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Ancoats,
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Summary

The Manchester Life Development Company (MLDC) has received planning consent to undertake a development at the Murrays' Mills complex of Georgian textile mills in the Ancoats area of Manchester (centred on NGR SJ 8508 9865). The complex was designed to comprises two large, multi-storey cotton-spinning blocks (one of which was two adjoining buildings), a warehouse and office block, two engine houses, a full-height chimney, and a private canal basin in the centre of the mill yard. A fourth multi-storey building, known as the Bengal Street Block, formerly occupied the Bengal Street frontage, creating an enclosed quadrangle, although this was destroyed by fire in the late 20th century.

The mill complex was established by Adam and George Murray in 1798, and was one of the first textile factories in the world to have been designed to house steam-powered spinning mules. The mill expanded considerably within a few years, and the principal components that occupy the site today had been completed by 1806, creating the largest complex of cotton-spinning mills in Manchester. In recognition of the immense historical and archaeological importance of the site, the component buildings have been afforded statutory designation as Grade II and Grade II* listed buildings. The mill complex had fallen into disrepair by the end of the 20th century, and significant public funding was obtained to carry out major structural repairs to the buildings to secure their future, and enable them to be passed onto an approved developer for sympathetic repurposing as residential units. This 'Shell Repairs Project' was completed in 2007, and was accompanied throughout by a comprehensive programme of archaeological survey and excavation, which culminated in the publication of a monograph on the mill complex. However, due to an economic downturn in 2008, the repurposing of the buildings was not progressed and the site remained unoccupied.

In 2015, the Manchester Life Development Company secured planning approval for a revised scheme (Planning Reference 108566/FO/2015/N2). The consented scheme aimed to secure the economic re-use of the historic mill complex through the creation of 108 residential apartments within the existing buildings. The proposals also allowed for a new five-storey building to be erected within the footprint of the former Bengal Street Block to form 16 residential apartments, together with the refurbishment of the two detached engine houses, the demolition of the former blowing room and canteen, along with alterations to public realm, including infilling of the central canal basin to create a new landscaped courtyard.

In order to offset the harm of refurbishment on any impact external features of the buildings, and internal fixtures and fittings, Manchester City Council, consultation with the Greater Manchester Archaeological Advisory Service and the Manchester Conservation Officer, attached a condition to planning consent that required a scheme of archaeological investigation to be undertaken as part of the development.

In November 2015, Salford Archaeology was commissioned by Graham Construction Ltd, acting on behalf of MLDC, to undertake the recommended programme of investigation. For the most part, this allowed for an archaeological watching brief to be maintained during refurbishment works, coupled with targeted excavation and recording of the former Bengal Street Block and the late 19th-century engine house at the northern end of the building, and excavation inside Old and Decker Mill Engine House.

The archaeological recording was carried out between December 2015 and March 2019, and has enabled elements of the comprehensive archaeological record of the mill complex that was compiled in 2005-07 to be enhanced. In particular, the current development has exposed previously unrecorded elements of the former Bengal Street Block, together with the foundations beds for the steam engine in the extant engine house that served Old and Decker Mill. Some further information on the development and fabric of the other buildings was also gleaned during the watching brief, which is presented in this report. However, in order to place these results in context, they are embedded amongst the conclusions drawn from the previous investigations to provide an holistic account of Murrays' Mills.

1. Introduction

1.1 Planning Background

The Manchester Life Development Company (MLDC) has received planning consent to undertake a development at the Murrays' Mills complex of Georgian textile mills in the Ancoats area of Manchester (Figure 1). The complex comprises two large, multi-storey cotton-spinning blocks, a warehouse and office block, two engine houses, a full-height chimney, and a private canal basin in the centre of the mill yard (Plate 1). A fourth multi-storey building, known as the Bengal Street Block, formerly occupied the Bengal Street frontage, creating an enclosed quadrangle, although this was destroyed by fire in the late 20th century.

The mill complex was established by Adam and George Murray in 1798, and was one of the first textile factories in the world to have been designed to house steam-powered spinning mules. The mill expanded considerably within a few years, and the principal components that occupy the site today had been completed by 1806, creating the largest complex of cotton-spinning mills in Manchester. In recognition of the immense historical and archaeological importance of the site, the component buildings have been afforded statutory designation as Grade II and Grade II* listed buildings.

However, during the late 1990s, the buildings experienced severe neglect, raising the possibility that they would deteriorate or collapse entirely. In response to this significant threat, the Ancoats Buildings Preservation Trust became involved with the site in 1997, and obtained full funding from the Heritage Lottery Fund and the former North West Development Agency for the permanent repair of the structure and fabric of the buildings. This programme of essential repairs was completed in 2007, at which date it had been intended to pass the buildings on to a preferred developer for the sympathetic conversion for mixed use (Plate 1). It was also intended to replace the former Bengal Street Block with a new building, and thus reinstate the enclosed quadrangle layout of the mill complex. However, the proposed development stalled in the wake of the economic downturn, and the mill complex has since remained empty.

MLDC is keen to progress the long-term future of the buildings by securing their economic re-use through the creation of 108 residential apartments within the existing buildings. The consented scheme also allow for a new five-storey building to be erected within the footprint of the former Bengal Street Block to form 16 residential apartments, together with the refurbishment of the two detached engine houses, the demolition of the former blowing room and canteen, along with alterations to public realm including infilling of canal basin to create new landscaped courtyard within associated hard and soft landscaping, lighting and other associated works. The planning application for this scheme of development was submitted to Manchester City Council in April 2015, and has since received approval (Planning Reference 108566/FO/2015/N2).



Plate 1: Aerial view across Murrays' Mills following the completion of the Shell Repair Project in 2007

Following consultation with the Heritage Management Director with the Greater Manchester Archaeological Advisory Service (GMAAS), who provides planning advice for Manchester City Council, it was recommended that a programme of archaeological investigation was required. In the light of this recommendation, Manchester City Council attached a condition to planning consent (Condition 6) that aimed to secure archaeological interests:

‘A phased programme and methodology of investigation and recording to include:

- targeted archaeological excavation and recording;
- a targeted historic building survey;
- a targeted archaeological watching brief.

A programme for post investigation assessment to include:

- analysis of the site investigation records and finds;
- production of a final report on the significance of the archaeological and historical interest represented;

Deposition of the final report with the Greater Manchester Historic Environment Record and dissemination of the results commensurate with their significance;

Provision for archive deposition of the report and records of the site investigation;

Nomination of a competent person or persons/organisation to undertake the works set out within the approved WSI.

Reason - To record and advance understanding of heritage assets impacted on by the development and to make information about the archaeological heritage interest publicly accessible pursuant to policy EN3 and DM1 of the Manchester Core Strategy (2012) and saved policy DC20 of the Unitary Development Plan for the City of Manchester (1995) and in accordance with NPPF Section 12, Paragraph 141.'

In November 2015, Salford Archaeology was commissioned by Graham Construction Ltd, acting on behalf of MLDC, to undertake the recommended programme of investigation and fulfil the archaeological planning requirements.

1.2 Aims and Objectives

The principal aim of the project, as stated in the approved Written Scheme of Investigation, was to ensure that any remains of archaeological interest that were to be exposed, damaged or removed during the course of the development were recorded to an appropriate standard.

The specific objectives of the project were:

- to clear a number of large items that are stored in the central courtyard against the external elevation of Old and Decker Mills;
- to undertake a programme of historic building recording of those elements of the Bengal Street Block/Decker Mill that were not accessible during previous archaeological investigations;
- to maintain a watching brief during pile probing works in the courtyard and within the footprint of the former Bengal Street Block;
- to maintain a watching brief during the removal of the existing floor slab in Old and Decker Mill Engine House;
- to maintain a watching brief during the excavation works for the foundations of the new building that will occupy the footprint of the former Bengal Street Block;
- to maintain a watching brief during the excavation works for new services in areas of archaeological sensitivity, including a zone around New Mill Engine House and the former boiler house for Old and Decker Mills;
- to undertake any post-excavation works required and create an appropriate site archive;
- to produce a full report that can be passed on in digital format to all stakeholders at the end of the project.

The programme of works was implemented between December 2015 and January 2019. This report presents the results obtained from the archaeological investigation incorporating, where appropriate, conclusions drawn from the earlier works undertaken in 2005-07.

2. The Setting

2.1 Location

The mill complex lies within Ancoats, on the north-east side of Manchester city centre (Figure 1). The Murrays' Mills complex occupy two blocks of land, although that under consideration is bounded by Murray Street, Jersey Street, Bengal Street and Redhill Street (Plate 1). The Rochdale Canal lies parallel to the south of the mills, immediately adjacent to Redhill Street. The mill complex is centred on SJ 8508 9865, at height of c 50m above Ordnance Datum (aOD).

2.2 Topography

Topographically, the Manchester Conurbation as a region is within an undulating lowland basin, which is bounded by the Pennine uplands to the east and to the north. The region comprises the Mersey river valley, which is dominated by its heavily meandering river within a broad flood plain (Countryside Commission 1998, 125).

The topography of the study area, however, reflects the shallow valley of Shooters Brook, a rivulet that flows westwards from Newton Heath, through Ancoats and into the river Medlock (Ashworth 1987, 22). Until the early 19th century, the brook flowed through Ancoats at the base of a relatively deep valley, and it was upon the northern berm of this valley that Murrays' Mills are situated. However, Shooters Brook had been culverted by 1820, and the topography of the valley has since been masked considerably by urban expansion (Miller and Wild 2007).

2.3 Geology

The solid geology of the area comprises Carboniferous sedimentary material and a series of Permo-Triassic rocks, consisting mainly of New Red Sandstone. The overlying drift incorporates Pleistocene boulder clays of glacial origin, and sands, gravels, and clays of fluvial/lacustrine origin (Hall *et al* 1995, 8).

3. Historical Background

3.1 Development of Ancoats

The construction of Murrays' Mills was integral to the development of Ancoats, which had emerged as the world's first planned industrial suburb by the early years of the 19th century. In order to place the mill complex in context, a summary history of its setting is presented below.

By the beginning of the 13th century, Ancoats was known as *Elnecot*, derived from the Old English *ana cots*, which means 'lonely cottage' (Cooper 2002, 13). As this name suggests, Ancoats was a rural area on the eastern periphery of Manchester. It retained a semi-rural aspect until the late 18th century, when the population of Manchester expanded at an unprecedented rate, and resulted in the transformation of Ancoats into a key industrial suburb.

This process of industrialisation began in the 1770s, when land owned by the Leigh family was sold to Thomas Bound, a builder, who then sold it on to others for development. The focus for initial development was at the corner of Great Ancoats Street and Oldham Road, and contemporary maps depict the main elements of the existing street plan laid out on former fields of the area. Building speculation then drove further expansion, with plots of land within a grid pattern of streets being sold for development.

The earliest factories in the area were several water-powered mills erected along Shooters Brook, to the south of Union (now Redhill) Street. There is some evidence to suggest, for instance, that New Islington Mill originated in the late 1780s as an Arkwright-patented water-frame mill (Miller and Wild 2007), although most of the firms operating in this area were essentially 'poor competition to the profitable Arkwright factory colony' (Little 2004, 31). However, in seeking a solution to the inadequate power supplied to their waterwheels from Shooters Brook, several firms experimented with steam power. A notable example was at Salvin's Factory, when John Kennedy is reputed to have first applied steam power to one of his spinning mules in 1793 (Lee 1972, 9). It was on the basis of a breakthrough in the application of steam power that created the explosion of factory building in Ancoats (Miller and Wild 2007).

The proposed line of the Rochdale Canal ran between Shooters Brook and the new focus of development, offering the potential of cheap and reliable transport for goods and materials. The completion of this canal in 1804 coincided broadly with the efficient application of steam power to cotton-spinning machinery, and a growth in the national demand for textiles. A small number of enterprising firms seized the opportunity presented by this combination of factors, resulting in the creation of a new breed of mill building in Ancoats. The net result was the creation of 'the World's first industrial suburb', an edge-of-town industrial estate with associated housing, community facilities (churches, pubs and charitable refuges) and related businesses.

3.2 Overview of the Development of the Cotton Industry

At the beginning of the 18th century, the English cotton industry was comparatively small. Most cotton materials were imported from India, but in 1701, and again in 1721, Acts of Parliament were passed which prohibited the wearing of Indian calicoes. These measures were aimed at assisting the English woollen industry, although it was actually cotton manufacturers that benefited. The benefits were, however, slow to be realised because of two limitations: the restricted supply of raw cotton, and the slowness of hand-spinning. The supply of raw cotton did improve during the 18th century, first from Levant, then from the West Indies and, after, 1783 from North America (Holland 1976, 39).

Improvements in the spinning process began with the introduction of James Hargreaves' spinning jenny in 1764, whereby a single worker could operate eight spindles simultaneously. Five years later, Richard Arkwright took out a patent for a water-driven spinning machine, called the water frame. The success of this machine enabled Arkwright to establish England's first cotton factory at Cromford, near Derby, in 1771. Arkwright's invention was improved upon by Samuel Crompton, who introduced the spinning mule in 1779. This machine combined the best features of the jenny, which made thin thread, with those of the water frame, which made strong thread. By using the mule, English spinners were able to make thin, strong thread from which fine cotton goods, such as muslin, could be manufactured to compete with those made in India.

During the second half of the 18th century, the technical revolution in the cotton-spinning industry transformed the economic and social structure of the region. At the beginning of this period, the manufacturing processes of spinning and weaving were still based upon the country cottage. By the end of the century, the industry had expanded to an incredible extent; between 1780 and 1800, imports of raw cotton into Lancashire increased from 5-6 million lb to 50 million lb *per annum* (Deane and Cole 1962, 52), and the number of spindles in operation increased from an estimated 1.7 million in the early 1780s to 4-5 million by 1812 (Baines 1835, 226). By 1815, 90% of Britain's cotton industry was located in Lancashire (Holland 1976, 43). There were numerous reasons for this phenomena: local workers were experienced in textile manufacture, there were few restrictive guild regulations as cotton was a relatively new industry, the favourable climate, the availability of pure water for bleaching and calico printing, abundant coal for steam power, plenty of female and child labour, existing trading links and a good and easily accessible port in Liverpool.

During 1790, 1791 and most of 1792, the cotton trade was expanding in boom conditions (Edwards 1967, 11). However, the ever-increasing prospect of war with France in 1792 caused a decline in the trade, and the declaration of war in 1793 accentuated difficulties and resulted in a contraction in trade with Europe. However, the effects were offset quickly by the rapid growth of exports to America, and the cotton trade emerged from the crisis by the end of 1793 (*op cit*, 12).

A rapid expansion of exports continued until autumn 1796, when problems occurred as the export markets were well-stocked and merchants became reluctant to give large orders until they knew the outcome of peace negotiations with France. More significantly, there was an increasing scarcity of money, and in February 1797 the Bank of England suspended cash payments (*ibid*). The year came to an end with bitter complaints that trade was dull and ‘money exceedingly scarce’ (McConnel Kennedy Papers, letter to W Wood, Carlisle 27/12/1797). The economic difficulties continued into the first half of 1798; in January 1798 mule spinners’ wages were reduced in several Lancashire towns, and many firms were selling yarn at great discounts, largely due to surplus capacity (Edwards 1967, 12). By June 1798, however, the trade had made a remarkable recovery and cotton imports increased rapidly and exports soared. Another set-back in autumn 1799 was initiated with a bad harvest that necessitated large imports of grain. The crisis was over by the beginning of 1800, and imports of cotton reached a new record peak (*op cit*, 14).

In October 1801, the preliminaries of peace with France were signed, and resulted in a period of very rapid expansion; 1802 saw spinners enjoying peak profits. However, the trade over-reached itself, and resumption of war in 1803 halted the burst of factory building (*op cit*, 15). The trade in general continued to be uncertain and fluctuated throughout 1804-05, although yarn exports continued to grow and soared to record levels in 1805, causing the price of yarn to rise. By this time, both spinning and weaving were carried on in almost all of the towns in South Lancashire (Catling 1986, 116).

The growth of the export trade, especially to Europe, continued to grow during the second decade of the 19th century. The export of twist and yarn, for instance, rose from £794,465 in 1812 to £1,119,850 in 1814, and then to £2,022,153 by 1820 (Lee 1972, 57). Switzerland, France and Germany in particular created a large demand for fine yarn, such as that produced by the Murrays.

