each with a large sandstone block base (Plates 9 and 11), both presumably representing earlier side walls of the head race. That to the west provides further evidence that the original waterwheel was placed in the western of the two bays, as it would have positioned the headrace into that bay. The documentary evidence suggests that the original waterwheel of the cotton mill was placed externally, and that the area was only enclosed when the wheel was replaced by a wheel in the position of that now present. However, internal evidence (*Section 3.3.29, below*) strongly suggests that the north wall of this structure was repositioned, by a distance of approximately only 4' (1.21m) to the north, almost certainly undertaken to incorporate a larger waterwheel (possibly the extant waterwheel).



Plate 9: North wall of wheel house and chamfered return of main mill



Plate 10: Concrete base of headrace



Plate 11: North wall of east wing and wall flanking headrace

- 3.2.6 The western extension of the mill was in the form of a cross wing, and originally extended beyond both the front and north facades of the earlier structure. It was of more ordered coursed rubble construction, with dressed quoins to the elevation returns, and projecting convex corbels at eaves height, carrying the moulded gutters, similar to those of the original construction. The windows were also of similar proportions to the earlier structure (Plate 12). The north wall of the wing had a single window at second-floor level. This was quoined either side, with those to the east forming part of the return of the wing, where it was butted by the later repositioning of the north wall of the main mill (Plate 13). On the western side of the window, the quoins continued to second-floor level, where a sandstone threshold appeared to be a reused lintel from an earlier structure (Plate 13), or more probably the lintel of a doorway below, forming a loading loophole, and that was refaced subsequently following the blocking of the doorway. Slight differences in the colour of the sandstone in this area suggest this may have been the case, and have a ragged western edge, suggesting that the quoins for the lower door were removed.



Plate 12: External west elevation of the west wing

- 3.2.7 At its south-eastern corner, the west wing was butted by a small rectangular privy tower, which was of similar construction, but with slightly differing course levels (Plate 5). This had narrow slit windows adjacent to the main façade in the eastern wall, which were presumably originally unglazed, providing ventilation, and a minimal amount of light to each privy.



Plate 13: Butt joint between the west wing and the north wall, with blocked doorway

- 3.2.8 The north wall of the original mill was repositioned approximately 11' (3.35m) to the north following the erection of the western cross wing, creating a wider L-shaped plan. The new wall was of similarly coursed construction to the west wing, which it butted, and had windows of similar style to each of the three floors (Plate 14). The north-eastern corner of the new wall, which now projected beyond the wheel house, was externally chamfered at first-floor level, with a lamb's tongue stop to the quoins above (Plate 9), allowing easier passage between the mill and the reservoir wall, positioned immediately to the north (Plate 9).
- 3.2.9 A rectangular stair tower was also added to the northern side of the mill. It is unclear whether this represented a contemporary construction to the repositioning of the north wall, or was a subsequent remodelling, as the western joint was obscured by a downpipe and vegetation, and the eastern joint comprises only five keyed courses between the window and door apertures that were placed at the junction of the two walls (Plate 15). The fact that the courses are not aligned in this position does suggest different dates of construction, with facing stones from the north wall possibly being removed in order to key the two structures together in this small area. The sill of the second-floor level window is also partially overlain by the stair tower wall (Plate 15), whereas it would more likely end at the joint between the two walls in a contemporary construction.



Plate 14: External elevation of repositioned north wall of main mill



Plate 15: East wall of stair tower



Plate 16: Mason's marks on stair tower quoins

3.2.10 The tower was only visible at ground floor externally on its western side, the remainder being below external ground level at this point. It was of similar construction to the other remodelling episodes, comprising coursed local sandstone, and with quoined returns to each elevation. Unlike the earlier fabric, many of the quoins retain mason's marks (Plate 16), again possibly indicative of a secondary date of construction compared with the repositioned north wall. The north wall of the stair tower was capped with a simple bell cote, with oversailing sandstone copings (Plate 17).



Plate 17: Bell cote above stair tower

3.2.11 The windows of the west elevation of the tower were similar in size to those of the main mill, but with the southern of two ground-floor windows retaining a possibly original 16-light vertical sash windows, typical of the nineteenth century (Plate 18). The north wall had smaller lights into the stairwell, whilst the east wall had a small 16-light window to the upper floor, and a narrow double door with 10-light fanlight providing the external access into the stair tower.



Plate 18: The west elevation of the tower, showing the 16-light window

- 3.2.12 A further extension was added to the east of the waterwheel. It was constructed in similar style to those to the west, in coursed local sandstone rubble, and again with quoined returns (Plate 19). It comprised 4 x 2 bays, angled around a slight bend in the road, and has a pitched roof with a loading loophole to both above ground-level floors and to the attic (Plate 19). This was originally placed centrally within the eastern façade, flanked by vertical windows to both floors, with all but the lower southern window having nine-light windows. That in the southern bay retained a 25-light vertical sash (Plate 19), which is probably an original aperture, being retained when it was partially blocked internally by the insertion of a staircase.
- 3.2.13 The northern wall was also repositioned subsequently, moving it flush to the wheel house, which had earlier been extended, as demonstrated by the quoins around its eastern return (Plate 11). This allowed for an extra window to be inserted at first- and second-floor level (Plates 19 and 20). The rebuilding of the wall can be seen within a subtle change in coursing and stone dressing at the northern end of the elevation, and a subtle change of gradient in the pitch of the roof (Plates 19 and 20).



Plate 19: East wing



Plate 20: North return of the east wing, showing rebuilt wall and inserted windows

3.2.14 A 20' x 23'6" (6.11 x 7.16m) further extension was added to the southern side of the eastern extension, butting the line of quoins in its south-eastern corner (Plates 19 and 21). Its original construction in coursed local sandstone rubble was similar to that to the north, but comprised only two storeys, at ground- and first-floor level. The east wall has nine-light vertical windows at first-floor level (Plate 21), with a horizontal six-light window at first-floor level in the west wall (Plate 22), flanked on its northern side by a small four-light tilt into the privy within the extension.



Plate 21: Southern extension to the east wing



Plate 22: Southern extension from south, with open-fronted insertion

- 3.2.15 A column of quoins in the east wall indicate the position of a former aperture at road level, blocked subsequently in stone (Plate 21). This possibly afforded access into a boiler house that was probably placed at ground-floor level within this extension. A sandstone block immediately above road level within the blocking (Plate 21) represents the lintel of a coal chute, suggesting that the boiler was retained after the blocking of the doorway. This may relate to the remodelling of the south-western corner of the extension, where the wall at ground-floor level was removed to produce an open-fronted bay (Plate 22), affording access to both the boiler / waterwheel axle bearing, and a store beneath the eastern bay. An aperture at ground-floor level was blocked with sandstone rubble, and represented an original doorway, and being the only aperture shown on a photograph of 1924 (Plate 2). An additional window with a rubbed sandstone cambered lintel (Plate 22), was inserted subsequently at first floor-level, and is depicted on a photograph of 1933 (Plate 3), taken following the removal of the chimney, itself shown on the Ordnance Survey plan of 1932.
- 3.2.16 The photograph of 1933 was also taken prior to the further extension to a third storey in brick, in five-stretcher English Garden Wall bond. This was originally rendered with incised mock-ashlar effect, and contained nine-light top-vent windows in the southern and eastern walls (Plates 21 and 22), all having chamfered lintels and sills, rather than the plain variants of the earlier phases.
- 3.2.17 The final structural additions to the main mill were a dust tower and small shed appended to the south elevation, towards the western end of the original structure. Both were of red brick construction, with the single-storey shed having a lean-to roof against the main building, and a doorway in its southern frontage. The dust tower was concrete rendered below a flat roof, and with louvered vents at second-floor level, and an entrance doorway at ground-floor level (Plates 4 and 5).
- 3.2.18 Two brick structures were erected to the south of the mill, opposite the western wing. The larger comprised a tall single-storey store / workshop, built in five-stretcher English Garden Wall bond, to a full-brick thickness. It had two doorways below concrete lintels in its northern façade, suggesting that it was originally divided into two parts, the western of which rose to first-floor level (Plate 23). The eastern end wall of the building was also removed subsequently, with an I-section steel structure inserted to support a single-pitch roof and an open-fronted extension to the east (Plate 23). A canopy between the building and the southern wall of the west wing was presumably inserted at this time, but has lost most of the corrugated galvanised aluminium sheets subsequently (Plate 23). A lower single-storey privy block was also appended to the western end of the building, and appears to have been re-roofed at the same time as the rest of the structure.
- 3.2.19 To the east, placed adjacent to the canalised brook, is a derrick crane (Plate 25). Although similar in appearance to that depicted in the photographs of 1924 and 1933 (Plates 2 and 3), the crane legs were renewed in 1954, and a new sheltered cabin was added in 1981 (Plate 24). It is probable that the gearing forms part of its original construction.



Plate 23: Remodelled store south of the west wing



Plate 24: Dating of crane features within cabin



Plate 25: Derrick crane

3.3 INTERIOR

- 3.3.1 **Ground floor:** the original ground floor of the Arkwright-type mill comprised the eight bays to the west of the wheel houses (Fig 2), measuring approximately 67 x 30'. The north wall was rebuilt flush with that of the western extension, approximately 10' to the north, and requiring significant internal remodelling. The ceiling beams measuring 6 x 14" are stop chamfered either end and appear to have originally spanned the width of the building unsupported, carrying east/west aligned 3 x 6½" joists on 12" centres (Plate 26). However, following the relocation of the north wall, the northern end of each beam was cut to form an oversailing scarf joint with a circular sawn 6 x 9¾" rectangular beam, bridging to the north wall (Plate 27).
- 3.3.2 Each scarf joint is carried on a cast-iron column (Plate 27). In the western three bays, these comprise 5" diameter columns with mid-height astragals and further astragals 15" above the 10" diameter foot (Plate 28). The diameter of the column head reduces to 4" diameter and fits into a separate cap, which is bolted to the soffit. The adjacent two columns are 3¾" diameter and have octagonal section feet of 6 and 13½" height respectively (Plate 29). The final column appears to be a combination of the two styles, being 5" diameter, but octagonal section below the lower astragal above a rectangular foot (Plate 30). It also has an integral head plate, unlike those to the west.