By 1830, the self-acting spinning mule had been developed by Richard Roberts. This machine was to have a significant impact, but it was slow to be adopted and, initially, did not affect the spinning of fine yarns as it was confined largely to the production of coarser yarns (Catling 1986, 115-16). In 1865, it was noted that ‘self-acting mules are seldom found in use for finer numbers than 80. The finer yarns are spun on hand mules’ (Neste 1865). However, by 1880, the self-acting mule had ‘almost entirely superseded the hand mule’ for the spinning of medium and fine counts (Spencer 1880).

The onset of the American Civil War caused severe problems for the English cotton industry as the blockade of America’s southern ports by the Federal navy cut off the supply of raw cotton on which Lancashire’s mills depended. This resulted in the Lancashire Cotton Famine of 1862-64. During this period, raw cotton increased in price from 9d per lb in 1861 to over 2s in 1863 (Holland 1976, 142). Mill closure, short time working and mass unemployment resulted; by November 1862, three fifths of the labour force were idle. From the peak of the famine in 1862/3, unemployment fell, but not until the end of the war, in April 1865, was normal working resumed.

Lancashire dominated the English cotton industry into the 20th century; during the early years of the 20th century, it has been estimated that some 76 per cent of the cotton operatives of the United Kingdom were within Lancashire (Chapman 1905, 37). The cotton industry reached its peak in 1914, with India, the largest single customer, buying 3,000 million yards of cotton cloth (Holland 1976, 142). However, Manchester's share of the industry declined; a total of 2,666,000 spindles were operative in Manchester and Salford at the beginning of the 20th century, compared to 11,603,000 in Oldham and 5,035,000 in Bolton (Chapman 1905, 41). Nevertheless, Manchester remained pre-eminent as a centre for the production of fine yarn, whilst Oldham was associated with coarse and Bolton with medium yarn (Walmsley 1893, 79).

Despite cotton remaining to be Britain's leading export until 1938, the industry declined rapidly between the wars, largely through a fall in exports. Countries that had formerly provided lucrative markets, and particularly India, developed their own mills. Japan captured many former British markets in China and the Far East, and the imposition of tariffs by America and Brazil caused further damage to the export of British cotton goods. A short boom period began in 1945 as a result of shortages caused by the war, but after 1952 British cotton textiles faced intense competition from manufacturers in the Far East. More seriously, however, was the widespread manufacture of man-made fibres; by 1962, 40% of British cloth production was in man-made fibres (Holland 1976, 278). The textile industry declined rapidly thereafter, and many of the textile mills fell into dilapidation or dereliction (Plate 2).

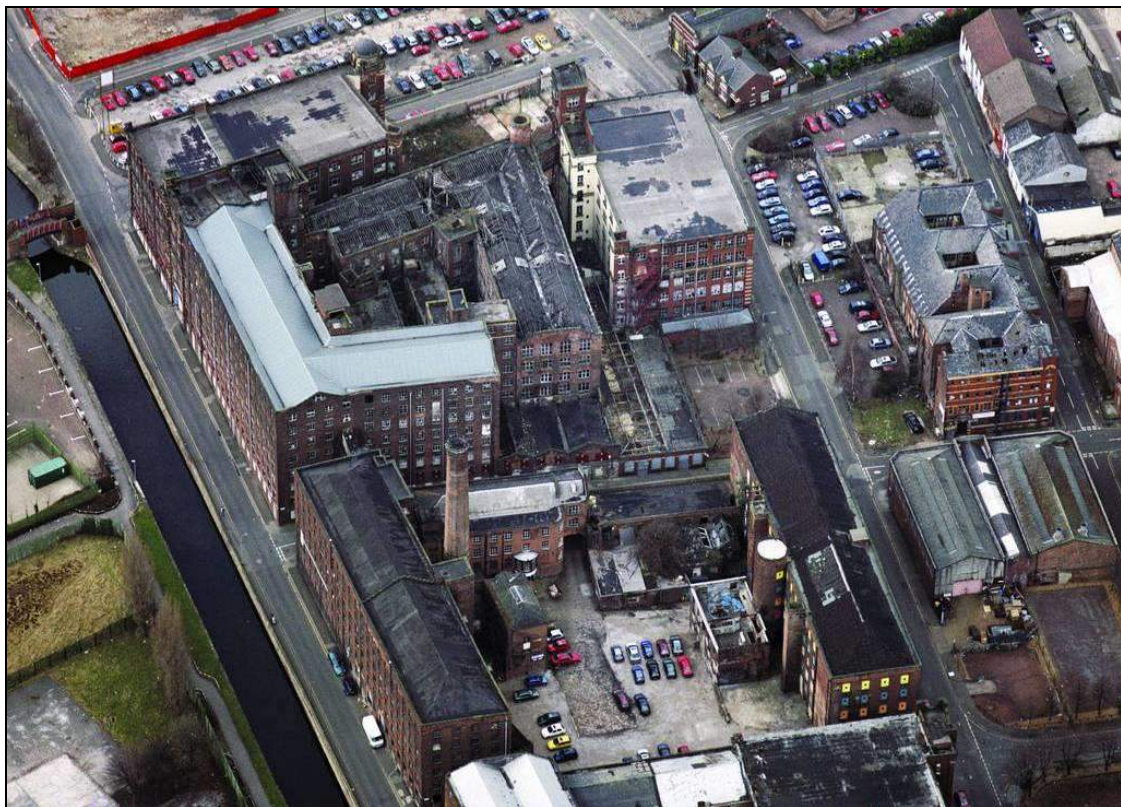


Plate 2: View across the dilapidated Murrays' Mills and adjacent mills in 2001

3.3 *A & G Murray*

The origins of the Murrays' involvement in Manchester's cotton-spinning trade may be traced to 1780. In this year, Adam Murray migrated from the village of Knockmalling, Kirkcudbrightshire in Scotland, to Chowbent (now Atherton) near Leigh in Lancashire, where he was apprenticed to a machine-maker called William Cannon (Lee 1972). Adam was joined there subsequently by his brother George, and his former neighbours James McConnel and John Kennedy, who were all similarly apprenticed to Cannon. Chowbent is not noted for having a tradition of machine-makers, although a travel writer by the name of Dorning Rasbotham described Chowbent in 1787 as a place where 'several families have acquired fortunes by making spinning jennies and carding machines which they send into Scotland, Ireland and different parts of the kingdom. Some of the mechanics do not keep less than 30 journeymen employed in the business' (Lunn 1971, 131).

It was at Chowbent that the Murrays developed their expertise in the manufacture and operation of spinning machinery. Their understanding of the machinery undoubtedly gave them some advantage over other cotton spinners. Indeed, as Chapman commented (1967, 216), Adam and George Murray, together with McConnel and Kennedy, 'gained the leadership of their industry because they combined technical expertise with the flair of the successful entrepreneur.' Moreover, this association of machine-builders-come-cotton spinners appears to have been unique to Lancashire and was a 'combination alien to the Midlands spinning industry' (*ibid*).

Adam Murray completed his apprenticeship in 1787, and wasted little time in establishing a business. By 1790, he had accumulated sufficient capital to relocate to Manchester and invest in land. A deed between Messrs Sedgwick and Murray, dated 24th June 1790, refers to the release in fee of a plot of land in Bengal Street, at its junction with Union Street, subject to a yearly rent of £19.2.1. However, it seems that Adam Murray did not occupy the property until the construction of Old Mill in 1798.

Entries in contemporary commercial trade directories indicate that Adam Murray was engaged primarily in the manufacture of machines during this period. A directory published in 1794, for instance, lists Adam Murray as a 'machine-maker' based at 12 Little Newton Street, Manchester (Scholes 1794, 95). He was clearly successful in this business and, by 1797, had expanded to occupy three factories in Ancoats - on Newton Street, Henry Street and Union Street - where he had machinery and stock insured to the total value of £2,000 (Guildhall MS 7253/32A); the premises on Union Street are referred to as 'Mr Lane's Factory'; this appears in an engraving of the fully developed mill complex that was produced in 1829 and published in 1831 (Plate 3).

The trade directories also provide evidence for Adam Murray being engaged in cotton-spinning within a few years, presumably in the first instance as a side-line occupation to machine-making (Scholes 1797, 90). The implication is that Adam built spinning mules, and that he used his own machines for spinning. It is clear that Adam Murray had decided to specialise in fine spinning, the most profitable branch of the cotton industry.

Cotton-spinning appears to have become Adam Murray's primary occupation rapidly, and George Murray soon joined him in partnership. A directory published in 1800 lists both Adam and George Murray as cotton spinners, again based at 12 Newton Street (Bancks 1800, 33). The same entry appears in a directory published two years later (Dean and Co 1802), implying that the Murrays continued to use Newton Street as their headquarters. A possible explanation for this may reside with the fact that the newly-constructed Old and Decker mills would have taken some time to fill with machinery. By way of illustration, in correspondence with Boulton and Watt on 3rd June 1789, Peter Drinkwater stated that 'the factory at Shudehill has been more than seven years filling with machinery and I am doubtful whether with convenience it could have been filled much sooner'.

The first reference to the Murrays' Mills in the trade directories is in 1804. Curiously, this lists George Murray, but not Adam, as a cotton spinner based at Union Street (Dean and Dean 1804, 118).

Following the death of Adam Murray in 1818, George ran the business until the 1850s. It was then taken over by George's sons, who were responsible for keeping apace with new technological developments, and the remodelling of the mills during the later 19th century.



Plate 3: Murrays' Mill in c 1829, showing 'Mr Lane's Factory' to the right (reproduced from Pyne 1831)

It would seem likely that the enclosed area to the north of the mill was used as a yard area; prior to the completion of the canal in 1804, all raw materials and finished goods would have been carried to and from the site by cart. It is also possible that at least part of the putative yard area contained a reservoir within the position of the canal basin that was later to occupy this portion of the site.

The mill was powered initially by a steam engine supplied by the firm of Boulton and Watt, the leading builders of steam engines at that time. In accordance with an agreement of 1st August 1798, Boulton and Watt undertook to supply the Murrays with a Sun and Planet engine at a cost of £620, with the promise to ‘provide...all necessary directions in writing and with proper plans & drawings for the erecting completing using and working the said Engine in the most useful & beneficial manner’ (MS 3147, 5/167).

Initial drawings for the engine (Plate 5) were supplied in June 1798, although seemingly not finalised until October (MS 3147, 2/10/35). It was to consist of a timber-framed double-acting beam engine of 12hp. The beam was to be constructed of ‘straight grained oak’, measuring 15’ (4.57m) by 12” (305mm) by 18” (457mm), and all other structural components were of deal. The flywheel, seemingly of cast-iron construction, was of 12’ (3.66m) and the power transmission was taken directly from the flywheel shaft. It was intended that the steam for the engine be generated by a single wagon boiler, which is shown on original plans to have been placed adjacent to the engine.

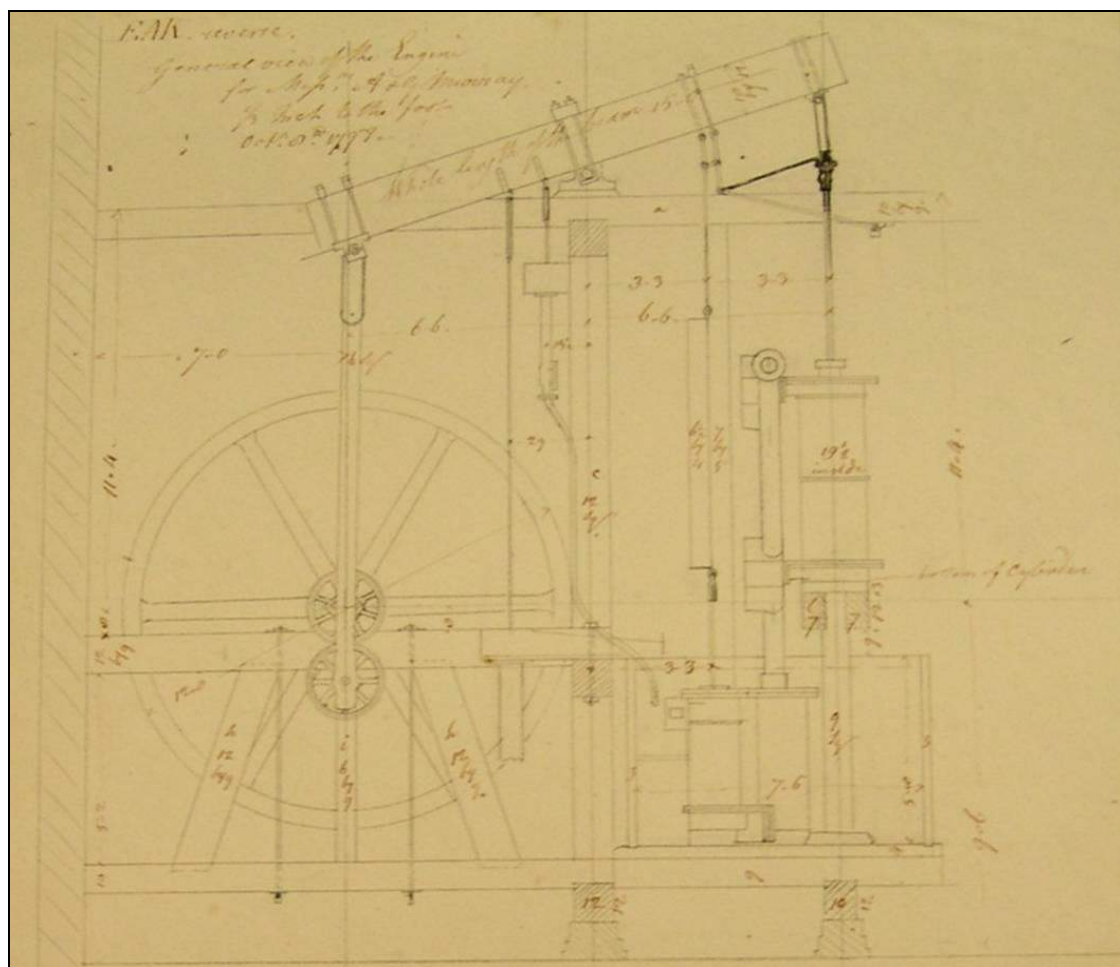


Plate 5: Boulton and Watt drawings for the original engine house of 1798 (MS 3147, 5/167)

A letter from the Murrays, dated 26th September 1798, states: ‘We take the opportunity of our friend, Jn Kennedy, to inform you that the Engine materials sent up per Worthington & Gilbert, are all laid down here in good order agreeable to your letter and have only to beg you send a Man of your approving to put it up. We hope it will be convenient for him to be here on or before the 8th October’ (MS 3147, 3/416/74).

It is not clear from Boulton and Watt’s plans precisely where the first engine was situated, although it may be deduced that its housing was to occupy an area measuring 28’ (8.54m) long, 9’ (2.74m) wide and over 25’ (7.62m) high. The plans also indicate the engine to have been placed across the building, with a chimney to the right, suggesting that it was sited at the eastern end of the mill. Whilst Bancks and Thornton’s map of 1800 (Plate 4) should not be relied upon for precise measurements, it is notable that the single block that represents Old Mill is shown to occupy more than half of the area between Murray Street and Bengal Street, implying an extension to have existed against the eastern gable.

There are very few references within the archive sources that provide information on the configuration of the processing machinery within Old Mill. It is likely that at least some, if not all, of the machinery was built by the Murrays themselves at their Newton Street or Henry Street premises. The yarn manufacturing was not, however, entirely mechanised. An eyewitness account of the mills, written some 32 years after the erection of Old Mill (Allen 1832), noted that the initial preparation of the cotton was undertaken by hand, and there is no reason to doubt that this would have been the case since 1798.

Phase 2 (1801 - c1804), Decker Mill: within three years the Murrays’ had effectively doubled the size of their mill with an extension to the east, referred to as Decker Mill. The economic boom that followed the signing of a peace treaty with France in 1801 was probably a major factor in the expansion of the site at this time. Decker Mill was also built to a height of eight storeys, although, at ten bays long, was slightly shorter than Old Mill. The original 12hp engine that had powered Old Mill was replaced with a 40hp model to drive both mills. The plans for this engine, dated to 1801 (MS 3417, 5/295), depict it as a double-acting beam engine, fitted with a cast-iron beam (Plate 6). The plans also show two flywheels and an associated boiler house fitted with two wagon boilers.

The original engine of 1798 was sold to a Mr Gaskell of Newton Heath (MS 3147/5/167), although prior to this it seems that the Murrays had considered upgrading this engine. Correspondence within the Boulton and Watt Archive, dated to March 1802, includes a request for the quotation for extra materials, such as the cost of pillars, connecting wheels, crank shaft plummer blocks and brapes (*sic*). It also included a request for calculating the difference between a cast-iron beam and a wooden beam for a 40hp engine.

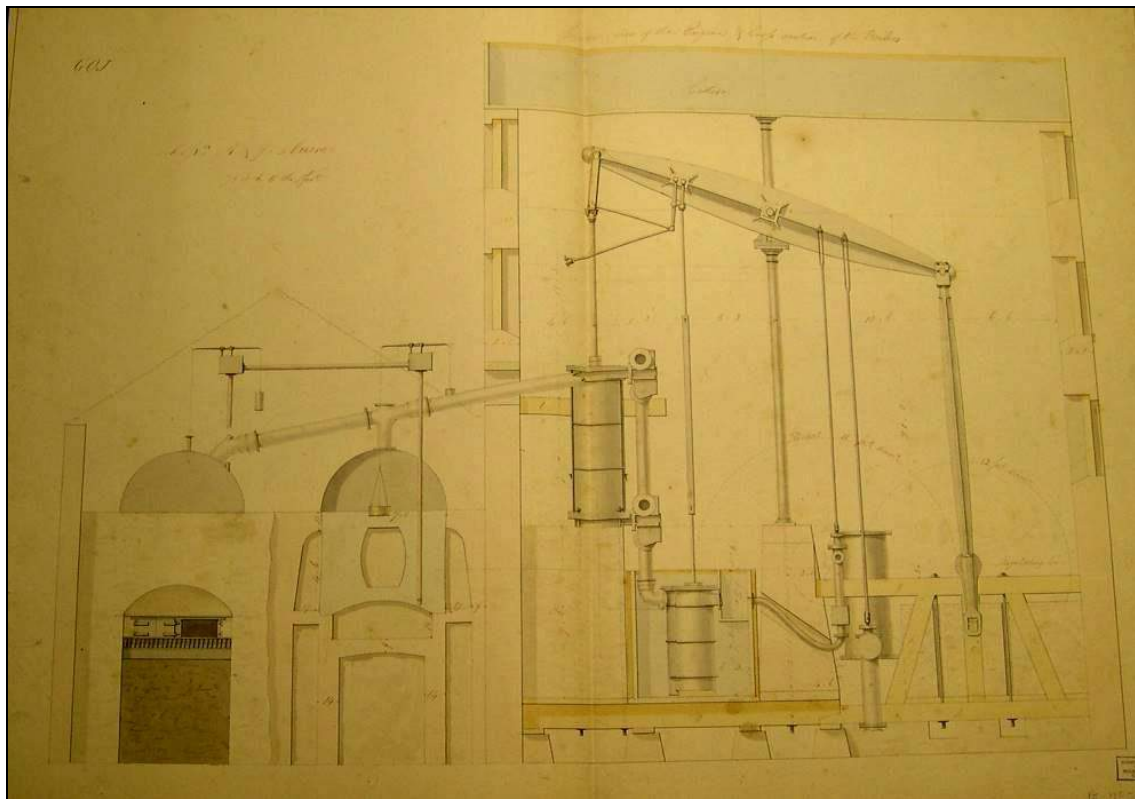


Plate 6: Boulton and Watt cross-section of the 1801 engine and boilers (MS 3147, 5/295)

In June 1802 James Watt junior reported to Matthew Boulton that: ‘A & G Murrays (engine) is working delightfully and they are perfectly pleased and satisfied...They are working about the same quantity of machinery as was driven by their Little Engine & with the same expenditure of Coals. Indeed the Engine is in such order that it starts after the Dinner hour without blowing. They would like to have an Estimate of the Extinguishing apparatus, which I have promised to send with Acct.’ (MS 3147 3/51/13).

Evidently the request for plans for this equipment was answered quickly, and by August 1802 they were drawn up (MS 3147, 3/295) (although one drawing, perhaps mistakenly, is dated February 1802). It is noticeable that it is not until these plans are produced that the position of the engine house is revealed: attached to the north side of the stair tower with a boiler house to the east (Plate 7). The fire-fighting apparatus is shown within the stair tower, giving the impression that its construction was designed to house the fire-fighting equipment. This would suggest that the design of the stair tower was not finalised until 1802, whilst the dates ascribed to the various plans and correspondence demonstrate the engine to have been installed and set to work before fire-fighting equipment had been fitted.

The successful operation of this new engine as reported by James Watt junior did not result in a quick payment by the Murrays. On 27th June 1803, James Watt junior reported to Matthew Boulton: ‘When looking over our Stock of bills here to see what others we might have of a Suspicious Nature, I find another from A & G Murray of £205 drawn by Mitchel & Constable(?) on Smith and Lindsey & Co, which as both the partners have suspended their payments’ (MS 3147, 3/52/18).

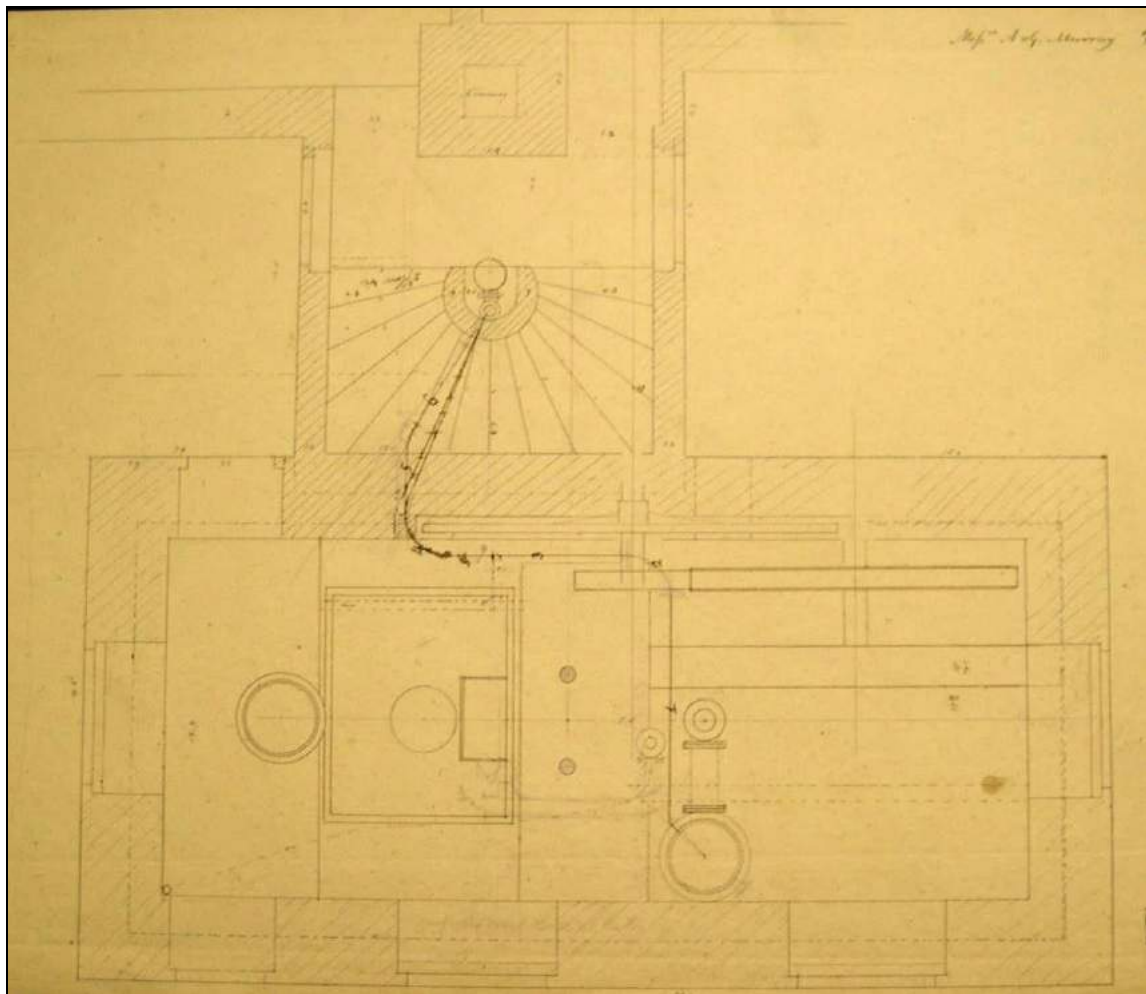


Plate 7: Boulton and Watt plan of 1802 showing the engine house and stair tower (MS 3147, 5/295)

By the 30th June James Watt junior had reached Manchester to pursue the matter and received assurances from George Murray: 'He says he expects to be able to take up both the Bills when due; and should they not be able so to do, he pledges his word to give Security upon the Engine, which as well as the Mill is free from any present incombrances (*sic*)' (MS 3147, 3/52/19).

The Murrays claimed to have debts owed to them amounting to £9000 in Glasgow and a further £6000 of funds available (*ibid*). By August 1803 £300 was paid, and a letter of the 2nd states that there were two further dividends owed of £205 and £500 (MS 3147, 3/52/32) bringing the total costs of the 1801/02 engine to £1005. After some further negotiation £205 of the remaining debt seems to have been paid in late October 1803 (MS 3147, 3/41/28). It is not clear when the rest was paid but the Murray's relationship with Boulton and Watt was clearly not too badly affected as they are recorded as having taken delivery of a pinion in that year (MS 3147, 3/44/12).

Phase 3 (c 1804 - c1817), Competing the courtyard: between c 1804 and 1806 the Murray Street Block, Bengal Street Block, New Mill and its associated engine and boiler houses, and the canal basin and link with the Rochdale Canal were all constructed. Ashton's 'Plan of Manchester and Salford', published in 1804, shows the canal to have been completed by this date. The Murrays' site, however, is depicted to comprise only Old Mill, although it is possible that the site had not been re-surveyed since Banks and Thornton's map of 1800. A plan in the Boulton and Watt Archive, dated 1805/06 (MS 3147, 5/364) illustrates the new additions to have formed a quadrangle arrangement enclosing a central yard, with an entrance off Murray Street providing the sole access (Plate 8). The result was, by contemporary standards, an enormous cotton-spinning complex with an unprecedented 84,000 mule spindles and 1,300 operatives (Williams with Farnie 1992, 160).

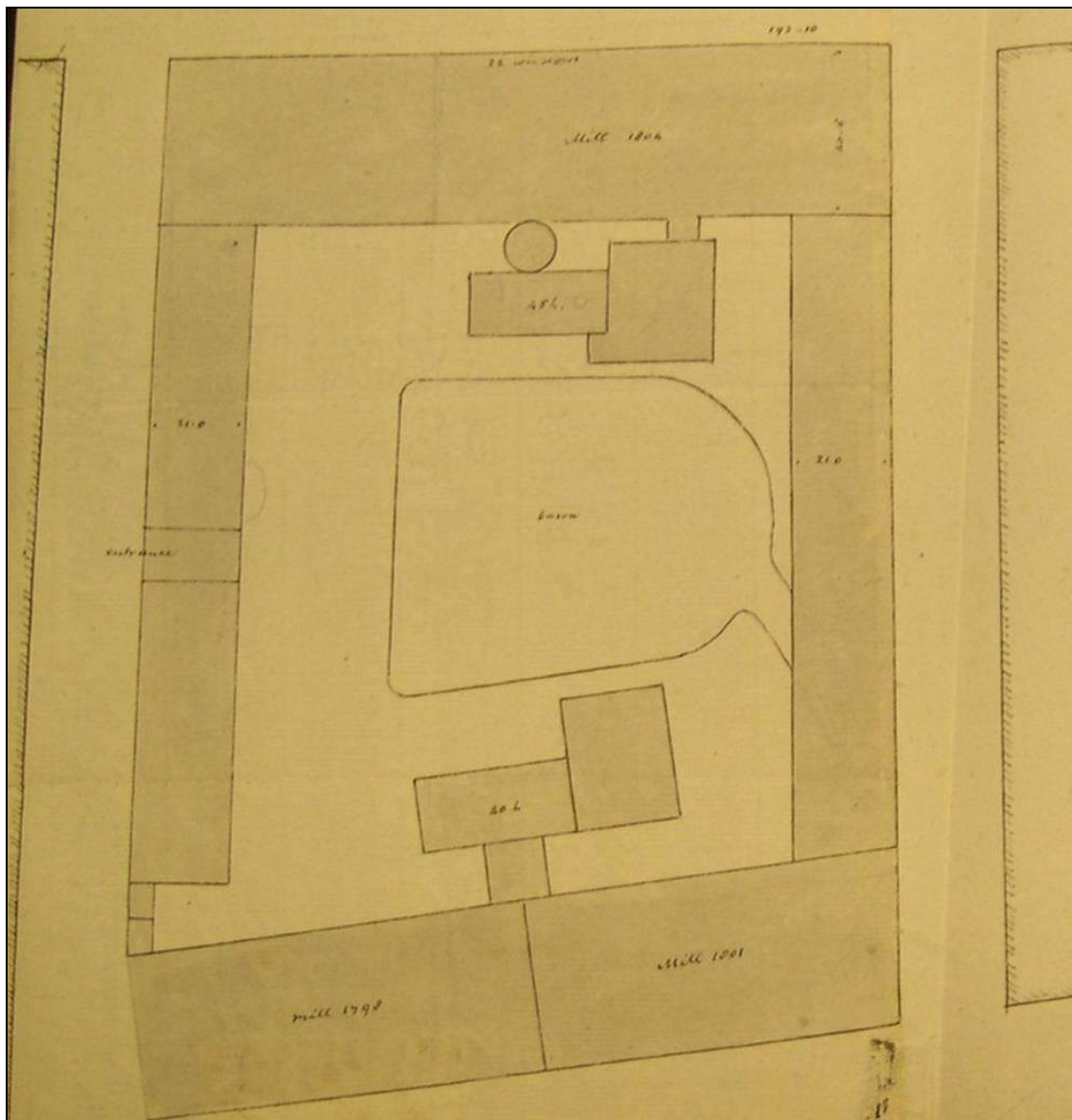


Plate 8: Site plan of Murray's Mills undated but probably c 1806 (MS 3147, 5/364)

This expansion was associated with the great increase in yarn exports during this period. In particular, the Murrays had established a powerful hold over the Scottish fine yarn market by 1808. It has been suggested that this was a direct result of the high quality of the Murrays' product, which probably reflected the superiority of their machinery (Lee 1972). A valuation of factories in Manchester made in August 1811 assessed Murray's factory at £20,455.16.0, which was the highest valuation in the given list (Daniels 1915). The same valuation assessed McConnell and Kennedy's concern at £18,152.14.0, whilst amongst the other 64 cotton factories thus assessed for taxation, the highest valuation was £10,130.8.0 (McConnell and Kennedy MSS, Inventory). A subsequent assessment, compiled only seven years later, valued the mills at £59,000.

The Rochdale Canal was vital to the site, and the incorporation of a canal basin within the enclosed courtyard of the mill complex was a unique innovation that contributed greatly to the success of the spinning enterprise. Primarily, the canal facilitated the importation of raw materials and the export of finished goods; a visitor to the site in 1832 noted the basin and observed boats 'discharging their freights of raw cotton and coal' and 'receiving the packages of yarn' (Allen 1832, 129). Additionally, the basin almost certainly provided the water required by the steam engine boilers.

Access to the courtyard basin from the canal was via the tunnel below the Bengal Street Block. Passage through the tunnel would have been restricted to narrow boats, such as those that plied the Ashton-under-Lyne Canal, which connected Manchester with the coalfields of Oldham, Ashton, Duckinfield, Hyde, Newton and Denton. The dimensions of the tunnel indicate it to have been a 'legging tunnel'; height restrictions and the absence of a towpath would have left the boat crews with no alternative but to haul the laden vessels by legging.

There is no reference to the construction or use of the canal basin in any of the former canal company's records, implying that it was entirely the responsibility of the Murrays, although they would presumably have been liable to an annual fee for the provision of water.