Plate 26: Large-scantling chamfered ceiling beams and exposed joists



Plate 27: Simple scarf joint in ceiling beams above ribbed capital



Plate 28: Inserted columns on the ground floor



Plate 29: Detail of octagonal-section column foot



Plate 30: Column with astragal in shaft

- 3.3.3 Many of the beams retain evidence for columns further to the south, and with infilled patches in the concrete floor below. Two columns survive in the western two bays of the original structure, both differing in style. The western is 5½" diameter with an astragal below a flared head and a square-headed plate with projections either side for bolts (Plate 31). The other is a simple 4½" diameter column with a weld to a simple rectangular head plate. Several late I-section stanchions and beams represent late stabilisation work (Plates 29 and 30).



Plate 31: Cruciform-section bolting head of column

- 3.3.4 The windows in the south wall are lower than those in the rebuilt north wall, placed 32" above floor level, compared with 46". Those in the north wall also rise to ceiling level (Plate 32), whereas those in the south wall have flat lintels below ceiling beam level. Whilst this may reflect the different dates of construction, it may merely represent an attempt to introduce more light into the northern part of the building, where the ground floor effectively forms a basement.
- 3.3.5 A doorway in the sixth bay of the north wall affords access into a stair tower, which was probably of contemporary construction to the repositioning of the north wall. The western part of the stair tower appears to simply form a subterranean foundation to the floors above, whilst a 2'6" wide doorway leads to a winding stone stair with 6" sandstone risers below heavily worn 2" x 11" stone treads with projecting noses (Plate 33). The stair is concrete-blocked level with the newel wall, which is of brick. A small 21 x 15" window in the east wall at ground level is stone blocked, whilst a 16-light timber-framed fixed light at ground level in the north wall is externally boarded, but is presumably original to the stair tower.



Plate 32: Vertical sash window in north wall



Plate 33: Base of stair tower with spiral staircase

- 3.3.6 The western two bays of the extant structure form a relatively early extension to the Arkwright-type mill. It comprised seven lateral bays, extending further to the south of original façade, and also beyond the original northern extent of the mill. Not only does the original position of the north wall align with a window position in the west wall of the extension (Fig 2), but also the beam positions within the extension are more consistent with a wider structure. The first and third bays of west wall of the extension are without windows, whilst all but southern of those extant house nine-light vents. The southern window instead retains a 25-light sash with simple chamfered transoms, and is possibly original. The south wall of the extension also retains a possible original doorway in the west bay with dressed stone jambs, and with a nine-light window to the east (Fig 2).
- 3.3.7 The western bay of the north wall of the extension also contains what appears to be an original doorway (Plate 34), with the corbelled footings of a hearthstone placed immediately to the east below ceiling level providing the only evidence for a fireplace on the floor above (Plate 34). An extant doorway in the adjacent bay within the west wall was inserted through a window aperture. The window to the east in the north wall had a flat sill, unlike those in the west wall, but was similarly placed 3' (0.91m) above floor level, terminating 8" (0.21m) below ceiling height.



Plate 34: Door in north wall of west wing, and corbels carrying hearth of fireplace above

- 3.3.8 The ceiling of the extension comprises north/south-aligned 3 x 4½" (0.08 x 0.11m) joists carried on 6½ x 13" (0.16 x 0.33m) beams, the third from the southern end having Baltic timber marks at its western end. All beams, with the exception of the fourth beam from the southern end, which is a circular-sawn replacement, are stop-chamfered at either end, but not above a central north/south-aligned 8 x 10" beam with rolled-edged soffit (Plate 35). This suggests that this beam represents an insertion, originally being supported at either end by a 3½" diameter, cylindrical column with octagonal section foot. That at the southern end was removed subsequently, leaving only the scar of the column head (Plate 36). The beam was also strap-jointed to alternate beams with cast-iron brackets (Plate 35).



Plate 35: Additional longitudinal ceiling beam in west wing



Plate 36: Scar for column capital

3.3.9 A similar beam, placed only 23" to the east, lies within the earlier part of the building, but almost certainly relates to this extension as its position is immediately adjacent to the removed west wall of the original structure (Fig 2). It has similar column scar, flitch plate, and semi-circular line shaft cut-out to the beam to the west. Both beams, and their accompanying flitch plates, have shallow half-joints at their north ends, presumably for column pads. A 6 x 12" circular sawn beam placed between them, spanning to the north wall is carried on an array of I-section steel beams (Plate 37), which presumably replaced earlier timber variants as seen on the floor above.



Plate 37: Close-set ceiling beams on late steel pad

3.3.10 The beams house evidence for three distinct power systems. The earliest was placed in the second bay from the north wall of the original structure and comprised semi-circular cut-outs, presumably for timber shafting (Plate 32). The fourth beam from the west end has the cut-out for this shaft only on its eastern face, whilst the cut-out in the beam to the east is shallow, and offset to the north, suggesting jointing in the shafting. The adjacent beam has no evidence for this shaft, whilst that in the penultimate beam lies significantly to the south, flanked by 8¼ x 4x1½" cut-outs at the base of the western face (Plate 38). In the eastern bay, the cut-out is placed slightly north of the centre line.

- 3.3.11 A more straightforward power shaft lay approximately 32" from the south wall. It comprises an upper pair of bolt holes 14" apart, with a pair of slightly smaller holes between, placed slightly lower and only 10" apart. The penultimate beam retains bolts in three of these holes, the upper being round-headed, with the lower being square-headed. All have square nuts on the west face. The western of the original beams has an associated drum scar, 11" wide, and 2" above the soffit (Plate 39), suggesting a diameter of approximately 18" for the drum. Similar bolt holes are also present in the eastern of the beams associated with the extension, but not in that 2' to the west. This suggests that this shaft was not original, but was confined to the eastern eight bays of the enlarged structure. The third shaft comprised a similar arrangement of bolt holes, placed approximately centrally within the enlarged structure. This continued through both of the inserted beams, and a pair of bolt holes, 2' apart, in the perpendicular beam to the north within the extension, may have housed a hanger for an end bearing.
- 3.3.12 A further similar shaft was placed 40" from the north wall (Plate 40). Again the penultimate beam retained four round-headed bolts, with 4" vertical gouges on the western face, positioned 19" apart, presumably relating to drum scars. Similar scars were observed on the remaining beams (Plate 40). The bolt holes were not present in the two beams to the east of the late stairs to the first floor, but both of these comprise circular sawn replacements, the original beams to the east being 6 x 12" pit-sawn beams with narrow chamfers. The main body of the western original beam is flanked by timber 9½ x 2" fitch plates for the majority of its original length, blocking the early cut-outs for shafting. This beam and the adjacent ones, also have a second semi-circular cut-out.

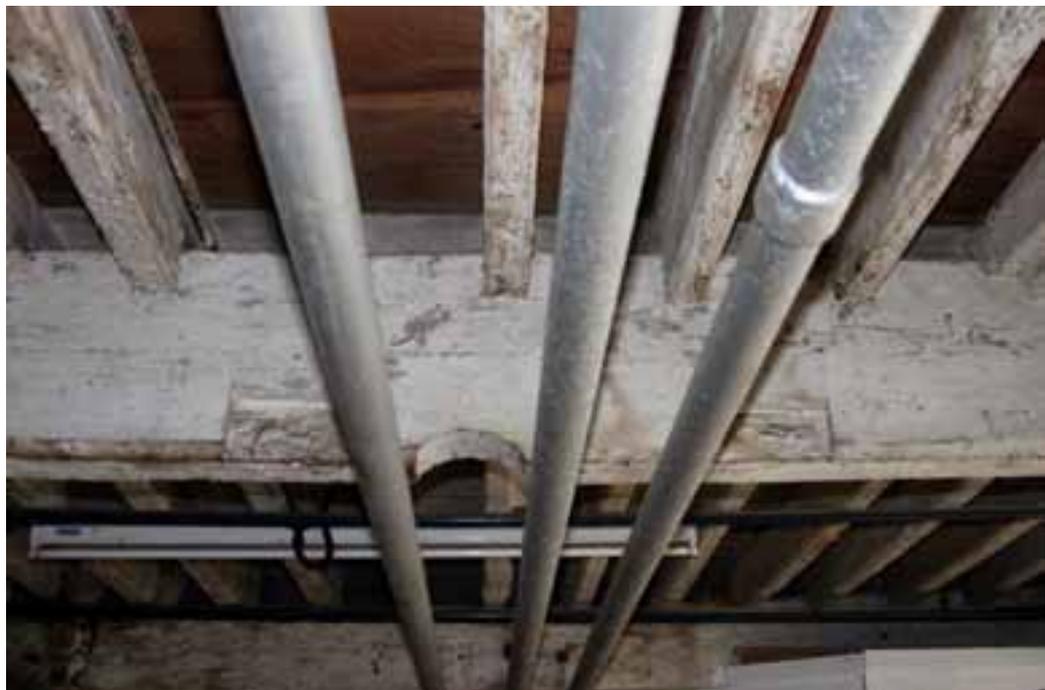


Plate 38: Semi-circular cut-out in ceiling beam soffit for original line shafting