Phase 4 (c 1817 - mid-19th century), Remodelling: a plan of c 1822 (Plate 9) shows the Murrays' Mills complex at what could be considered the peak of its early growth. It shows Old and Decker mills and New Mill as consisting of eight stories with staircases (noted to be of the same height in the case of New Mill), the engine houses for Old and Decker mills and New Mill, with boilers to the east. Both the Murray Street Block and Bengal Street Block are shown as factories of four stories. A number of smaller structures are also shown, including an oil house and shed attached to the Murray Street Block, a waste room attached to the Old Mill engine house, and the entrance to the carding room on the west side of New Mill. There is, in addition, a gasometer house across Bengal Street next to Little Mill.

Important modifications to the mills were undertaken some time during 1817 (but presumably before Adam Murray's death c 1818), when William Fairbairn, and his partner James Lillie, overhauled the power transmission systems. Samuel Smiles (largely quoting from Fairbairn himself (Pole 1877)) describes the process of their commission by the Murrays:

'Mr Fairbairn called upon the Messrs. Adam and George Murray... Mr Adam Murray received him kindly, heard his explanations, and invited him to call on the following day with his partner. The manufacturer must have been favourably impressed by his interview, for next day, when Fairbairn and Lillie called, he took them over to his mill, and asked whether they felt themselves competent to renew with horizontal cross-shafts the whole of the work by which the mule-spinning machinery was turned. This was a formidable enterprise for a young firm without capital and almost without plant to undertake; but they had confidence in themselves and boldly replied that they were willing and able to execute the work. It may be sufficient to state that by working late and early – from five in the morning until 9 at night for a considerable period – they succeeded in completing the alterations within the time specified, and to Mr Murray's entire satisfaction.' (Smiles 1876, 315-6).

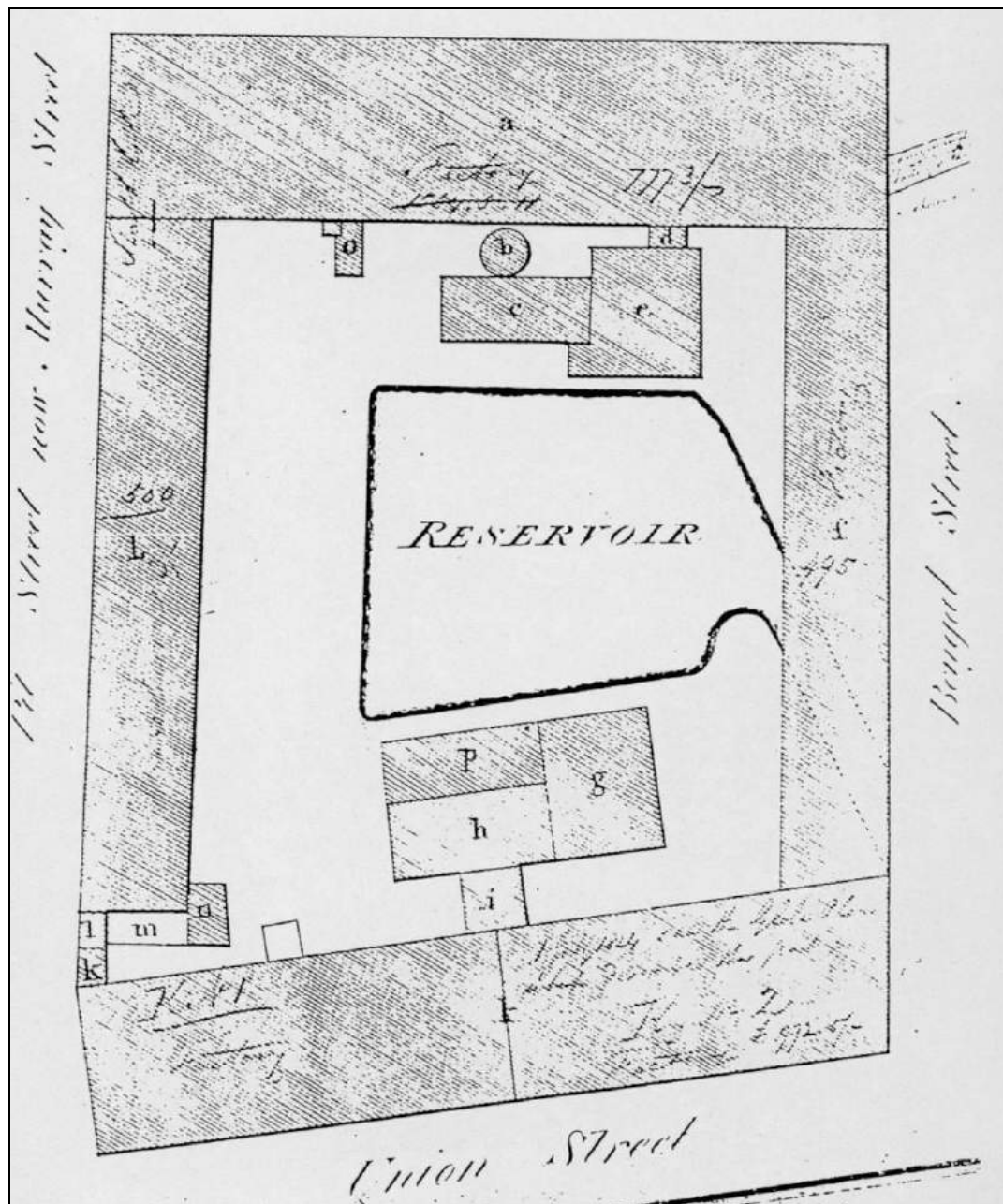


Plate 9: Plan of Murray's Mills produced in c 1822

This account of Fairbairn and Lillie's work also provides a description of the working of a cotton mill, although not necessarily Murrays, in the early part of the 19th century: 'They found a machinery driven by large square cast-iron shafts, on which huge wooden drums, some of them as much as four feet in diameter, revolved at the rate of about forty revolutions a minute; and the couplings were so badly fitted that they might be heard creaking and groaning a long way off. The speeds of the driving-shafts were mostly got up by a series of straps and counter drums, which not only crowded the room, but seriously obstructed the light where most required for conducting the delicate operations of the different machines. Another serious defect lay in the construction of the shafts, and in the mode of fixing the couplings, which were constantly giving way, so that a week seldom passed without one or more break-downs. The repairs were usually made on Sundays, which were the millwrights' hardest working days... but when trade was good, every consideration was made to give way to the uninterrupted running of the mills during the rest of the week.' (Smiles 1876, 323).

Fairbairn's modifications addressed the problems that existed in the operation of the mills, and his work for the Murray's, and also at McConnel and Kennedy's mills, enabled him to engineer suitable solutions: 'the introduction of lighter shafts driven at double or treble the velocity, smaller drums to drive the machinery, and the use of wrought-iron wherever practicable, because of its greater lightness and strength compared with wood. He also provided for the simplification of the hangers and fixings by which the shafting was supported, and introduced the "half-lap coupling" so well known to millwrights and engineers.' (*op cit*, 324).

The exact details of Fairbairn and Lillie's modifications to Murrays' Mills are not outlined in any documentary sources, although Fairbairn published an account of his work carried out subsequently at McConnel and Kennedy's mills, whereby rows of columns supporting iron beams and brick ceilings were moved in order to accommodate larger mules (Fairbairn 1866).

It is considered likely that some of the columns currently within Old and Decker mills were used as conduits for gas lighting, and it seems possible that such a system was installed by Fairbairn and Lillie. Hollow columns were certainly used elsewhere to circulate gas around a building, as at Chorlton New Mill and Albion Mill in Manchester (Williams with Farnie 1992), although the system installed at McConnel Kennedy Mill in 1809 (MS 3147, 3/478/19; MS 3147, 3/478/21) appears to have been routed independently. This system consisted of ¾ inch pipes, with nozzles and hanging burners, attached to the beams and fed by a reservoir inside a gasometer house.

Notes by James Watt junior with reference to Birley's mill in Chorlton in 1806 provide some idea of the gas systems installed during this period. It seems that at this mill, two gas lights to each mule were required with two mule rooms per floor (Clark 1978, 212).

Gas lighting had certainly been installed in Murrays' Mills by 1819, as it is referred to specifically in an insurance policy of that date (Sun ins. pol. 945442/11937). The plan of c 1822 depicts a gasometer building on the east side of Bengal Street, south of Little Mill. The large size of the gasometer house suggests that it supplied the whole of the Murrays' complex, possibly via a tunnel beneath Bengal Street. Further evidence for the use of gas lighting is provided by George Murray's response to questions from The Central Board of Commissioners to Manufacturers in 1834, in which he stated that 'during the winter months our works are lighted with gas in the morning and evening' (PP(HC) 1834 (167) XX).

An eyewitness account written in 1832 refers to the method of heating the rooms within Murrays' Mills: 'the apartments are all warmed by steam from the boilers of the engine, conducted through cast-iron pipes, in some cases arranged near the floor, with the design of distributing the heat more uniformly' (Allen 1832, 130). Similarly, George Murray stated to the Central Board of Commissioners to Manufacturers in 1834 that 'we endeavour to keep the rooms at 75° Fahrenheit; our directions are that no steam be put into the mills if the rooms are at that temperature' (PP(HC) 1834 (167) XX).

It was during this period that an engraving by McGahey after J Harwood first appeared in George Pyne's *Lancashire Illustrated in a Series of Views*, published in 1831 (Plate 3). It depicts Old and Decker mills with eight stories (seven and a basement) and what appears to be a parapet around the roof, and the Bengal Street Block with six storeys. The entrance to the canal tunnel is also shown.

Some details of the site's infrastructure in 1833 are provided by George Murray's answers to a Parliamentary Commission questionnaire (PP(HC) 1833 (450) XX). In this document, George Murray stated that most of the spinning mules were of 324 spindles. During the previous year, an eyewitness noted that the Murrays' Mills contained some 90,000 spindles (Allen 1832), which equates to approximately 278 spinning mules. The account also states that the 'labour of three persons at a mule of 300 spindles is required' (*op cit*, 130). Similarly, Rashleigh (1844) stated that in 1829, the Murrays' complex contained 90,936 spindles, and employed a total of 147 spinners. By 1841, however, the number of spindles had been increased to 100,296 and the number of spinners to operate them decreased to 62 (*ibid*). By way of comparison, McConnel Kennedy had 200 spinners operating 126,816 spindles in 1829, which changed to 87 spinners operating 132,192 spindles by 1841. These figures clearly indicate great improvements to the spinning machines installed within the mills during this period.

The Ordnance Survey 60": 1 mile map, published in 1849, shows some modifications to the site, including extensions to the east and north of the engine and boiler houses that served Old and Decker mills, and a stair tower added to the Bengal Street Block. This growth was probably in response to an increase in trade brought about by the influence of the end of the Napoleonic Wars and the expansion of the Nottingham lace market, which many of the larger Manchester fine cotton spinners benefited from. The Murrays had been preparing twist for this lucrative market since the 1830s (Lee 1972), and was probably the main rationale for constructing Doubling Mill and Fireproof Mill during the early 1840s.

Phase 5 (mid-19th century - 1898), Enlargement: following the death of George Murray in c 1855, George's sons, Benjamin and James managed the company. The details of changes wrought to the site during their period of management are not well documented, although the Ordnance Survey 1:500 Town Plan of 1891 depicts a new engine and boiler house and chimney to have been erected adjacent to Old and Decker mills (Plate 10). This map also shows clearly the route of the flue to the chimney to lie against the southern elevation of the engine house.

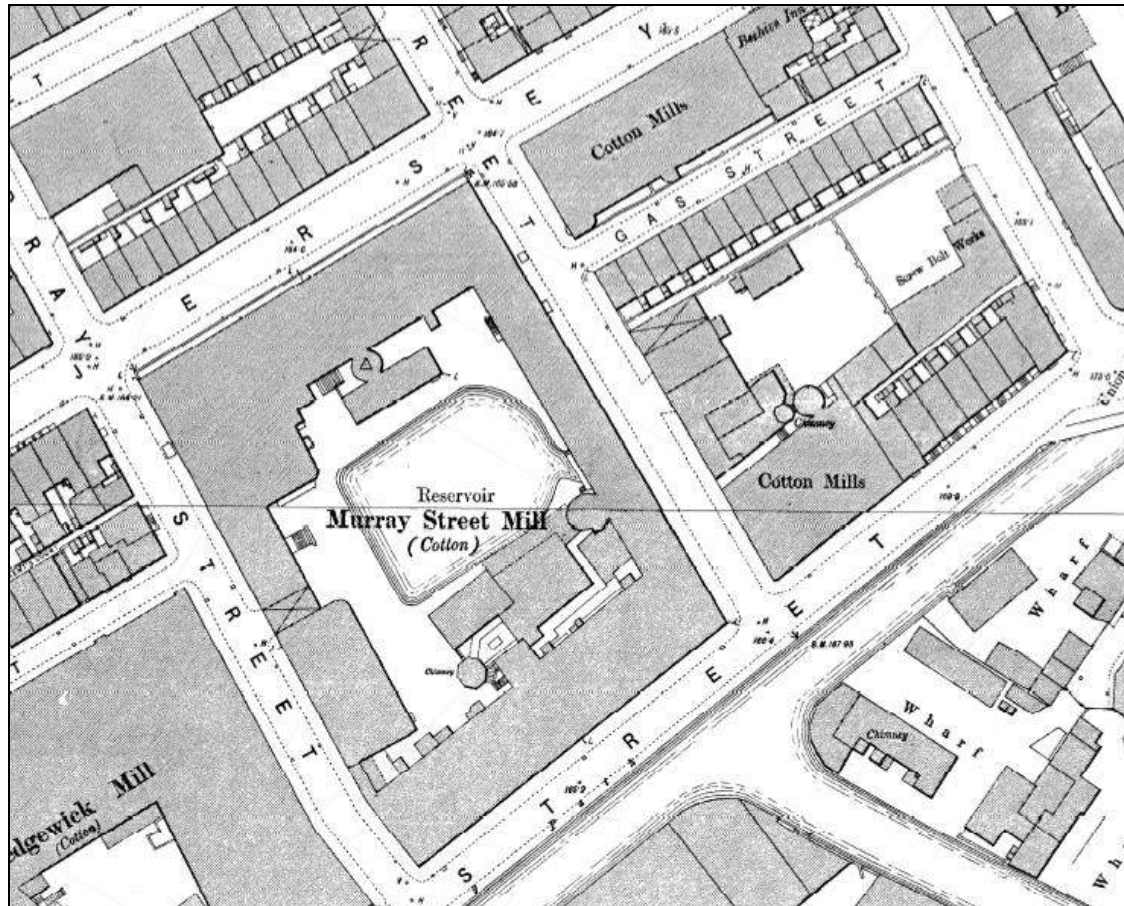


Plate 10: Extract from the Ordnance Survey 1:500 Town Plan of 1891

The updating of the power systems required considerable remodelling of this part of the site, including the erection of a detached chimney. Octagonal-shaped chimneys of this type became common during the 1860s, although at this date were often mounted on a square plinth; this trend became less common towards the end of the century. The chimney built for the Atlas No 4 mill in Bolton, erected after 1875, is a good parallel to the one at Murrays. There are no references within the archive sources to provide any further details, so the precise date for the construction of these buildings remains uncertain. It has been suggested that the size of the engine house and the brick embellishment to the eaves suggest a date of around 1860-70 (RCHME and GMAU 1989, 33). A lease of 1891 refers to the erection of a new boiler house between 1887-91, although the location of this structure is not specified and may relate to the plot on the eastern side of Bengel Street.

In 1878, the company changed its name to A & G Murray Limited. Ten years later the firm was described as ‘one of the oldest and most important in this country’...a large and increasing concern’. Furthermore, ‘during recent years the mills and machinery have undergone a complete remodelling, and the internal arrangements are upon the most modern and approved principle’ (History Publishing Company 1888, 89). Indeed, the ability of the firm to keep apace with modern technological developments was cited as a primary reason for the continued success of the firm, allowing it to ‘forge ahead of many more modern and recently constructed establishments’ (*ibid*).

These sentiments were reiterated in 1895, when it was reported that ‘in every respect the firm have kept pace with the times, and have constantly shown themselves among the first to adopt new and advanced methods...the firm’s mills are among the largest and best in the district and are fully equipped for exceptionally extensive operations in fine spinning, have 120,000 spindles, with complete preparing plant and employing about 500 hands...’ (Men of the Period: Lancashire 1895, 59). At this time, George R Murray (a grandson of George Murray) managed the company together with Herbert Dixon.