Plate 39: Scar of drum attached to line shaft

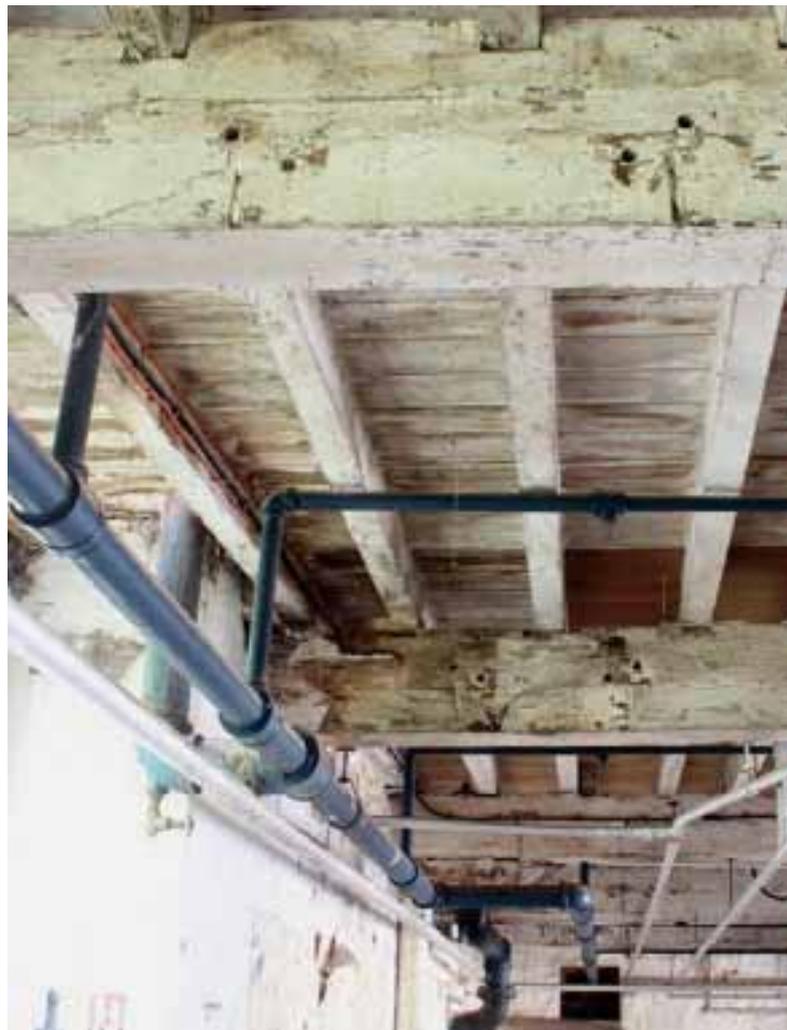


Plate 40: Bolt holes and scars for northern line shaft, with end bearing in background

- 3.3.13 Additional timbers were placed between the eastern beams at their northern ends. One of these has bolts projecting from the soffit, 2' apart, relating to the northern line shaft, and aligns with a 2' wide end bearing box in the east wall (Plates 40 and 41) above a significant stone base supporting the gearing for the waterwheel above (Plates 41 and 42).



Plate 41: Substantial stone base for gearing footstep with line shaft end bearing box



Plate 42: Large sandstone footstep for waterwheel gearing

3.3.14 Within the western extension, the longitudinal beam clasped to the ceiling beam (Plate 35) had several cut-outs in its western face for line shafting, the southern example having an accompanying 18" (0.46m) diameter drum roller scar (Plate 43). However, none of these aligned with other line shafting, which ran perpendicular to this beam, strongly suggesting that it was reused in its present position. At their eastern end, the ceiling beams of the extension are lap-jointed into a 5½ x 12" transverse beam with a very slender chamfer. This has a gouged 6 x 4" semi circular shafting rebate towards its northern end, overlain by a later 3½ x 10" timber fitch plate on its eastern side, demonstrating the disuse of the line shaft at this time. The beam also bears the compression scar for a column head plate in a similar position to extant columns further to the east within the original part of the mill.



Plate 43: Scar of line shaft drum on face of beam

3.3.15 A stone privy tower, measuring only 6' 6" x 4' was appended to the eastern side of the extension to the original structure, in the re-entrant angle in the south wall (Plate 5). The window in the adjacent bay was narrowed and blocked subsequently behind an external brick shed, as was a narrow slit window in the east wall of the privy tower.

3.3.16 In the eastern bay of the ground floor of the original structure, a partitioned area latterly housed a large machine linked to the main dust extraction unit. The window aperture appears remodelled to the full width of the bay on its eastern side, with a timber lintel above a stone wall infilling, recessed 6" behind the original wall face. This housed a 31" wide, 3' high casement adjacent to a 19 x 53" vertical aperture, externally stone blocked and with a projecting internal sill (Plate 44). This is similar in style to a rope drive bearing aperture, but possibly housed the drive to an external pit saw.



Plate 44: Blocked aperture in the south wall of the engine house, with possible bearing box on the left

3.3.17 The floor of the adjacent 8' 4" wide bay is 2' higher. This bay has a transverse stone wall, placed on the probable alignment of the original north wall, and which has an 8' southerly return on its western side (Fig 2). At its base, the return has a 7' sandstone block with a central 30" wide rebate, infilled with brick (Plate 45). A cupboard above infills an original aperture through the wall, blocked by a board on the western face. This relates to an axle and drive shaft, but it remains unclear whether this was associated with an earlier waterwheel than that present in the bay to the east, or a later engine, which was almost certainly placed in this bay.



Plate 45: Pad for axle mounting, with curved rebate infilled with brick

3.3.18 The east wall has a brick-blocked doorway at its southern end, adjacent to a full-height doorway in the south wall, which appears original. The west wall has a corbel at its northern end, placed below beam height in the main structure to the west, but significantly below the rebuilt ceiling within this bay. A 3' 6" x 4' 6" aperture to the south houses the axle of the extant waterwheel, and is of dressed block construction (Plate 46). The 5¼" diameter iron axle has a phosphorus bronze lining to its mounting, the top plate of which has been removed (Plate 46).



Plate 46: Waterwheel axle

3.3.19 Access to the first floor from the ground floor is provided by a late internal stair, placed against the north wall within the west wing, replacing the winding stair in the stair tower, which was blocked subsequently at this level.

3.3.20 **First floor:** the first floor is of similar construction to the floor below, with scarfed beam extensions to the extant north wall (Plate 47). All of the original beams are supported by timber props at their approximate mid point, several of which retain bark, although that in the eastern bay is lamb's-tongue chamfered to each face (Plate 48). Several beams have further timber props to the north or south, whilst the two inserted beams at the junction with the western extension have a slender cast-iron column, with slight entarsis, and an octagonal foot at their mid-point (Plate 48) with timber props below a pad spanning both beams at the north end. These augmented or replaced cast-iron columns, similar to those at the mid-point, the western of which survives beneath the scarf joint within the western ceiling beam (Plate 50).



Plate 47: General view across the first floor, looking north-west



Plate 48: Scar of large drum and chamfered prop



Plate 49: First-floor columns with octagonal-section feet



Plate 50: Timber props to ceiling beams adjacent to cast-iron column to scarf joint

3.3.21 The western beam has a replaced section on its eastern face, which possibly relates to the end of the original line shaft. The infilling timber has bolt holes relating to later hangers (Plate 51), observed on each beam to the east, the last of which has an apparently associated scar for a very large wheel or drum (possibly 6' diameter), the joists above all being replaced (Plate 48). This drive aligns with a large blocked bearing box in the east wall (Plate 48), associated with the extant gearing for the present waterwheel. Circular cut-outs in the eastern three beams relate to an earlier line shaft, placed almost immediately to the south, whilst the adjacent beam has a repaired soffit, presumably infilling the earlier cut-out. The third beam has a 2' wide 1" deep scar for a drum on its western face, and a large strengthening timber bolted below (Plate 52). The beam to the west has a similar strengthening member projecting from the south wall.



Plate 51: Timber fillet in beam face and later line shaft hanger bolt holes



Plate 52: Rebate for drum on original line shaft, with cut-out in soffit for shaft

- 3.3.22 A line shaft, placed midway between the timber props and the south wall, ran the full length of the original structure, and has angled scars, possibly relating to approximately 20" diameter drums, on the eastern face of several beams. A shaft adjacent to the south wall has metal framing where it passed through the strengthening member on the fourth beam from the east wall (Plate 47), but appears to have terminated in the bay to the west. A final shaft was placed adjacent to the original north wall, and has a scar on the eastern beam suggestive of a 12-15" diameter drum.
- 3.3.23 All beams have narrow cast-iron columns placed below the scarf joint, with that below the fifth beam having an L-section head plate, offsetting the column to the western side of the beam (Plate 53). Many of the other columns have significant lean, particularly the eastern three bays (Plate 54). The flooring of the main mill at first-floor level comprises 5½" and 4½" north/south-aligned boards.
- 3.3.24 The extension to the western end of the mill has a door in the eastern bay of the south wall, with a dressed surround, and apparently representing an original loading door from the yard. All windows throughout the floor in all but the west wall, and the east bay of the south wall are recessed to floor level, with those in the north wall again being offset to a higher level (Plate 55), as at ground floor level. Several retain 25-light small-paned timber windows. The window aperture of the east bay of the south wall has a 20" high sill and a curved 30" high rebate in its western jamb (Plate 56), possibly cut away to allow for the headstock of a wider mule.



Plate 53: L-section column head plate



Plate 54: Deflection of first-floor column



Plate 55: 25-light window in north wall, first floor



Plate 56: Rebate in south wall, possibly for mule headstock

3.3.25 The east wall of the spinning block does not continue to the repositioned north wall, instead having an eastward return 7' from the extant north wall (Fig 3). This is of coursed-rubble construction on its northern face, and probably represented the face of an engine house, partitioned within the enlarged mill. It was punctured by a ceiling-level beam (Plate 57), which appears to have been used to extend the original mill into the position of the external waterwheel, once the new waterwheel had been installed within the enlarged structure. This is supported by a column below a butt-joint at its north end (Plate 58), similar to the beams in the main spinning block, and demonstrating that it predated the repositioning of the north wall. This area was timber panelled latterly to create a store. A vertical aperture in the east end of its south wall presumably carried a shaft or belt from the adjacent gearing associated with the waterwheel.



Plate 57: Extant waterwheel gearing



Plate 58: Column carrying scarf-jointed of extended ceiling beam

- 3.3.26 The stair tower was of fireproof construction at first- and second-floor level, and is divided by a stone partition into two chambers. External access into the stair tower was afforded in its east face, at first-floor level, which is the external ground-floor level at the rear of the mill. It comprised a narrow double-door with 10-light timber skylight above (Plate 14), leading to the half-landing at first-floor level. The north wall of the stair tower had windows into the stairwell, with a blocked 16-light window on the spiral between the first and ground floors, and an extant 25-light fixed window between the first and second floors (Plate 59).

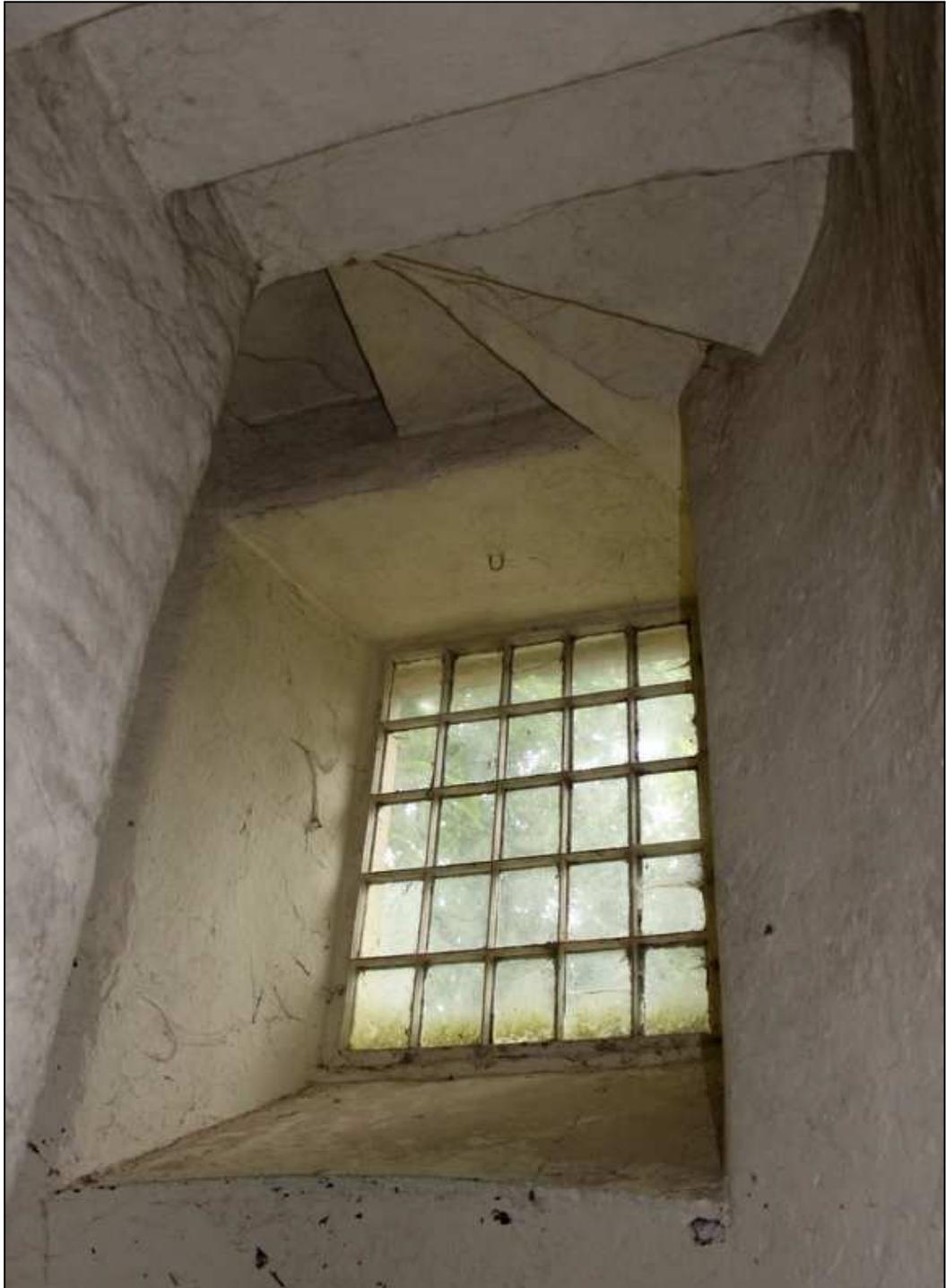


Plate 59: Stair-light window with fireproof spiral stair above

3.3.27 At first-floor level, a full width, full-height stone-arched aperture (Plate 60) afforded access into the west bay of the stair tower, which had a brick fireplace in its north-east angle (Plate 60). This formed part of an office which had a timber panel partition to the main structure (Plate 60), with the second floor landing being carried on a T-section fish-bellied beam (Plate 61). Within the main body of the mill, the main control valve, or 'Christmas tree' for the Mather and Platt sprinkler system was placed adjacent to stair tower (Plate 62), with a rare survival of an associated replacement sprinkler-head cabinet, mounted on the wall nearby (Plates 62 and 63).



Plate 60: Wide arched opening into office within western side of stair tower



Plate 61: Fish-bellied T-section beam carrying stair tower landing



Plate 62: 'Christmas tree' control valve of sprinkler system



Plate 63: Cabinet housing spare parts for sprinkler system

3.3.28 The bay adjacent to the extant waterwheel has a full height, 32-light window in the south wall (Plate 8). This is an insertion into the original fabric, and is typical of that associated with an engine house, having been inserted when an engine was added to supplement the waterwheel in times of water shortages. The bay also houses the gearing for primary motion shaft from the waterwheel. This was driven by a pinion wheel, placed almost at the apex of the waterwheel (Plate 64), with its axle extending through the dividing wall just below ceiling level of the first floor, within a substantial cast-iron bearing box (Plate 65). The pinion was driven by an internal ring gear (Plate 64), with the wheel placed slightly above the water chute, as this part of the waterwheel had the greatest torque. The western end of the shaft was housed in an angled axle bearing, placed on a large-scantling timber (Plate 66), positioned between a cross beam at ceiling height, and a stone base within the floor to the north (Plate 67). The ceiling beam was carried on a cast-iron hanger placed on the east wall, and was supported by a cast-iron column, rising from ground-floor level at its western end (Plate 57). This demonstrates that the beam post-dated both walls, and was almost certainly inserted concurrently with the present gearing and the steam engine. The cross beam also supported the ceiling beam above, which appears to have been inserted in the position of the original east wall, following the extension of the mill, during the insertion of a new waterwheel in the adjacent bay. The drive shaft from the waterwheel forms the axle of a large, 8' diameter, eight-spoke gearing wheel, placed adjacent to the east wall (Plate 66). This drove a much smaller 2' diameter eight-spoke wheel of similar style, the axle of which was also placed on the angled beam (Plate 66) and housed in an end bearing box within the eastern wall (Plate 68). Between the two gear wheels, a vertical timber chute formed an oiling point for the system (Plate 66), accessed through a 2' x 18" trapdoor in the floor above.



Plate 64: Pinion wheel on rim gear of waterwheel



Plate 65: Axle and bearing of pinion wheel



Plate 66: 8' gearing wheel on pinion wheel axle



Plate 67: Gearing driven by pinion wheel, with clutch-plate on drive shaft



Plate 68: Compression scar and bolts associated with vertical shaft from steam engine

- 3.3.29 A shaft driven by the 2' wheel extended immediately below the ceiling beam towards the spinning room to the west, and terminated in what appears to have been a clutch plate, almost adjacent to the gear wheel (Plates 66 and 67). The great difference in size between the two wheels would have given a massive increase in the rotational speed of the line shaft, in comparison with that of the primary motion shaft, which again rotated at a much greater speed than the waterwheel itself. The clutch afforded the ability to disconnect the waterwheel gearing from the primary motion shaft, allowing it to be powered by the supplementary steam engine.
- 3.3.30 The gearing for the waterwheel was also spatially very compact, in the north-west corner of the room, and independent of its floor, which was a later insertion. This compactness of the gearing allowed the supplementary steam engine, added to provide for the inconsistent water supply, to be placed within the same bay, and spanning the ground and first floors.
- 3.3.31 The primary motion shaft, beyond the clutch plate has been removed, but it originally passed through a bearing box in the west wall of the bay (Plate 57). This had an additional offset angled casting in its face (Plate 57), presumably associated with the linkage of the shaft from the engine. Bolt holes, two bolts, and compression scars in the soffit of the transverse beam within this bay (Plate 68), relate to a mounting for a hanger, possibly carrying a bevel gear, translating a vertical drive from the engine below towards the wall-box to the west.
- 3.3.32 The current waterwheel is the full height of the ground and first floors, and almost the full 7' width of the bay in which it is housed (Plates 69 and 70). This represents an extension to the original mill, with this waterwheel probably being erected whilst an original waterwheel continued to function in the adjacent bay to the west. The high breast-shot wheel has cast-iron rims housing metal sheet elbow-buckets (Plate 71), supported by slender timber spokes socketed into a small diameter cast-iron hub (Plates 69 and 70).



Plate 69: Extant waterwheel with slender timber spokes



Plate 70: Axle and eastern bearing of waterwheel



Plate 71: Detail of buckets and spoke sockets

- 3.3.33 The east wall of the wheel pit diminishes in thickness to each floor level, consistent with that of an external wall (Plate 69). Quoin stones on the edge of an infilled aperture at the north end of the east wall, just below ceiling level (Plate 72), appear to represent the southern jamb of a doorway affording access to the waterwheel, prior to the construction of an extension on its eastern side. A concrete bridge with doorways either end, inserted across the southern side of waterwheel bay, cuts the waterwheel, rendering it unusable, but provided access between the original mill, and a later extension to the east of the waterwheel, and was inserted after 1933, when the waterwheel became redundant.
- 3.3.34 A stone-built extension to the east of the wheel chamber had only a low narrow passage, affording access to the waterwheel axle bearing at ground-floor level, where it was terraced into the hill slope. At first-floor level, the extension was erected to the same width as the earlier waterwheel chamber, and infilled the space to the edge of the lane to the east. It appears to have originally comprised a single large room, with windows in each of its three external elevations, and probably represented a preparation room or warehouse, with cut-outs in the soffit of the timber ceiling beams suggesting it had two line shaft positions (Plate 73). The north wall was repositioned subsequently to the level of the expanded waterwheel house, apparently coinciding with its conversion to an office. A chimney breast was included in the repositioned wall, with a projecting corbel carrying a ceiling beam inserted in the position of the original wall (Plate 74). A stud partition wall was almost certainly contemporary, and separated the probable office from the southern part of the floor, with an entrance lobby to the original double doorway in the eastern wall (Fig 3). This had a small-paned 16-light timber skylight above, similar in style to a 25-light sash window to the south (Plate 19), which was internally partially overlain by an inserted half-turn staircase, placed in the south-east corner of the extension (Fig 3).