Phase 6 (1898 - c1948), Fine Cotton Spinners’ and Doublers’ Association: in 1898, the Fine Cotton Spinners’ and Doublers’ Association Limited was formed, comprising a total of 31 concerns with a share capital of £4,000,000 and an issue of debenture stock of £2,000,000. A & G Murray, together with the firm of McConnel and Kennedy, were amongst the original firms to amalgamate.

By 1909 the Association had expanded to include 50 businesses, controlling 4,000,000 spindles (Fine Cotton Spinners’ and Doublers’ Association Limited 1909). At this time, A & G Murray also had premises at Cross Heath, Staffordshire, which are depicted as an inset on an engraving of the site published in 1909 (Plate 11). Documents held by the Greater Manchester County Record Office, which concern the installation of gas meters at Cross Heath in 1955 (B/CTLD/1/48), confirm A & G Murrays’ ownership of these premises. Subsequent correspondence, dated October 1965, implies that this branch of the firm outlived A & G Murrays’ occupation of their Ancoats premises.

The engraving of 1909 features the north-facing elevation of New Mill, but also shows the Murray Street Block to its original height of four storeys and part of Old Mill. The stair tower that served Old and Decker mills is depicted to be taller than the mill buildings, and another tower at the west end (probably a toilet block) may be discerned.

A useful source of information for the development of the site during the second decade of the 20th century is provided by a deposited building plan of 1926 (Plate 12). This shows the electric sub-station adjacent to the Bengal Street Block, and labels the economiser, which seemingly required a remodelling of the route of the flue to the chimney.

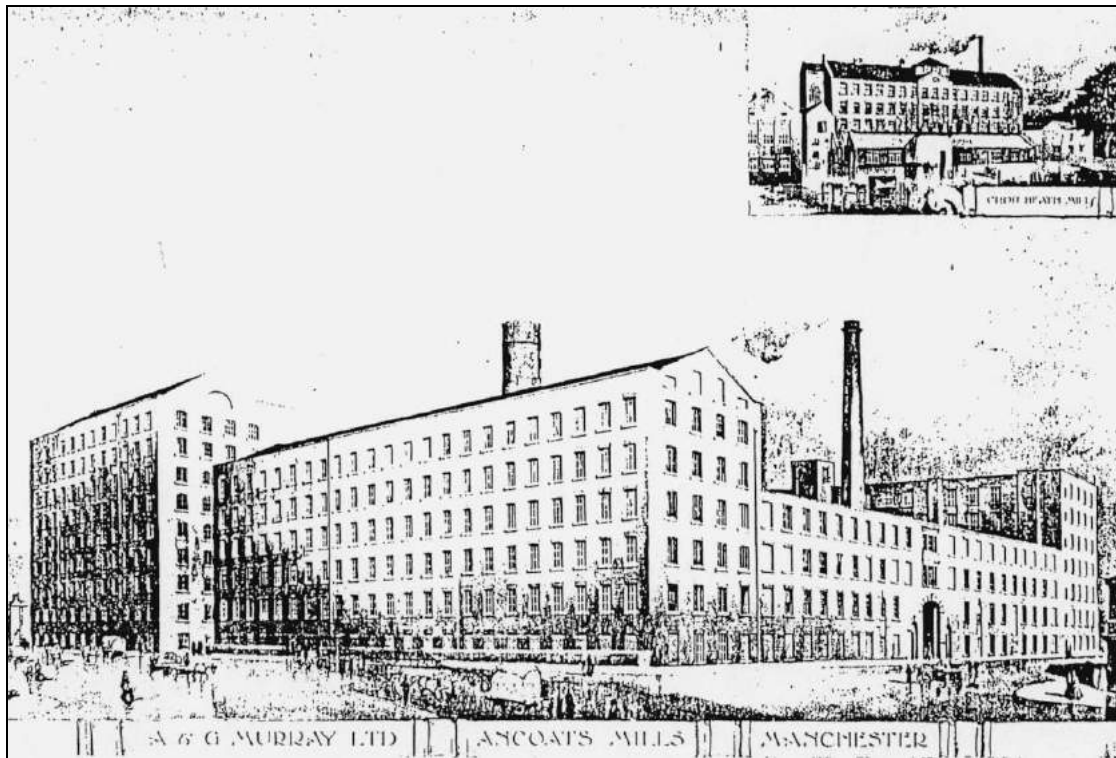


Plate 11: A view of Murrays Mills from the north-west in 1909 (from Fine Cotton Spinner and Doublers Association Limited 1909)

Modifications to the mill complex during this period included the installation of electric motor drives. Documentary sources have not furnished a date for the introduction of the electric drive system, although the sequence of building control plans held by Manchester City Council indicate that the only electric sub-station to have been placed on the site was added between 1905 and 1926. This was added to the west side of the Bengal Street Block, and presumably served the entire site.

Some time after this date a larger toilet block was added to Old and Decker mills; this larger toilet block is certainly in place by 1926 (Manchester City Council Planning Department 1926; Plate 12). The plan of 1926 also show a small outshut to the east of this, as well as a further structures to the west, which certainly correspond to the smaller toilet tower on the later plans.

It was during this period that the canal basin and link arm went out of use, and were almost entirely filled in. The exact date at which this happened is not known. The basin is still present on the Ordnance Survey map of 1893, and the link to the canal is shown on a plan of the site, dated March 1902 (MC 3834M 892), although the basin appears to have been filled in. Neither elements are shown on the Ordnance Survey map of 1911. In 1946, the Fine Cotton Spinners' and Doublers' Association Limited was re-named as the Fine Spinners' and Doublers' Limited.

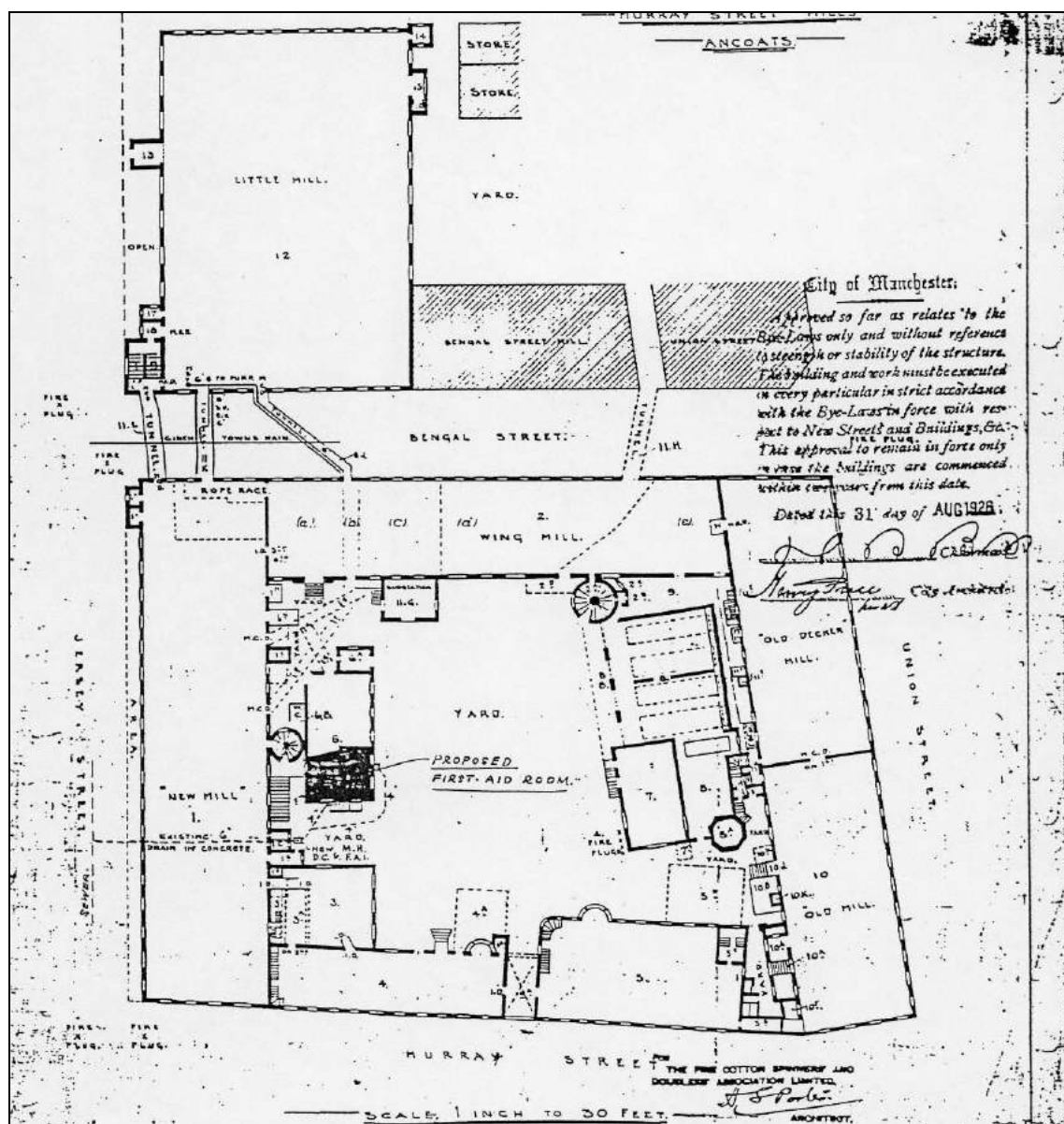


Plate 12: A deposited building plan of the Murrays' Mills dated 1926

Phase 7 (c 1948 - 1950s), The End of Spinning: cotton production seems to have ended between 1948 and 1960, when the Fine Spinners' and Doublers' Limited conveyed the mill complex to two or more separate companies. Old and Decker mills appear to have been the first elements of the complex to have been sold. The deed of conveyance, dated 6th February 1948, was between the Fine Spinners' and Doublers' Limited and Messrs F and SS Hurst, who purchased the two mills for £5,800.

During the same year, a lift shaft was added to Decker Mill, loading doors were constructed on the ground floor, and strengthening work was carried out (Manchester City Council Building Control Department 1948). It was evidently still used for clothing manufacture as Ordnance Survey maps demonstrate (1960 1:2500 Series, Sheet SJ 85 98).

An air-raid shelter was built to the east of the Murray Street Block, north of the main entrance. The date of construction is not known, although it has been suggested to correspond to the Second World War (Donald Insall Associates and Structural Perspectives 2002, 47). However, this structure is not shown on an aerial photograph of 1948 (541/25/16 May 48), making its date later still. During the 1950s, it was used briefly by the BBC.

Phase 8 (post-1950s): during the second half of the 20th century the site was used for a variety of functions. Limited strengthening work was apparently carried out in Old and Decker mills in and improvements to sanitation were also carried out relatively late in the 20th century (Manchester City Council Building Control Department 1959; 1961).

The 1966 revision of Goad's Insurance Plan labels Old and Decker mills as various clothing factories and warehouse, with the basement being used as a carpet warehouse. The engine house was noted to be vacant at this time, although a 'coal pile' is marked to lie adjacent to the Bengal Street Block stair tower, suggesting that the engine had not long been out of service.

The last part of the 20th century was particularly unkind to the Murrays' Mills site. The boiler house for the Old and Decker mills engine house was still standing in 1985, but had been demolished by 1990 (RCHME and GMAU 1989, 18). The heavily altered Bengal Street Block was also destroyed in a fire in 1999, leaving only the stub walls at the south end.

4. *Historic Building Investigation*

4.1 *Introduction*

The area of the Murrays' Mills complex included within this project lie within an irregular, sub-rectangular area bounded by Redhill Street (south), Murray Street (west), Jersey Street (north) and Bengal Street (east). Elements of the complex survive to the east of Bengal Street, but are not included within this project. For ease of nomenclature, the term 'Murrays' complex' only includes those elements within the present study area (Figure 2). Within this area survive the remains of six major structures, of differing dates, several of which contain further elements:

- Old and Decker mills
- Old/Decker Mill Engine House
- New Mill
- New Mill Engine House
- Murray Street Block
- Bengal Street Block

4.2 *General Description*

Historically, the Murrays' Mills complex was bounded by the four main mill structures; Old and Decker mills (one structure) along the southern boundary, New Mill, along the northern boundary, and the Murray Street and Bengal Street blocks along the western and eastern site boundaries. Within the courtyard formed by these structures was a canal basin, now infilled. The two surviving engine houses were located on either side of the canal basin. Entrance to the site for pedestrians and road traffic was via the Murray Street Block only, whilst canal access was afforded via a tunnel under the Bengal Street Block from the Rochdale Canal, located to the south of Redhill Street.

All the structures of the Murrays' complex are of brick construction. Within the earlier fabric, the bricks appear locally-made, mould-thrown brick, originally bonded with a pale lime and sand mortar. Brick dimensions were generally 9" by 3⁷/₈" by 2³/₄" (229mm x 98mm x 70mm), slightly less deep than typical bricks of the period, which tended to have a depth of between 4¹/₄" to 4¹/₂" (108mm to 114mm (Harley 1974, 76)). External elevations, on the street frontages, were constructed in Flemish bond, whilst the courtyard elevations were in English Garden Wall bond, with rows of headers every five courses. Internal elevations were also roughly constructed in English Garden Wall bond. Later construction reflects the improvements in brick manufacturing, with the use of extruded brick.

The present layout of the site retains much of the early fabric, with the exception of the Bengal Street Block, which was demolished following fire damage in 1999.

4.3 *Old and Decker Mills*

4.3.1 *Introduction*

Old and Decker mills are orientated approximately east/west along Redhill Street (formerly Union Street) and face south onto the Rochdale Canal. They form a single structure, which presently comprises six floors and a basement (Plate 13). The original part of the structure, and indeed the site, is Old Mill, which is rectangular in plan, and comprises the western 11 bays of the present building. The ten-bay Decker Mill was then added to the eastern end, infilling the area to Bengal Street, which is not parallel to Redhill Street, aligned slightly to the north-east. Therefore, the eastern bay of Decker Mill is wider on the northern side, to maximise the space to the street frontage. Access to the expanded building was via a central, square plan, external stair tower, containing a spiral stair, affording access to Old and Decker mills either side of the central dividing wall. A multi-phase toilet tower also projects from the western end of the north elevation, and the ruinous remains of the later Bengal Street Block butt the eastern end of the north elevation. Two rectangular heating towers also project from the north elevation, spaced at approximately $\frac{1}{3}$ distances from the ends of Old and Decker mills.



Plate 13: View of Old and Decker Mill, overlooking the Rochdale Canal

The principal fabric is brick, faced in Flemish bond on the external south (front) elevation and English Garden Wall bond on the external north (courtyard) elevation. The internal walls are also generally faced in English Garden Wall bond. The hipped roof comprises a timber structure, with iron fixings, covered with a mix of Welsh and Cumbrian slate.

On each floor the ceiling is generally supported by transverse timber beams, each supported by a single row of hollow, cylindrical cast-iron columns, mostly along the central line of the building, but with some offset slightly to the north or south. These columns inter-link between floors, creating continuous pipes from basement to attic, seemingly as part of the former gas lighting system. Span brackets, supporting the beams, are also attached to the columns.

The flooring consists of multiple layers of timber boards, some tongue-and-grooved, over east/west-aligned joists. These are undersealed with a mixture of modern board, lathe and plaster and metal sheets, which formed part of the fireproofing of the mill. There is also water piping for the latest sprinkler system attached across the ceilings, as well as electric cabling ducts, wiring and lights.

The building is a multi-phase structure, with the fabric being altered as technology and demand increased throughout the 19th century. The latter phases demonstrate the decline of the cotton industry from the mid-20th century, and the transition of the structure from a working spinning mill into a building containing several small manufacturing companies, and finally to an abandoned structure. The present structure retains information within the fabric, which demonstrates the rise and fall of the industrialised cotton industry over a period of nearly 200 years.