Plate 72: East wall of wheel house with quoin return of probable doorway at to



Plate 73: Evidence for original line shafting in east extension



Plate 74: Chimney breast in repositioned north wall of east extension

- 3.3.35 A rectangular 24 x 17' stone structure was added to the southern face of the original eastern extension, and comprised a two-storey building at ground- and first-floor level. The ground floor appears to have originally housed a small boiler, with a coal chute in the east wall, adjacent to the road. A photograph of 1924 shows the south wall as a blank façade with a central ground-floor doorway (Plate 2), but it was remodelled to form an open-fronted bay in the south-west corner, carried on I-section steel beams and a stanchion. This afforded access to a narrow low passageway to both the coal chute and waterwheel axle bearing.
- 3.3.36 At first-floor level the extension comprised a lobby, adjacent to the earlier extension, with three doors to a privy and two further offices (Fig 3). The privy had a small four-light tilt window at the top of the west wall (Plate 75), and a modern toilet suite, whilst the floor in the western of the two larger rooms was raised by 2'6" (0.75m) in the southern part of the room, above the open-fronted bay below. The larger eastern room had two nine-light top-vented timber windows in the eastern wall, both probably original to the construction of the extension. The north wall had a fireplace cut into the 2' (0.61m) thick wall of the earlier extension (Plate 76), possibly placed in a window aperture of the earlier structure. Two convex sandstone corbels below the ceiling almost certainly carried a wall plate associated with the roof of the extension, prior to a brick-built second floor being added, at which point, the ceiling height also appears to have been increased to its present level.



Plate 75: Privy in southern extension of east wing



Plate 76: Sandstone corbels in south external wall of original eastern extension

3.3.37 **Second floor:** the second floor of the spinning block was similar to that below, with timber props supporting the original beams at their midpoint. Whilst most were plain, that in the eastern bay of the original spinning block was lamb's tongue-chamfered (Plate 77). The original beams were, however, not scarf-jointed into timber beams extending to the wall of the northern extension of the original mill, as on the floors below, but instead remained short of the repositioned wall (Plate 78), their exposed ends being supported on hollow cylindrical, cast-iron columns of varying type, having either a flat or a ribbed head plate (Plates 78 and 79), and a plain, or octagonal-section foot (Plate 78).



Plate 77: Drum scar and line shaft bolt holes, second floor



Plate 78: Second-floor columns supporting exposed beam ends



Plate 79: Plain column capital, second floor

3.3.38 Windows were similar to those on the floors below, with the exception of those in the north wall, which matched those elsewhere, rather than extending to wall-head height (Plate 78). Many housed nine-light, top-vent windows, although some timber 25-light vertical sash windows also survived (Plate 80).



Plate 80: Second-floor windows

3.3.39 In the north-east corner of the original main body of the mill, a butt joint between two phases of construction was clearly visible (Plate 81). This has dressed sandstone blocks on the southern side, demonstrating that this originally represented an original southward return of the wall, and therefore that the waterwheel house was extended beyond the mill, prior to the repositioning of the north wall of the spinning block. An end-bearing box, placed immediately below ceiling height within the dressed blocks of the wall return (Plate 81), represents a late insertion, and demonstrates that a line shaft was placed within this position following the extension of the mill, matching those on the floors below. Evidence for a further line shaft, placed immediately north of centre within the original structure was observed as on the floors below, with bolt-hole pairs, and cut-outs in each tie beam (Plate 77), with additional drum scars on the eastern face of several timbers (Plate 77). Similar bolt pairs for a line shaft on the opposite side of the timber props to the tie beam were also observed, and were similar to those on the floors below.



Plate 81: Quoins of wheel house in east wall of main mill

- 3.3.40 A timber stud partition extended to the south of the original eastern stone wall return, across the full width of the building (Fig 4). Although this followed the alignment of the partition between mill and waterwheel house on the floors below, it is probable that the area above the engine house at second-floor level was open-plan following the expansion of the mill, with the construction of an internal waterwheel house. Evidence within the roof space (*Section 3.3.31, below*), and the full height of the wheel house wall to the north (Plate 81), show that the appended wheel house was of similar height to the mill, and thus had a floor above the waterwheel, effectively making it an internal wheel, rather than being a lower, wider structure adjoining the outer face of the mill. The floors of the bay adjacent to the new waterwheel also appear to have been incorporated into the main spinning block at all floor levels.
- 3.3.41 Within the western extension of the mill, a blocked aperture in the north wall had dressed stone jambs and lintel, and appeared to have formed a fireplace (Plate 82). This may have formed a small office in the original construction of the west wing, where it extended beyond the main mill at that time. It was presumably blocked when the earlier structure was extended, with the whole of the western extension forming part of the enlarged spinning floor.



Plate 82: Jamb and lintel of fireplace in north wall of west wing

3.3.42 The earliest extant element of the roof comprised king post trusses, with clasped ridge purlin and sandstone roof tiles, carried on three purlins to each pitch (Fig 4; Plate 83). The purlins were butt-ended above the trusses which have chiselled roman numeral assembly marks on their eastern faces (Plate 84), and originally had angled braces from the angled king post foot to immediately below the central purlin of each pitch, as demonstrated by blocked or redundant sockets in this position on each principal rafter (Plate 77). The king posts of each truss were cut subsequently, and the angled braces removed, with collar planks placed across each truss, at the height of the upper purlins (Plates 77 and 83). This created an open loft, and dovetail housed sockets in the tie beams (Plate 77), demonstrating that the loft formed was floored at this time. The new collars also have semi-circular cut-outs in their upper faces (Plate 83), almost certainly to carry a pipe for the sprinkler system, rather than a timber line shaft, which would have generated too much friction and heat in a weight-bearing timber housing.



Plate 83: Remodelled king post trusses



Plate 84: Chiselled carpenter's assembly marks

- 3.3.43 The western extension of the mill has a perpendicular roof formed of braced king post trusses, with the king post stirruped to the tie beam with an iron strap (Plate 85). Despite the obstruction caused by the king posts, longitudinal trimmers between the tie beams have double-tenon mortices in their faces for floor joists (Plate 86), indicating that the roof space was utilised.
- 3.3.44 The western end of the roof was presumably originally hipped, and thus a new truss needed to be installed to carry the ridge from the original roof to that of the perpendicular extension, in order to avoid a valley between the two roofs. The truss installed was of queen post type, with two vertical members having a jowled head (Plate 87), carrying the shorter principal rafters, a straining beam placed between the two posts, and the weight of the upper purlin, which was housed in a notch within the head (Plate 88). These queen posts were also cut subsequently, and replaced with a pair of iron rods, placed immediately on their inside (Plate 87).
- 3.3.45 A lath and plaster wall was also inserted into the roof space between the two roofs (Plate 87). The purlins of the new west roof were trenched, through purlins, rather than being butt-ended, as in the earlier roof, and were longitudinally jointed with simple splayed scarf joints (Plate 89).



Plate 85: King post truss above west wing



Plate 86: Mortices for ceiling joists above west wing



Plate 87: Lath and plaster partition between roofs of main mill and west wing, and queen post truss with replacement iron rods



Plate 88: Jowled head of queen post, carrying side purlin, with adjacent replacement rod



Plate 89: Scarf joint in purlin of west wing

3.3.46 The extended north bay of the original mill had a separate low pitched roof of common rafters over a square-section ridge purlin (Plate 90). The valley between the two roofs was carried on the northern ends of the original tie beams, and presumably drained through the external wall at the eastern end. The stair tower had a perpendicular pitched roof comprising simple coupled trusses, with the southern principal rafter oversailing that of the north pitch, and having the ridge purlin trenched into its apex (Plate 91). A single purling to each pitch was also trenched into the trusses (Plate 92). The joint between the stair tower roof and had an end wall panel of lath and plaster (Plate 92), creating a separate room above the stair tower. This had a doorway in its southern face, into the loft (Plate 92), with an apparent original corridor above the roof of the north bay to a second, now removed, doorway into the main loft. The stair tower also retained fire hoses in the roof space, and at second floor landing level, manufactured by EJAY Walker brothers of Preston and Chester (Plate 93).



Plate 90: Common rafter roof of extended northern bay of main mill



Plate 91: Apex of stair tower roof



Plate 92: Doorway in attic above stair tower, with associated lath and plaster partitions



Plate 93: Maker's plate on fire-fighting hose reel

3.3.47 The roof structure above the engine and wheel houses differed from the main roof, comprising two queen post trusses (Plate 94), with jowled feet (Plate 95) and each post carrying the upper of two rectangular-section purlins to each pitch. Posts below the lower purlin do not form part of the truss, but instead form studs for a former partition to the eaves (Plate 94), which appears to have been a relatively recent addition, and certainly post-dates the extension of the mill to the east, as it is also present within this part of the roof.



Plate 94: Queen post trusses above engine and wheel houses



Plate 95: Jowled foot of queen post

3.3.48 The roof of the eastern extension appears similar to that above the engine and wheel houses, having open bays within the attic. However, the trusses comprise queen struts, rather than queen posts, with the vertical members supporting the principal rafters of the truss (Plate 96), which extend only as far as the collar (kerb principals). The struts have similar jowled feet to the earlier examples to the west (Plate 96), suggesting that angle braces to the lower purlin may have been utilised in the original construction of both phases of the roof. The collars of each truss, and the straining beams of the earlier trusses to the west have semi-circular cut-outs, similar to those of the king post trusses to the west, and almost certainly relate to a pipe for the sprinkler system, rather than for a line shaft (Plate 94).



Plate 96: Queen strut truss above east extension

- 3.3.49 The eastern gable of the extension has a double door, forming the upper floor of a loading loophole (Plates 94 and 96), with direct access to the road (Plate 19). It retains no evidence for a hoist, but has an associated trapdoor in the planked timber floor (Plates 94 and 97).



Plate 97: Loading door and associated trapdoor above east extension

- 3.3.50 The brick extension to the south of the eastern extension of the mill has a separate pitched roof. This is carried on a solitary king post truss with a skylight band on the north pitch (Plate 98). Smaller, timber-framed skylights to both pitches of the earlier roofs (Plates 83 and 97) probably also represent insertions. The southern extension also has a corbel projecting from the chimney stack in its north-east corner, which possibly carried an external gutter on the earlier extension.