4.3.2 Phase 1 (1798 - 1801)

Old Mill retains much of its original fabric shell. It was built, in 1798, of locally-made, mould-thrown brick, by the construction of 3' (0.92m) thick, 8-skin walls, bonded in pale lime and sand mortar. The southern and western external elevations were faced in Flemish bond, with different colour variations apparently being chosen to emphasise the pattern. The northern and eastern elevations were constructed in English Garden Wall bond, typically with rows of headers every five courses. Each of the 11 bays has a window, 4' (1.22m) wide, and 5'6" (1.70m) high to the crown of a shallow brick, single-skin segmental arch. Each has a slightly projecting sandstone sill, which quite possibly relates to the earliest phase. Nothing survives of the original window frames.

Internally, the bays were divided by large-scantling, chamfered timber beams. These were of Northern European softwood, and 25 survive within the main floors, with several exhibiting Baltic timber shipping marks (Plate 14). Those within the eastern bay all have narrower chamfers, and are of slightly different scantling, but as several exhibit evidence of the original line-shafting, it would appear that they are original.



Plate 14: Example of a Baltic timber mark in Old Mill

The width of the bays within Old Mill varies quite markedly. Although many of the bays have replaced beams, these have been inserted into the original positions. The end bays are significantly wider, with the eastern bay by far the widest, suggesting that the original access to each floor had been via this bay. The variance in width of the other bays (maximum of 1' (0.30m) between adjacent bays) probably relates to inconsistencies during construction, rather than any design feature of the structure. The bay widths are consistent vertically through the building.

The original columns supporting the large timber beams have been replaced. However, several compression marks and scars were observed on the soffits of the beams, which appear to represent the positions of the original columns (Plate 15). It is considered probable that the original structure had two rows of columns, positioned approximately 13' (3.96m) from each of the long-walls. The earliest surviving columns within the Murrays' Mills complex, those within the upper floor of New Mill and the Murray Street Block, are all slender, solid cruciform section, cast-iron columns, typical of the period (Falconer 2001, 19f). It is most probable that those originally in Old Mill were of the same style, although there is no surviving physical evidence to confirm this. There is similarly no evidence for the use of cast-iron 'crush boxes' at the column head, as in New Mill, and it is most likely that the column heads were capped with cast-iron pads attached to the beam soffits, as in the Murray Street Block.



Plate 15: Rebate denoting original column position, second floor, Old Mill

The internal apertures of the windows within each bay are also of differing proportions, probably signifying the speed of construction and functionality of the structure, rather than it having a need of internal symmetry to match the visible exterior. Standard internal window aperture widths range from 58½” (1.49m) wide to 64” (1.63m) wide, with smaller 31” (0.79m) windows to the east of the heating tower and original toilet block in the north elevation. The internal window sills are all formed of convex arched brick work, starting 2’ (0.61m) above the floor.

The end bays of the mill also had similar windows, four on each floor, with the exception of the basement, ground, and first floors of the eastern end. This signifies the position of the first engine house, which housed the timber-framed, double acting 12hp Sun and Planet beam engine supplied by Boulton and Watt. The engine house would appear to have been flush with the northern end of the mill, side on to Union Street, with the boiler house to the east (Plate 16). The Boulton and Watt plans for this engine show a flue leading to the chimney, heading south from the boiler. This suggests that the original chimney was located to the south of the engine house, possibly flush with Union Street. Access into the engine house was provided from the ground floor of the mill, via the northern of two brick-arched, 2’8” (0.81m) wide apertures set 10’ (3.05m) apart. The southern aperture has a more rounded segmental arch, and what appears to be a broken out sill, just above floor level. This probably represents a window positioned immediately south of the 28’ (8.54m) wide engine house.

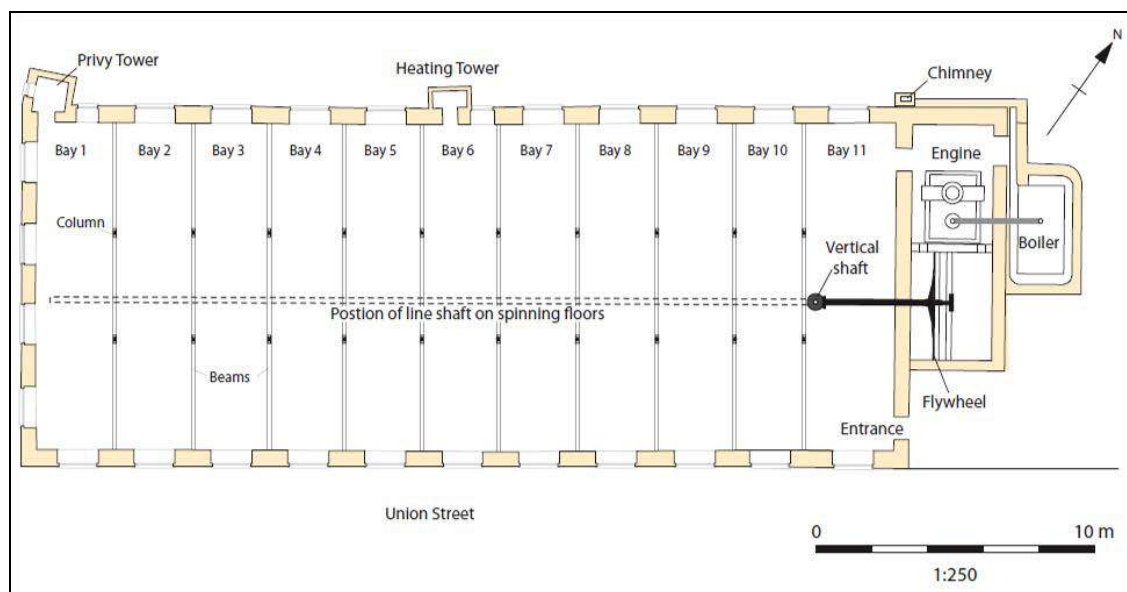


Plate 16: Plan of Old Mill, showing the postulated position of the original steam-power plant

Semi-circular rebates for horizontal line-shafts in the beams of Bays 9 and 10 on the fourth and rectangular rebates in the beam of Bay 9 on the third and fifth floors, suggest that the line-shaft was located 17'4" (5.30m) from the south elevation, 21' (6.41m) from the northern elevation, as shown on the Boulton and Watt plan.

Two doorways were observed in the east elevation of Old Mill, within the basement. The northern door is heavily obscured, but appeared to be 2'8" (0.81m) wide and set 3' (0.92m) from the north elevation. It has a timber lintel on the internal side and appears to have led into the engine house. The southern door, which has a shallow-curved sandstone lintel, is of similar width, and lies 16" (0.4m) from the south elevation. It is possible that this doorway represents the original access into the mill, probably from steps down from external ground level. No evidence for an alternative original doorway into the mill was observed during the survey. Similarly, no physical evidence for the position of the original stairs between the floors survives.

A small 4' (1.22m) square tower, representing a toilet tower, projects from the western end of the north elevation, on an angle to the north-east, following the line of what is now Murray Street. This has a narrower 3'6" (1.07m) wide window aperture on the eastern side, and a narrow 2'4" (0.71m) wide doorway, both of which appear to be original features.

In the central bay (Bay 6) of the north elevation is an 8' (2.44m) wide, rectangular tower, projecting 4' (1.22m) from the external elevation. Internally it typically projects one skin of bricks (4½" (0.11m)) from the wall face in the upper floors, but is flush with the wall face from the second floor. The tower forms part of the original construction of the mill, and is a heating tower, designed to create a warm and humid atmosphere on the spinning floors, to reduce breakage of the cotton. On the internal face of the tower are floor level recesses, 2½" (0.06m) deep, 20" (0.51m) wide, and 32" (0.81m) high with timber lintels.

Many retain a 13" (0.33m) high, top-hung timber vent at the base, some with evidence of metal sheet coverings. In the basement, a 9" (0.23m) wide angled timber vent was also observed at beam level within the tower, and it appears likely that these have been removed elsewhere.

The height of the mill had been reduced by a single storey by the early 20th century, as shown on a photograph taken in 1903 (MCL 128947), but the earlier trusses were re-used. The fact that the trusses differ slightly between Old and Decker mills, would suggest that they were constructed at different times, but within a short period of time, as the type of trusses remained the same. This fits well with construction dates for the two mills only four years apart.

Internally, the roof comprises queen post trusses (Plate 17) with upper king posts above the straining beam, with additional members under the principal rafters, braced to the jowled queen posts. The king posts have jowled bases, braced to the principal rafters and clasp the narrow board ridge purlins. The queen posts are strapped to both the principal rafters and the tie-beams with iron stirrups held in place with gibs and cotters, with additional timber wedges driven into the underside of the mortices within the tie-beams. Several of the trusses, purlins and rafters bear Baltic timber shipping marks, showing that all the main timbers within the mill were from a similar source.



Plate 17: The roof space in Old Mill prior to the refurbishment in 2005

Most of the trusses bear chiselled assembly marks on the eastern face, most commonly in the form of Roman numerals, but occasionally letters (Plate 18). On several trusses the assembly marks differ between the northern and southern sides, always between I and II. It is interesting that several different marking systems appear to have been employed simultaneously within the roof of one structure, although it quite probably just denotes the work of different carpenters.



Plate 18: Carpenters' assembly marks in Old Mill roof

The roof was most probably originally hipped at both ends, each with a longitudinal half-truss of similar style to the main roof. Dragon-beams support the principal rafters of the hip. Each pitch has three butt-purlins, each tenoned and pegged through every truss. The rafters are aligned on 18" (0.46m) centres, and are mainly the full length of each pitch. They are typically 2 1/2" by 3 1/4" (64mm x 83mm) in section, and are nailed onto the purlins and birds mouth jointed to the wall plates, which sit on the inner face of the external walls. The tie-beams of the trusses all have dovetailed joist sockets, demonstrating that the upper floor had a ceiling, rather than being open to the rafters. The fact that similar joists were used to the floors below strongly suggests that the roof space also had a floor, and light was probably provided by a skylight on the north pitch. Evidence remains throughout much of the roof for lath and plaster underscoring of the roof, although it is not clear whether this is an original feature.

Evidence was also observed for internal guttering within the roof space, comprising a 4 1/2" (0.11m) square rebate cut into the southern dragon-beam, above a similar-sized roundel in the floor below, and a rebate in the rafter immediately above. A similar roundel was also observed 4' (1.22m) from the northern elevation, flush with the western elevation. These features would suggest that they drained water from behind a parapet wall, projecting above the upper floor, a feature not made clear in early depictions of the site.

4.3.3 Phase 2 (1801 – c 1804)

The second phase of Murrays' Mills followed rapidly, with construction of Decker Mill commencing in 1801, only three years after the completion of Old Mill. This almost doubled the size of Murrays' concern, adding a further ten bays to the eastern end of Old Mill (Plate 19). It was of similar construction and height, and filled the remaining frontage of Union Street, up to the junction of Bengal Street. On the northern side, Decker Mill was constructed approximately 4' (1.22m), wider, having an internal width of c 42' (12.69m).

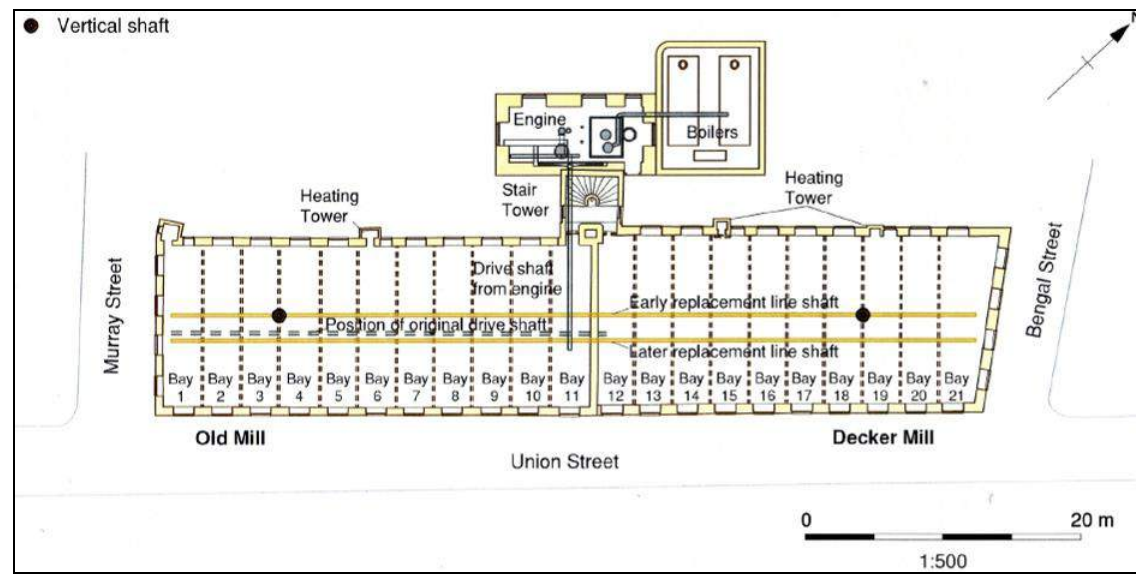


Plate 19: Plan of Old and Decker Mill

Prior to the construction of Decker Mill, a new engine house had to be constructed, on the north side of Old Mill, to allow yarn production to continue once the original engine house was demolished to allow erection of the new mill. This housed a 40hp engine, the main drive-shaft of which entered the building parallel to the east wall of Old Mill within the basement (Plate 19). The original chimney also lay within the position of the new mill and, therefore, had to be replaced. A new, rectangular chimney approximately 6' (1.83m) by 5' (1.53m) was constructed in the north-eastern corner of Old Mill, projecting 14" (0.36m) to the east and 3'6" (1.07m) to the north. A butt joint in the east external elevation of Old Mill, immediately south of the chimney, was observed, demonstrating that the chimney was not an original feature of Old Mill. The new chimney was enclosed within a stair tower, affording access to both mills, and must have been at least 72' (22.0m) high, although the Boulton and Watt drawings show a tapering stack extending above the water tank atop the stair tower, suggesting that it was significantly higher.

The stair tower was rectangular in plan, 14'6" (4.43m) wide, projecting 13'6" (4.11m) from the northern side of Decker Mill. It was positioned centrally around the dividing wall between the two mills, which required the partial blocking of the eastern window in the north elevation of Old Mill, the eastern jamb of which, now formed the door jamb into the tower. It was of fireproof construction, with an entrance at ground-floor level on the eastern face.

The stair tower comprised a spiral stair around a central C-section, shaft, which housed a stand-pipe, cisterns and fire-fighting equipment on each floor, supplied by Boulton and Watt. Rather than timber floors and beams, the stair tower had slender T-section fish-bellied cast-iron beams supporting sandstone flag floors. The cistern and riser in the stair tower has been retained as a feature in the refurbished building (Plate 20). The 13 steps between each floor comprised roughly dressed sandstone blocks, capped with flagstones. The tower was lit by small 2' (0.61m) wide windows, positioned approximately 3' (0.92m) to the north of those now present.



Plate 20: The fire-fighting cistern at the base of Old and Decker mills stair tower

Whilst the construction of Decker Mill is similar to Old Mill, several subtle differences were observed. The bay widths of the new mill are more regular, each being 9' (2.74m) wide, with the exception of the eastern bay (Bay **21**), which was 6'6" (1.98m) wider at the northern end, due to Bengal Street not being parallel to Union Street. The windows are of the same proportions, being equally variable in their internal width as those in Old Mill, but the sills differ slightly, having straight angled brick sills, as opposed to the curved ones of the earlier structure. The new structure had two heating towers on the north elevation, almost at $\frac{1}{3}$ distances along the mill, 27' (8.30m) from the western end, and 30' (9.20m) from the east end, within Bays **15** and **19**. The internal flue is 1'6" (0.46m) wide and 2'1" (0.64m) deep, and is not heavily sooted, suggesting that pipes ran through the flue. The upper vents appear similar to those in Old Mill, typically 1'6" (0.46m) wide and 10" (0.26m) high. As in Old Mill, most of the internal faces of the heating towers appear partially rebuilt, but they differ from Old Mill, in that 6½" (0.17m) square section sandstone blocks project through the ceiling into the floors below, forming narrow hearth-stones, tied into the wall with iron straps. The western tower (Bay **15**) is also different within the basement, where it has a double-skin brick arched opening (subsequently blocked), 4'4" (1.32m) wide and 5'3" (1.60m) high.