Plate 98: King post truss and glazing band above raised south extension

4. DISCUSSION

4.1 INTRODUCTION

4.1.1 Kirk Mill clearly represents an important multi-phase structure, and provides a very rare surviving example of a water-powered textile mill within the county. The mill comprises six main developmental phases, although several are physically unrelated, and thus may be broadly contemporary. Many of the building styles and materials used are relatively non-specific, having a wide date-range of utilisation, typically from the mid-nineteenth to early twentieth centuries.

4.2 PHASE 1 (C 1785)

4.2.1 The original cotton-spinning mill was constructed in 1785, and measured approximately 33' (10.06m) wide, and around 69' (21.03m) in length. Particulars of a sale from 1788 (*Manchester Mercury*, 15 Apr 1788), suggest that the original waterwheel was external to the mill, and it is therefore likely that the subsequent enclosure of the original wheel may have occurred during the construction of a second waterwheel on its eastern side. This appears to pre-date the repositioning of the north wall in the early nineteenth century (Phase 3), as it had a quoined return beyond the original north wall of the mill.

4.2.2 Internally, the mill was originally of non-fireproof construction, pre-dating such technologies, and was of a sufficiently narrow width for single large-scantling beams to span the entire floor, which were unsupported. Examples of this type of construction very rarely survive, as the loading stress almost always produces greater strain on the beams than was acceptable. No evidence survives for the position of access between the floors, although the probable placement of a stair in the north-west corner of the widened structure, may mirror that of the original stair.

4.2.3 Although evidence for many line shafting positions survives within the mill, it is probable that the deeply gouged scars placed to the north of the centre-line of the mill represents the position of the original shaft. This would be the most logical place for a primary motion shaft, driven directly from a pinion wheel on the axle of the original waterwheel. Shafting at this time would have comprised timber members, producing a very slow and inefficient power transfer to the machinery. However, the machines themselves would have been small, requiring little power, making the system initially sustainable.

4.3 PHASE 2 (C 1790-1801)

4.3.1 The mill changed ownership in the last years of the eighteenth century, and the documentary sources reveal plans for the west extension and a new waterwheel at this time. This is consistent with the stratigraphic relationships between the structures, and demonstrates a relatively large-scale expansion of the mill.

- 4.3.2 The new waterwheel was placed within a wheel house of full three-storey height, in a bay to the east of the original waterwheel. This will have allowed the waterwheel to be constructed with the earlier waterwheel still working, thus giving a minimal disruption to the working of the mill. The new waterwheel almost certainly utilised the original line shafts and timber rollers, the greater need for power being provided by a larger waterwheel, as increasing the efficiency of the gearing and shafting within the mill was not easily achieved at this date. Once the new waterwheel was operational, the original waterwheel was removed, and the original east wall of the mill was removed, extending it from eight to nine bays in length.
- 4.3.3 The eastern extension of the building, along the angle of Malt Kiln Brow, also probably dates from this phase. The style of construction and apparent original fenestration suggest an early nineteenth-century date, although it is not implausible that a structure of later date may simply have copied an earlier style, to more closely match the original buildings. Also, given that its extension to the south appears to have contained the boilers for the steam engine, it is clear that the northern part of the east end of the structure was built prior to this time, and was possibly erected during the second phase of construction, concurrently with the buildings to the east of the road, around the turn of the nineteenth century.

4.4 PHASE 3 (C EARLY NINETEENTH CENTURY)

- 4.4.1 This phase represents significant internal remodelling of the structure, which included external remodelling on the northern side of the building. The first of these appears to have been the extension of the wheel house on its northern side, by a distance of only approximately 4' (1.21m). This was presumably undertaken for the installation of a yet larger waterwheel. It also appears likely that an access doorway was included at the north end of the east wall, where it projected beyond the extension to the east. This would have afforded access to the water box and chute. It is unclear whether this was associated with the installation of the present 32' wheel, which was built to maximise both the power and functionality of the wheel. Early waterwheels were driven directly from their axles, but this created great torsion forces, which even with heavy spokes, often led to breakages. A breast-shot design of the waterwheel enabled it to rotate effectively in reverse, meaning that the water exiting the wheel chamber was flowing in the same direction as the tailrace, and therefore had no braking effect on the waterwheel.
- 4.4.2 One of the major improvements in waterwheel design around the turn of the nineteenth century was the introduction of a pinion wheel, powered by a rim drive, and generally placed close to where the power was generated (near the water chute), for maximum torque. The pinion wheel not only massively increased the rotational speed of the drive shaft, due to the effect of gearing from a large to a small cog, but also removed the twisting effect on the axle, allowing it to be constructed with much more slender, and thus lighter spokes, requiring less energy for rotation, and less frequent failure. Similar wheels were commonly used within textile mills of the nineteenth century (Wenham 1989, 232). A similar, if smaller example was installed at Higher Mill, Helmshore, approximately 20 miles to the south-east, in 1850.

- 4.4.3 The steam engine was almost certainly installed during this phase. This would have been a relatively small, vertical beam engine, occupying the bay adjacent to the spinning floors, having an indicative tall vertical window above a doorway installed in the southern façade of this bay. An associated boiler house would have been required, and this appears to have occupied the ground floor of the south extension to the east range, possibly added during Phase 2. Charging the boiler with coal was undertaken from the eastern end, but it is unclear whether the original structure was of a single storey, or the two-storey structure depicted in the photograph of 1924 (Plate 2), with preparation or storage space above.
- 4.4.4 The repositioning of the north wall of the main mill by approximately 12' (3.66m) to the north represented a significant structural challenge, but is not recorded in the documentary sources. It certainly post-dated the construction of both the west wing and wheel houses, but the manner in which the trusses are supported, with simple scarf joints above hollow-section cylindrical cast-iron columns, suggests a relatively early date. The new north bay was built with its own pitched roof, parallel to that of the earlier structure, and presumably draining through the parapet wall at either end. This obviated the need to replace the whole roof structure, or reduce the wall height of the north wall to allow the north pitch to extend at the same angle as the original trusses.

4.5 PHASE 4 (C MID-NINETEENTH CENTURY)

- 4.5.1 It appears probable that the construction of the stair tower was not contemporary with that of the north elevation, although it may have followed rapidly. Both were certainly complete by the time of the first edition Ordnance Survey map, surveyed in 1844. It provided easy external access to all floors of the mill, and also allowed the internal stair to be removed, freeing more floor space for machinery. The tower was much larger than required for simply housing a stair, and also contained offices at first- and second-floor levels, possibly reflecting greater administrative needs, or potentially again creating more floor space for machinery in the main mill. The stair tower did not have integral privies, a common feature in larger mills, but a small privy tower constructed in the re-entrant between the west wing and the main mill is probably of similar date. Gas lighting was apparently also installed around this time, with the mill having its own gas retort, although no evidence for this structure survives above ground level, and its position remains unclear. No internal evidence for gas lighting was observed.
- 4.5.2 It is unclear whether the repositioning of the north wall of the east range was undertaken during this phase, or concurrently with the construction of either the stair tower or the southern extension to the east wing during the previous phase. Rather than replace the northern pitch of the roof, or add an additional roof, as with the expansion of the main mill, sprockets were added to the rafters of the north pitch, lessening the angle of its base, and extending it beyond the repositioned wall. This large-scale undertaking, for a minimal gain in floor space, is likely to have been prompted by an apparent change of use of the eastern extension to form the main office for the complex. Moving the wall allowed for extra windows to be inserted, and a large fireplace was also built into the new wall.

4.6 PHASE 5 (C LATE NINETEENTH CENTURY – EARLY TWENTIETH CENTURY)

4.6.1 Cotton spinning ceased at Kirk Mill in 1866, and was sold for use as a woodworking, and subsequently chair-making factory in 1874. One of the advantages of the design and construction of textile mills was they could be converted for alternative use with relative ease, making their erection a much lesser risk for speculators. The change of use of Kirk Mill from a cotton-spinning mill to a chair-making factory appears to have left little physical record within the fabric of the building. Many of the alterations undertaken during this period were also commensurate with those undertaken in spinning mills, most notably the insertion of a fire-fighting sprinkler system, and the strengthening of ceiling beams. This similarity is not unsurprising, as the issues associated with the two industries had much in common, with fire being the greatest threat in both cases. Improved working conditions, lighting and ventilation, were also common themes, and the refenestration of the majority of the complex also probably dates from this time. The main difference at Kirk Mill is that these changes were undertaken in timber rather than cast iron, which was being more widely used elsewhere, not only structurally, but also for window frames. This was presumably because the woodworking role of the mill allowed timber to be used much more cheaply and with a greater knowledge of the materials concerned. Externally, a saw pit and crane were installed, the latter of which still survives in a modified form.

4.7 PHASE 6 (C MID-LATE TWENTIETH CENTURY)

4.7.1 Whilst little changed in the manufacturing process during the twentieth century, several additions were made to the structure, most notably the addition of an upper floor to the southern extension, sometime after 1933. Machines powered by electricity were installed, and the waterwheel became redundant, eventually being partially removed for the insertion of a 'bridge' at first-floor level between the eastern and western part of the mill. The steam engine was also removed, although the boiler was probably retained for heating purposes until the latter part of the phase.

4.7.2 Further detached structures were added on the southern side of the mill, including workshops and a privy, with a small store butting the original structure adjacent to the stone-built privy tower. A large brick tower was also installed for a full-height dust extraction tower, placed approximately centrally on the southern wall, with associated galvanised ducting installed throughout the interior of the mill. Structural steelwork was also inserted, particularly at ground-floor level, to maintain the structure to late twentieth century safety standards. The building was finally abandoned in 2010, having been owned by the Berry family, for the manufacture of furniture, predominantly chairs, since 1903.