There are slight differences between the trusses in Old and Decker mills, in that those in the latter are slightly wider, and have wider set queen posts. The assembly marks also differ, in that they are located on the western faces of the trusses, whilst those in Old Mill are on the eastern faces. The Decker Mill cottars also differ slightly, in that the protruding spikes have been bent into a curl rather than cut off.

With the removal of the engine house from the gable end of Old Mill, the power transmission system required alteration. With the positioning of the new engine house centrally beyond the northern elevation, the drive-shaft now entered the building in the eastern bay of Old Mill (Bay **11**), again at basement level. Bolt holes and rebates in beam soffits c1' (0.30m) north of several of the later columns in Decker Mill, and a rebate in a comparable position in the beam of Bay **9** on the ground floor in Old Mill, suggest that the new horizontal shaft was located to the north of the original shaft by approximately 4'6" (1.42m). This corresponds to a 27" (0.69m) x 28" (0.72m) blocked aperture in the east wall of Old Mill, located immediately above a 3' (0.91m) diameter circular gouge in the wall. The gouge was 6" (0.15m) wide and a maximum of 2" (0.05m) deep, and most probably relates to a collar on the line-shaft relating to the transfer of power from the main drive-shaft.

Phase 2a: it would appear, from stratigraphic relationships on the beams of Bay 18 in Decker Mill, that the vertical shafting for the new horizontal line-shafts was not moved until after original construction. Ogee moulded timber sole plates, typically 3'6" (1.07m) long and 9" (0.23m) high, were attached to the western side of the beams of Bay 18, immediately to the north of the horizontal shafts. These survive *in-situ* from the ground to the fourth floors (Plate 21), with the exception of the second, where a ¼" (0.01m) deep rebate and bolt holes mark its position. Similar rebates were observed on the western face of Bay 3 beams in Old Mill, on the ground, first second and fifth floors, demonstrate the position of the vertical shaft within Old Mill. A top steady bracket was also observed on the fifth floor of Decker Mill, within the side of the later raised ceiling height of Bay 18. A smaller 17" (0.43m) by 5" (0.13m) bracket was observed on the eastern side of the collar of Truss 3, above a 21" (0.53m) by 17" (0.43m) hole in the floor.



Plate 21: Sole plate to house the vertical transmission on the fourth floor of Decker Mill

Evidence of two further line-shaft mountings were observed within Old and Decker mills, which must have gone out of use once the columns were re-aligned, as they were blocked by the later span brackets. Both were located to the south of the main horizontal shaft, and comprised either rectangular or semi-circular rebates on the beam soffits, some also having blocked bolt holes through the beam faces. The southern was located 15'6" (4.73m) from the southern elevation, and was observed on the first, second and fifth floors, and in the soffit of Truss 19, with the second shaft located 2'4" (0.70m) to the north, observed only on the third floor, and quite probably representing a displacement of the same shaft.

4.3.4 Phase 3 (c 1804 – c 1817)

Shortly after the construction of Decker Mill, the Bengal Street Block was added to the northern side of the eastern two bays of Decker Mill. Only the fifth and sixth floors retained windows in the north elevation of these bays, those below being brick blocked (Plate 22). The provision of doorways between the two mills is unclear, as most of the detail is obscured by late toilet facilities.



Plate 22: Blocked windows in the north elevation on the forth floor of Decker Mill

4.3.5 Phase 4 (c 1817 - Mid-19th Century)

The next main phase of construction within Old and Decker mills comprised an internal re-orientation of the building. This involved the replacement of the double row of columns with a single, roughly central, column, allowing larger mules to be placed longitudinally within the building. The process does not appear to have been undertaken as a single event, as shown by a large variation in the types of columns and associated span brackets used. However, in order to introduce the new span brackets, the horizontal line-shaft(s) firstly had to be moved outwards, so as not to be interrupted by the brackets.

It appears, from the rebates observed in beam soffits on all floors of both mills, that the single, almost centrally positioned, horizontal shafts, were replaced by a line shaft to the north. Roughly cut, semi-circular rebates, up to 6” (0.15m) wide and 3” (0.08m) deep, were cut into the beam soffits at approximately 5’ (1.53m) from the north elevation. The documentary evidence suggests that the work was undertaken by Fairbairn and Lillie in c 1817, ‘without stopping the machinery, or only such portion as we might require for the time being’ (Smiles 1876, 316).

The next process in the re-orientation of the mills was to replace the double row of columns with a single, central column in each bay. This was undertaken in several episodes, with a variety of column types, and associated span brackets used throughout both mills. All the column types are of hollow cylindrical design, in cast iron. All incorporate a horizontal beam carrying bracket, and a gas passage bypassing the beam to allow vertical flow between floors. Six different design variations have been identified.

The Type I column (Plate 23), is the most widespread, with the beam carrying bracket on the column offset beyond the column centre line. The gas passage through the column is reduced to half its diameter as it rises up past the beam, with the full diameter re-established in the socket connection between floors. On the opposite side to the beam-carrying bracket the reduced section column is stiffened by a narrow vertical rib. The Type II column differs only slightly, in that it incorporates a double-T socket within the column shaft, allowing transfer of gas between vertical columns.



Plate 23: An example of a Type I column on the second floor of Old Mill

The Type III column shows the greatest variance from other column designs, in that the gas bypass of the beam is in the form of a separate off-take pipe (Plate 24). This was positioned just below the beam, connected by a flanged joint to the pipe, which had an elbow joint projecting the pipe through the ceiling. This type was only observed on the fifth floor, and unfortunately the mechanism of its re-attachment to the column above does not survive.

The Type IV column actually comprises two very similar designs. The columns all vary from the Type I column in that, rather than reducing the column diameter to bypass the beam, the whole column shaft is displaced around the back of the beam, forming a pronounced bulge (Plate 25). The slight variance in Type IV columns is in the angle of the initial displacement of the shaft around the beam, with several examples being more abrupt than others.



Plate 24: Type III column in Decker Mill



Plate 25: Type IV column in Decker Mill

Type V columns are very similar to the Types I and II columns, with the only difference being that the stiffening rib to be found on the back of column Types I and II is absent from those of Type V. Type V columns all have the double-T sockets in the main shaft, as found in Column Type II. Most Type V columns also appear to have undergone drilling to the webbing of the carrying brackets supporting the ceiling beam. Type VI columns differ from Type V only in that they do not have the interconnecting double-T sockets.

Four types of span brackets were identified. These are associated with every Phase 4 column, and cantilever out along the beam from offset carrying brackets incorporated into the column designs. In every instance, timber packing pads, of various thickness, were inserted between the carrying bracket and span bracket, demonstrating that the columns and brackets were not precision cast for each position, and were not original features of the mill construction. The span brackets were attached to the beams with bolts through the face of the span bracket heads, secured by hand-made nuts (of different dimensions), on the rear of the beam.

Each span bracket has additional supporting points to the beam, located at either end, effectively reducing the span of the timber beam, and presumably intended to replicate the support offered by the original columns, which were located in similar position to the span bracket ends. In Types A, B and D, the support was in the form of a projecting shelf, typically 8" (0.21m) wide, and the full width of the beam. The Type C bracket differs in that the entire bracket is L-shaped, with a 5" (0.12m) wide base, that thickens to full beam width for 8" (0.21m) either end. All bracket types differ in the style of decoration of the bracket face.

The distribution of columns demonstrates a more regular pattern within Old Mill than Decker Mill, comprising Type I columns to all floors except the basement, where the modified Type II columns were utilised. This would suggest that the repositioning of columns within Old Mill was undertaken as a single planned episode, with all columns cast to a single specification, presumably by one supplier. However, a variety of associated span bracket types (A, C and D) were utilised, suggesting that this was somewhat more experimental technology, or possibly that many were replaced at a later date. The fact that nearly all the beams require pads to house them onto the span brackets means that replacement would have been entirely feasible.

The distribution of span bracket types does not appear to follow any pattern, although Type B were found only within Decker Mill, and the basement and second floors had exclusively Type A brackets, where still present. The only column line where only one type of span bracket was observed exclusively was in Bay 1, but they only survived on two floors.

Phase 4a: once the replacement of columns had been completed, it would have been possible to replace the five pairs of transverse mules on each floor of either mill, with much larger mules, aligned in pairs, longitudinally down either side of the new columns.

A further row of rebates, similar, but more smoothly cut, than those to the north of the new column line, were observed approximately 5' (1.53m) from the southern elevation. Flywheel gouges were also observed in similar positions on three of the trusses in the roof space, in Bays 1, 3 and 9. They also appear to represent the position of a horizontal line-shaft, positioned at a similar distance from the long-wall. Whilst the method of creating these rebates appears very different to those to the north, it is possible that they are broadly contemporary features, probably relating to the re-orientation of the mules on the spinning floor.

4.3.6 Phase 5 (Mid-19th Century - 1898)

This phase comprises the second half of the 19th century, and represents the growth of the Murrays' Mills complex. However, within Old and Decker mills, little structural change can be directly attributed to this phase. A major alteration was undertaken to the power source of Old and Decker Mills, with the construction of a new engine house, to the north of the Phase 2 engine house.

The new engine shaft had a drive-shaft which was offset slightly to the north of that relating to the Phase 2 engine. A new 2' (0.61m) wide bearing box was inserted into the north wall of the stair tower, to carry the drive shaft, which had to pass to the eastern side of the C-section vertical newel within the stair tower. The confined space within the stair tower, and the desire to keep the old machinery working whilst the replacement system was constructed, led to a rebate having to be cut into the eastern wall of the newel, to allow the drive shaft to pass.

A massive bearing was inserted within the southern side of the stair tower (Plate 26), with two very large (3' by 2'7" (0.92 x 0.79m)) cast-iron brackets being visible at the eastern end of the northern elevation of the basement in Old Mill. The eastern of the two plates is L-shaped, bolted to both the north and east elevations, where it partially overlays the brick blocking of the original doorway, demonstrating that it had been blocked prior to the relocation of the line shafting (Plate 27).

The 9' (2.74m) wide bearing was the full height of the ground floor within the stair tower, and comprised three main bearings. The first housed a horizontal bevel gear, translating the north/south alignment of the drive shaft through 90°. A second housing to the immediate west again rotated the horizontal shaft, allowing it to pass into the basement of Old Mill, through the original aperture, allowing a simple transfer of connection from the old engine to the new.

A third bearing to the east supported a continuation of the east/west-aligned shaft, which continued through the eastern elevation via a smaller bearing box. This allowed power from the new engine to be transferred along the northern external side of Decker Mill, into the basement of the Bengal Street Block; this would not, however, have been possible until the associated new chimney (Phase 5) became functional, as the drive shaft passed through the earlier flue.



Plate 26: Huge casting for the power-transmission system installed at the base of the Old and Decker Mill stair tower



Plate 27: Large plates associated with Phase 5 engine in the basement of Old Mill

A refenestration of the entire complex was undertaken at some point in the mid-19th century. An engraving of the mills published in 1831 depicts a different style of window, which may have been the original type. These window frames, presumably of iron, appear to have had openings towards the base, and significantly more window panes, as shown in the engraving in the gable of Decker Mill and the Bengal Street Block. They were replaced with timber frames, each containing only nine lights, the central one partially opening on a central horizontal axle.

The insertion of external fire escapes post-dates the refenestration, but probably by only a short margin. Cast-iron staircases were attached to the northern external faces of Old and Decker mills, in Bays **5** and **18**, cutting through the western parts of the existing windows. Although both differ slightly in style, they bear similar makers stamps of 'J & JH' and are probably contemporary in date.

4.3.7 Phase 6 (1898 – c 1948)

This phase relates broadly to the ownership of the site by the Fine Cotton Spinners' and Doublers' Association Limited, which took over A & G Murray Ltd in 1898. Modifications to the mill complex during this period included the electrification of the mills. This would have had little impact within the structure of the mill, except that the vertical drive-shafts would have become redundant. Power was supplied directly to the horizontal line-shafts from an electric motor on each floor.

Many of the timber beams appear to have been replaced around this time with I-section rolled steel joists. The beams are unlikely to have been installed before 1890 and, in the absence of the British Steel mark, the sections were probably rolled before 1932. The use of cast iron for the vertical supports also suggests an earlier rather than a later date.

The replacement of many of the timber beams appears to have coincided with the reduction in height of the mill, reducing it to seven storeys. This was certainly undertaken prior to 1903, when the building was photographed (MCL 128947). The trusses were re-used, although not in the same order, as shown by the discrepancy of the numbering of assembly marks observed on the vast majority of the trusses.

The central three bays were built higher on the fifth floor, projecting into the roof spaces of both Old and Decker mills. These bays also had the columns replaced with closed-cap hollow cylindrical columns, on all floors, demonstrating that the original route for the gas supply, via the columns, was modified. Several transverse RSJ's running across the central bay of each floor appear to have housed bearing brackets for four steel ropes which ran vertically through the building to the basement, with bearing boxes visible in the ceiling within Decker Mill.

Also within the early 20th century, prior to 1926, but after the lowering of the roof, a much larger, three bay, 30' (9.23m) wide, toilet block was added onto the eastern side of the existing toilets. This had three large windows per floor (a central 12-light and flanking nine-lights) and was decorated with projecting brick and stone string courses and engaged-columns with entablature-style tops in brick.

The toilet tower also had a personnel passage at first-floor level into the southern end of the Murray Street Block. This appears to be a contemporary construction, but later than a further passage from the western end of the fifth floor through the northern window aperture into McConnell Kennedy's Mill across Murray Street which was probably built after the amalgamation of the two companies at the end of the 19th century.

4.3.8 Phase 7 (c 1948 - 1950s)

A brick lift shaft was added into Decker Mill in 1948 (Manchester City Council Building Control Department 1948). Correspondingly larger doorways onto Redhill Street on the ground floor were also constructed at this time and the floor was strengthened. Doorways between Old and Decker mills were also inserted on each floor. A timber staircase into the basement at the western end of Old Mill was also added at this time.

The lift shaft was removed in 2017, although this necessitated the complete removal of the floorboards and joists from two bays to enable the structural elements of the lift shaft to be removed safely. This work provided a dramatic vertical section through the interior of the building (Plate 28).

4.3.9 Phase 8 (Post-1950s)

This last phase relates to post-textile manufacture in Old and Decker Mills. Stud partition walls were added throughout the building forming a number of small rooms. In some cases new floors were also added and other minor alterations were carried out. Many changes to windows were undertaken, allowing better ventilation of the structure. These alterations were probably carried out from the 1960s onwards, and some at least may be related to recorded changes in sanitation at that time.



Plate 28: Section through Decker Mill necessitated to enable the removal of the lift shaft in 2017

4.4 *Old and Decker Mills Engine Houses*

4.4.1 *Introduction*

The structure referred to as Old Mill/Decker Mill Engine House, located within the courtyard to the north of Old and Decker mills, was the latest of a series of steam-power plants that drove the mills (Plate 29). It is unknown precisely when this building was erected, although it may be dated broadly to the later 19th century.



Plate 29: Old and Decker Mill Engine House during refurbishment works

Whilst the earlier structures have been demolished, significant information about their form and location survive within the existing fabric of both mills and the present engine house. When combined with the results of the documentary research and excavation, this allows some description, analysis and phasing of the development of the power source for this area of the Murrays' Mills complex. The late 19th-century steam-power plant also benefitted from intrusive archaeological investigation, which included the full excavation of the boiler house in 2006, and the limited excavation inside the engine house in 2018.

4.4.2 Phase 1 (1798 – 1801)

The original engine house for Old Mill appears to have been constructed at its eastern end, flush with the north elevation. The evidence upon which this is based is drawn from archive sources and surviving physical remains.

Detailed drawings of the engine house specification by Boulton and Watt, suggest it was 28' (8.54m) in length internally, and 9'10" (3.00m) wide, with a 9'5" by 10'5" boiler house on its eastern side. The plan shows the flue to a chimney, which appears to have been located to the south, probably fronted onto Union Street. It also shows access into the engine house at the north end of the east elevation, with further access being observed from within Old Mill, at a corresponding point in the basement, and at the southern end of the west wall of the engine house at ground floor level. The engine would presumably have had windows in the east, and probably north and south elevations, although these are not illustrated.

4.4.3 Phases 2 - 4 (1801 – Mid-19th Century)

The construction of Decker Mill, on the eastern end of Old Mill, subsumed the original engine house and chimney, and demanded their relocation. The only practical option was on the northern side of the new structure, within the courtyard. This would have presumably been undertaken during the earliest phase of construction of the new mill, in order to allow power to the existing machines in Old Mill to be maintained once the Phase 1 engine house was demolished to allow construction of Decker Mill.