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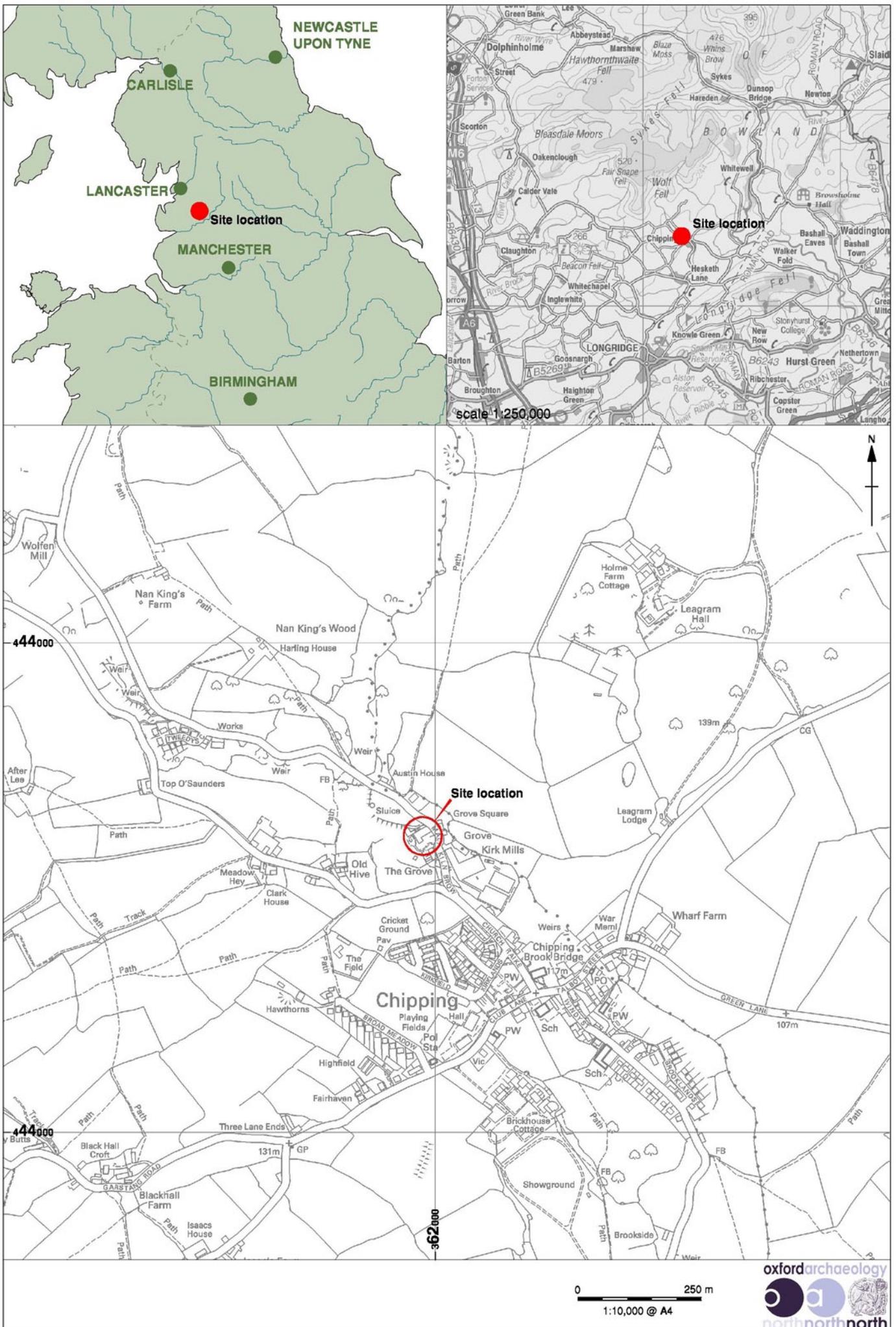


Figure 1: Site location

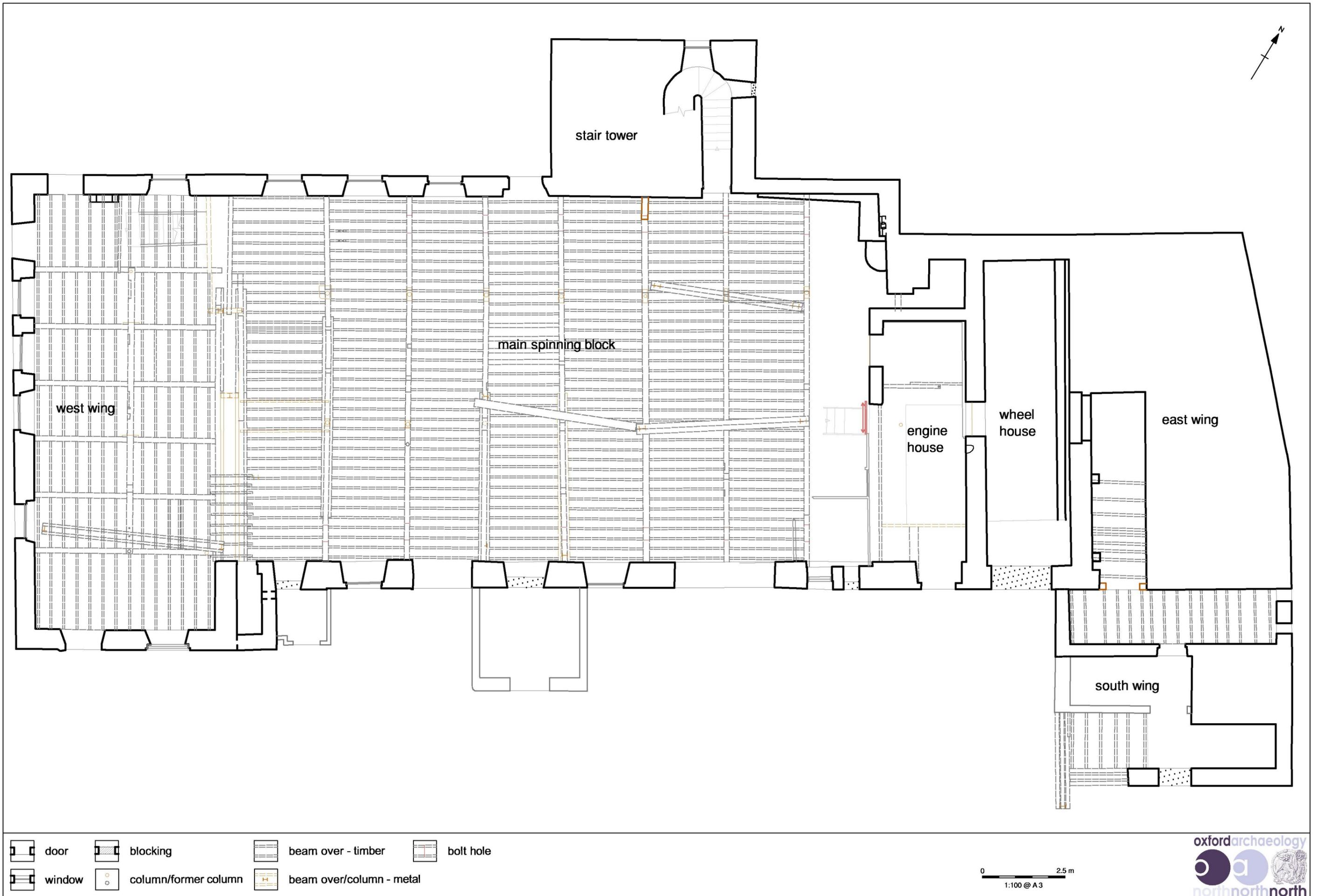


Figure 2: Ground-floor plan

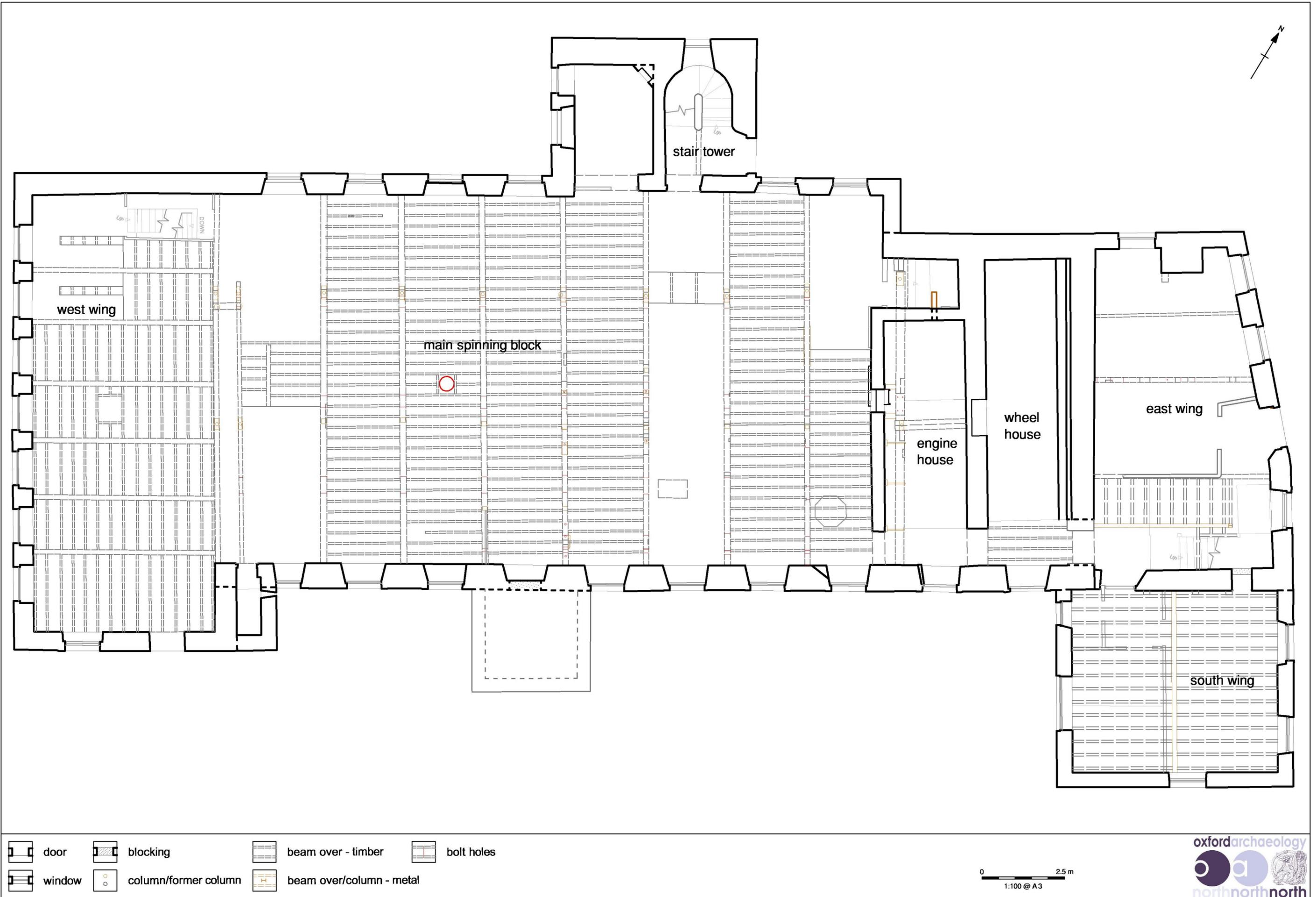


Figure 3: First-floor plan

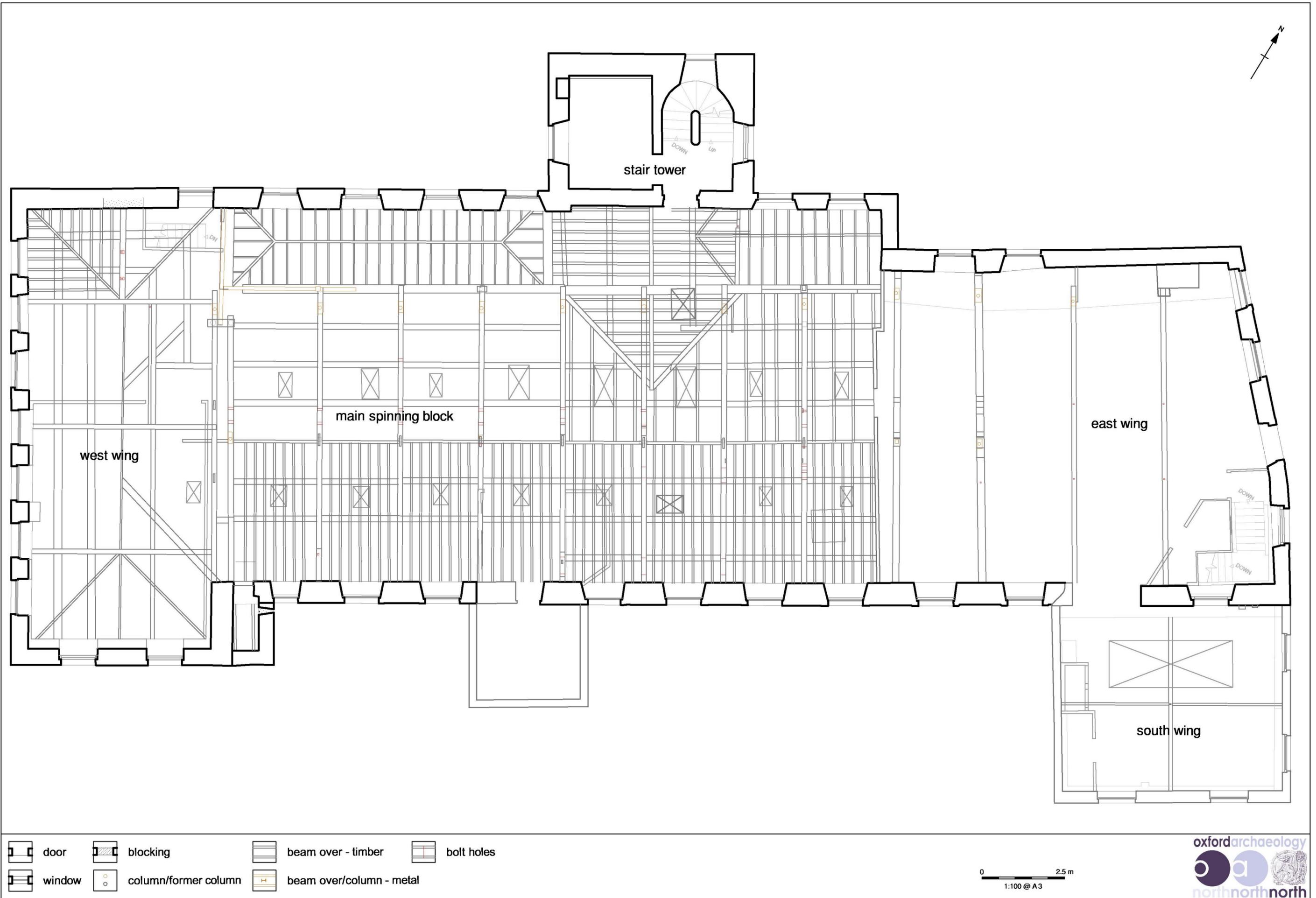


Figure 4: Second-floor plan



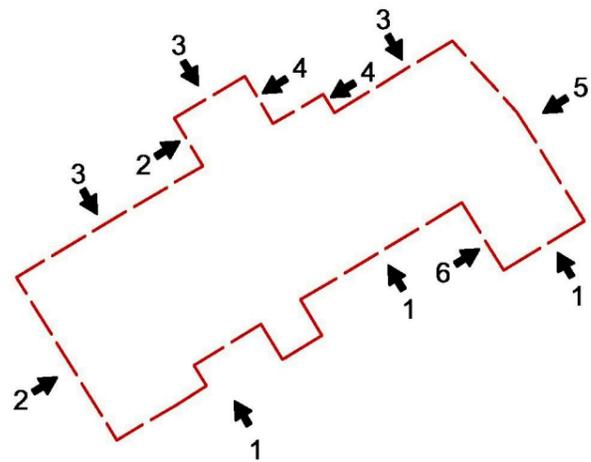
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Elevation 2



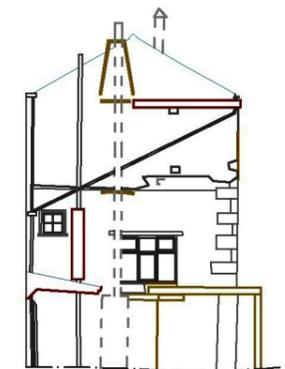
Elevation 3



Elevation 4



Elevation 5



Elevation 6

- Ground level
- Timber
- Brick
- Metal
- Stone

0 25 m
1:1000 @ A3

Figure 5: Elevations

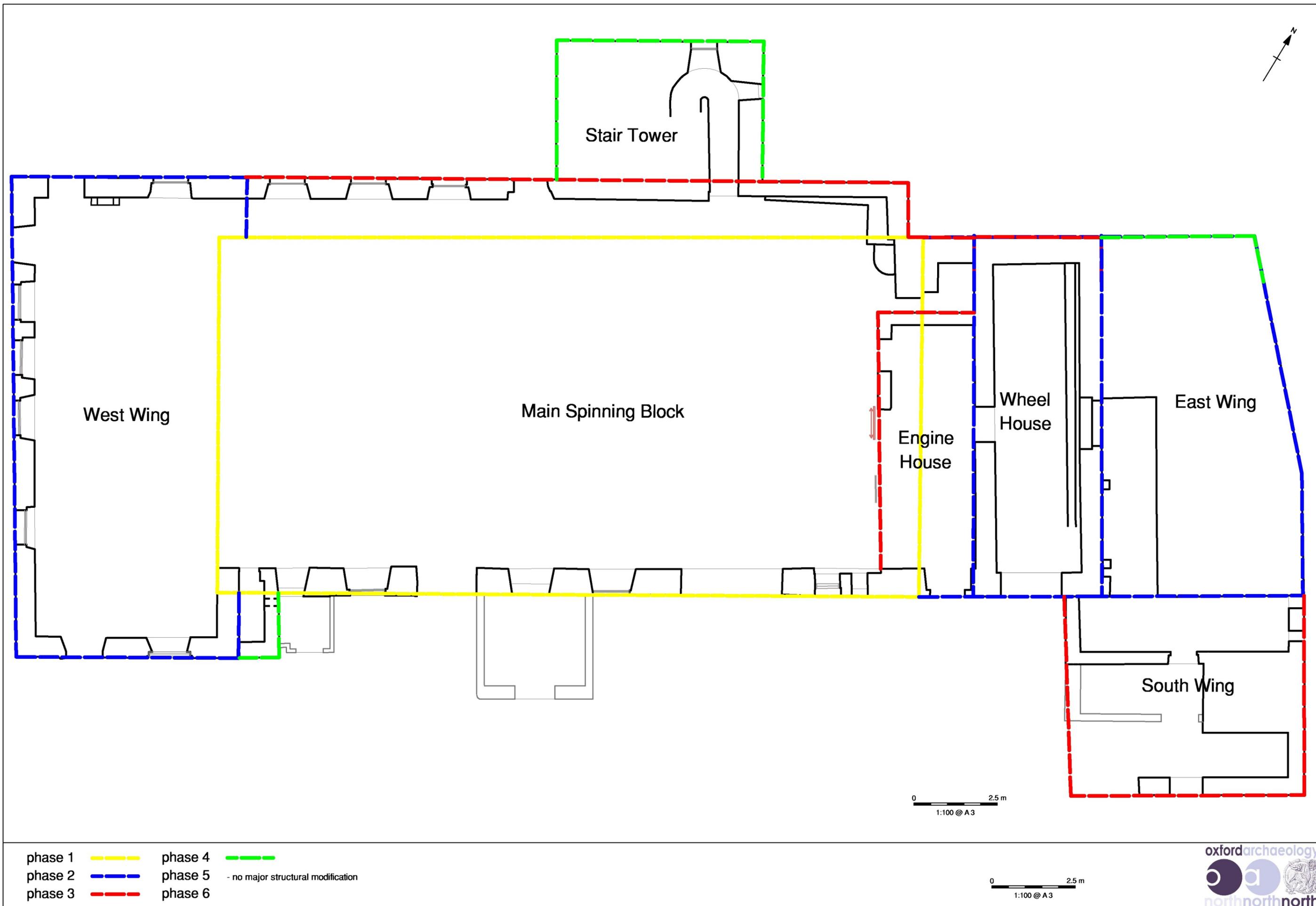


Figure 6: Phase plan