Although the Phase 2 engine house was demolished subsequently, some of its fabric was incorporated into both the stair tower and the later (Phase 5) engine house. Whilst both walls also contain information pertaining to the Phase 5 engine house, and later use of both structures and the intervening area, it is possible to identify several features relating to the Phase 2 engine house. Analysis of these features is facilitated by the details within drawings of the engine from the Boulton and Watt archives.

Within the north elevation of the stair tower is situated a large timber sole plate, 7'5" long (2.25m), 0.7m above present ground level (Plate 30). It is of large scantling, formed of box-sectioned heartwood, with the upper and lower faces retaining the natural curves of the tree trunk, with the northern end cut slightly at an angle to produce a flat surface to retain the brickwork above. It has a central, roughly cut semi-circular rebate, 2'4" (0.71m) wide and up to 10" (0.26m) deep in the centre. This rebate has a chamfered outer edge, 1" (0.03m) deep and 13" (0.33m) wide, with well preserved tool-marks on the eastern side. Either side of the rebate are 2½" (0.07m) square bolt holes, 10" (0.26m) from the east end of the timber, and 16" (0.41m) from the west. Both retain 2" (0.05m) square headed bolts, flush with the face of the timber. The sole plate represents the housing for the axle of the main drive-shaft into Old Mill from the engine.

The timber sits on a course of greenish Cumbrian slates, 7" (0.18m) to 10" (0.26m) wide, suggesting that they were possibly re-used roof slates from the original engine house roof. These overlie a course of header bricks, which, in turn, overlie a 2½" (0.07m) high timber rail, flush with the wall face, and surviving to 8'10" (2.70m) in length, with a badly rotten western end.



Plate 30: Timber sole plate associated with the Phase 2 power-transmission set into the stair tower

At the eastern end of the surviving south elevation of the Phase 2 engine house the wall is 2' (0.61m) narrower than the stair tower above. The extra thickness of the tower is supported on a 3' (0.92m) high, 2' (0.61m) cast-iron concave corbel. The casting extends a further 2' (0.61m) down the wall face, 1½" (0.03m) thick in section, resting on a broken 6" (0.15m) sandstone pad. Two courses of broken brickwork below possibly marks the position of a transverse wall within the engine house.

What appears to be the full extent of the northern elevation of the Phase 2 engine house survives intact, although with many late alterations (Fig 9). It measures 37'8" (11.50m) in length, and survives to 23'1" (7.04m) above present ground level, above which it is rebuilt. Despite the later alterations, several features that appear to relate to the Phase 2 engine house were observed within the wall fabric.

At approximately first-floor level are the remains of two round-headed, blocked apertures. The western is better preserved by far, and comprises a 6' (1.83m) wide, 9'9" (2.99m) high brick-lined opening, with straight reveals, a double row, header segmental arch, and 3" (0.08m) projecting rolled-edge sandstone sill. Below the sill the segmental arch is mirrored, but is infilled with contemporary brickwork, flush with the wall face, acting as a relieving arch, spreading the load of the aperture through the wall below. The aperture above is blocked on the internal face with later brickwork. Little remains of the eastern aperture, which is blocked flush with the wall face, although it is possible to distinguish the position of the sill, the segmental arch, and elements of both jambs.

A sub-rectangular blocked feature, 2' (0.61m) wide and 4'2" (1.27m) high, between these two large apertures is aligned directly opposite, and slightly above, the sole plate opening in the southern elevation of the Phase 2 engine house. The ephemeral feature is observable by a misalignment in the coursing of the original brickwork, and has a soldier course lintel, with two further such courses blocking the top of the aperture. At its base it has a cast-iron plate, surviving to a width of 18" (0.46m), which may relate to a sill or bearing box. The purpose of the blocked feature is unclear, but it may have been associated with the fixing of the timber framing for the original engine.

At a similar level, towards the eastern end of the elevation, is a further, badly obscured and remodelled sub-rectangular aperture. It measures *c* 5' (1.52m) wide and *c* 6' (1.83m) high, with a well-defined eastern jamb, and a probable soldier course blocked sill. This may relate to a feature, most probably a window, shown in a similar position in the Boulton and Watt plan of the 1801/02 engine. The feature was also visible on the internal face of the engine house, suggesting that original fabric survives to full wall thickness within the lower levels of the present structure.

4.4.4 Phase 5 (Mid-19th Century - 1898)

Little appears to have changed within the engine house until the later 19th century, when a new engine was obtained to power Old and Decker mills. In order to minimise the disruption to the running of the mill, the new engine had to be installed prior to the disconnection of the existing engine, in order that power to the mules might be maintained. This was accomplished by constructing a new engine house, to the immediate north of the Phase 2 engine house, and offsetting the new drive-shaft. Once the new construction had been completed the internal power transmission of the mill could then be re-connected to the new main horizontal drive-shaft, which still entered in the eastern bay of Old Mill basement (Bay 11).

The new engine house, which survives intact, although heavily remodelled, incorporates the northern wall of the earlier engine house, and is the same length. However, the wall was significantly heightened, by *c* 14' (4.27m), with the additional wall height being a brick narrower (0.10m). The fabric of the new engine house was built of mould-thrown red brick, which externally is laid in English Garden Wall bond (with three rows of stretchers to one row of headers), with string courses picked out in yellow brick. It has hipped gables and a Welsh slate roof with ceramic ridge tiles. There is a central raised skylight, which may be later, with a rolled lead ridge and the wall tops have closed eaves above denticulate brickwork.

A single cast-iron segmental hopper is present on the west elevation with a cast-iron downpipe below, while all the remaining downpipes have been replaced with plastic. The joint between the earlier south wall (Phase 2) and the later structure was clearly observed in the eastern gable, and is also visible in the western gable. Internally, the structure was of three bays, each divided by king post trusses with jowled bases and heads and a clasped ridge. Additional braces are positioned from the tie-beams to the principal rafters, which are asymmetrical to the walls, the northern one joining the tie beam within the wall thickness, the southern 0.4m from the wall, and both are attached with iron bolts. The hips of the roof are constructed with a pair of purlins within each pitch, halved over the truss and mitred to hip purlins. A skylight was provided by the addition of vertical timbers above the upper purlins, the gap between these and the ridge board being glazed. The roof space is finished with lathe and plaster over the rafters, the rafters probably attached to the wall plates with bird's beak joints. The wall plate of the south elevation butts the inner face of the wall, and is supported on timber corbels socketed into the wall.

The new structure featured larger arched windows than those in the north side of its predecessor, spaced slightly wider and deeper on the northern elevation. Those in the earlier structure were retained. Additional windows were also created in the eastern and western elevations, although that in the western end has been remodelled.

Access to the structure was afforded via an external cast-iron stair, similar in style to the fire escapes of Old and Decker mills, into the base of the western window aperture in the north elevation; this was removed as part of the recent refurbishment works. A further stone straight stair led into the base of the aperture in the eastern elevation, also at first-floor level, and presumably gave access from the engine house into the contemporary large boiler house constructed on its eastern side. A doorway at ground level, at the base of the cast-iron stair on the northern side, afforded access directly from the canal wharf into the engine house.

Either side of the windows in the east and west gables are two pairs of dressed sandstone blocks, each measuring *c* 6' (1.83m) by 18" (0.46m), the lower pair above the first-floor doorway, with the second pair 5'6" (1.68m) above. These represent load-bearing pads for the framing of the new engine. Two similar 3' (0.92m) long sandstone blocks were observed above the eastern window in the north elevation, with similar blocks observed internally within the fabric of the south elevation. All contain bolt holes, suggesting that the upper part of the framing, above the beam, was attached across the engine house at this point. Lower within both north and south elevations, slightly east of centre, a single large 6' (1.83m) sandstone block, with two pairs of bolt holes, represent the position of the entablature beam of the new engine. At ground-floor level below the entablature beam bearing blocks similar blocks supporting the axle of the engine were also observed, offset slightly to the west, positioned centrally within the north and south elevations. The block in the northern elevation had compression marks of two large oval plates in its external face, whilst that on the south elevation projected 4" (0.10m), has a semi-circular rebate 18" (0.46m) wide, 1' (0.30m) high and up to 14" (0.35m) deep cut into the centre of its face. This would appear to represent the position of a connector or drum on the external end of the axle.

The drive-shaft from the new engine lay immediately to the east of, and below, the axle pad in the south elevation, and was protected through the wall of the engine house within a 3'1" (0.96m) high, 3' (0.93m) wide cast-iron bearing box, inserted into the original fabric of the Phase 2 engine house, and with extruded brick rebuilding around its edges. A similar bearing box was observed in the north elevation of the stair tower, opposite that to the north, marking the position of the Phase 5 drive-shaft entry into the base of the stair tower. Within the stair tower, the bearing box sat on an inserted sandstone block pad, 5'3" (1.60m) long, similar to those within the Phase 5 engine house. A later blocked aperture below this pad, of similar width to the bearing box above, and presumably of similar date, is probably related, but its exact purpose remains unclear.

Two further apertures in the eastern gable relate to the association with the contemporary boiler house to the east. A central 20" (0.51m) wide, 2'6" (0.76m) high aperture, with three-course segmental brick arch, housed the condensate return pipe, whilst a 28" (0.69m) wide, 3' (0.93m) high aperture to the south of the first-floor doorway, with two-course segmental brick arch, housed the steam pipe from the boilers to the engine.

The western two bays of the north elevation were two courses thicker (9" (0.27m)) on the internal face than that to the east, presumably reflecting the extra structural stability required to support the new engine, which, unlike its predecessor, was not a free-standing structure. The main stress of the engine would have been in the central and western ends of the engine house, and, therefore, materials could be saved, by reducing the wall thickness towards the eastern end of the structure.

A new chimney was also constructed to serve the new, and larger, boilers. It was located to the south-west of the Phase 2 engine house and was of octagonal plan, of mould-thrown brick construction, with iron straps attached all along its length and stepped string-courses at the top. There is a small aperture at approximately second-floor level identifiable as a flat arch and jambs in yellow brick blocked with red brick, which presumably allowed access, although the feature was blocked subsequently. It is probable that the casting supporting the base of the stair tower was strengthened by an iron tie-rod, 1½" (0.03m) diameter, along the northern side of the stair tower at this time.

Evidence within the lower part of the south external elevation of the engine house would suggest that the bypass flue for the economiser lay to the north. The remains of a layer of iron plating cut into the wall and projecting outwards forming a 'cover', were observed immediately below, and to the east and west of the Phase 5 drive-shaft bearing box. To the west of this are what appear to be the remains of springers for an arch orientated east/west along the elevation. An area of rebuilding at the base of the north-east elevation of the chimney represents the blocking of the aperture of this flue into the chimney.

The floor of the engine house was removed during the refurbishment works in December 2016. These revealed the intact stone blocks that had formed the foundation beds for the engine (Plate 31). The size and layout of these engine beds suggest that they were intended to house a twin cylinder beam engine, with the narrow channel between the rows of foundation stones housing the central flywheel.



Plate 31: Stone foundation beds for the late 19th-century engine the powered Old and Decker Mill

Further excavation of the engine house was not carried out, and the stone foundation beds were all retained *in-situ* beneath a new floor.

The steam required for the new engine was raised in a bank of new boilers, which were housed immediately to the east of the engine house. Substantial remains of this boiler house were revealed during excavation in 2006, which exposed *c* 75% of the original building (Plate 32).



Plate 32: The remains of the boiler house for Old and Decker Mill excavated in 2004

Four parallel walls, lying on a broad north/south alignment, were revealed to have formed three adjoining boiler bays of equal size. Each of these partition walls were composed of different types of bricks; each facing course consisted of refractory bricks, whilst standard bricks of both machine-pressed and hand-made variants were used in the bodies of the walls. The widths of the walls varied slightly; the eastern wall of the boiler room was 0.47m wide, the partition wall between the eastern boiler bays measured 0.58m wide, the next partition wall to the west was 0.82m (32") wide, and the final partition wall was 0.37m wide.

All of the partition wall faces internal to the building was butted by a low wall, creating a series of 0.82m wide raised benches at a height of *c* 1m, equating to 11 courses, above the floor of the boiler bays. The component bricks were all laid in regular courses. As with the partition walls, the exterior faces of the bench walls comprised refractory bricks with standard bricks forming the interiors. In addition, a layer of thin slates bonded in clay had been inserted between the lower courses of each wall, presumably in order to protect the refractory bricks from rising moisture. The upper surface of each of the bench walls comprised refractory bricks, aligned along the length of the boiler bays.

The refractory bricks within the fabric of the boiler house structures had evidently been obtained from different sources; ‘Milnes Ltd Brighthouse’ supplied some bricks within one of the partition walls, ‘B Gibbons Jnr Ltd Stourbridge’ within a bench wall, and ‘Glenboig’ within another bench wall. This suggests that the demand for these specialised type of bricks outstripped the resources of a single supplier.

A series of boiler mounting blocks, moulded from refractory clay, had occupied the top course of each of the bench walls, although only a few survived *in-situ*. Each of the blocks measured 0.39m x 0.37m x 0.30m. The blocks raised the boiler slightly above the bench walls to allow air to circulate around the body of the boiler. At the northern end of each bench wall, the interior corner incorporated bull-nosed refractory bricks, creating a rounded edge, whilst the junction with the partition walls was bonded to an angled buttress (Plate 33).



Plate 33: Detail of the westernmost excavated boiler bay, showing bench walls

The floors of each boiler bay measured 1.12m wide, and were composed of at least two courses of refractory bricks, aligned along the length of the building. The floors extended 1.44m to the north of the bench walls. At the northern end of each bay was a square-shaped cut out in the floor. These represented drop-down areas for cleaning out dirt within the boilers, suggesting that the canal had provided the water source for the boilers. The precise mechanism by which the boilers were fed with water, however, remains unclear, although it is thought that they were fed via a large feeder tank situated in the corner of the Bengal Street Block and Decker Mill (S Roberts pers comm).

An iron grill set into the floor of the westernmost exposed boiler bay was revealed to cover a culvert. The culvert was square section, measured 0.55m wide and 0.6m deep, and lay on a broad east/west alignment. It contained water, but was not flowing. The route of the culvert to the east is uncertain, as there was no indication for its presence within the other boiler bays. It seems unlikely that the culvert was associated directly with the boilers, but merely took a route beneath.

An iron pipe, aligned east/west, was exposed along the northern edge of the boiler house at floor level. Traces of red lead paint were identified on the surface of the pipe, as were the degraded vestiges of lagging material, indicating that the pipe probably represented the main steam main from the boilers to the engine. This was corroborated by the high-pressure flange joints between pipe sections.

The northern elevation of the boiler house was represented by three brick piers, situated on a raised platform at a height of *c* 0.7m above the boiler bays floors. The piers were positioned 3m apart, and each survived to a height of 0.8m. The piers measured 0.82m square, although the easternmost was slightly smaller. Each of the piers comprised mortar-bonded hand-made bricks, laid in regular courses. Some of the pier faces had been rendered with cement. A photograph taken in October 1985 shows the boiler house intact, and comprising a double hipped roof with a central dividing wall and four arched openings in the front adjacent to the canal basin (Plate 34). The excavated piers provided the foundations for the arched openings.



Plate 34: Photograph of the boiler house taken in 1985

The raised platform along the northern edge of the boiler house was 2.5m wide, and clearly represented a charging platform from where coal was loaded into the boilers. It was situated 0.65m below the level of the canal basin and associated flagstone yard. The platform was composed largely of an early type of concrete, which comprised a large proportion of crushed bricks. The southern edge of the platform was supported by a brick wall, 0.70m high, which lay along the entire length of the boiler house. This comprised hand-made and machine-pressed bricks, and presumably acted as a revetment wall for the boiler house.

A series of 11 large sandstone slabs, placed at an angle of *c* 20° from the vertical, marked the northern edge of the charging platform (Plate 32). These effectively formed an extended chute, down which coal could be transferred from boats in the canal basin to the charging platform, and thence directly into the boilers. Several stone slabs were missing from the western end, exposing a thick deposit of grey-brown clay.

The trench was not excavated as far as Decker Mill wall due to Health and Safety constraints, although limited investigation by hand revealed the flue and control features from the boilers to lie within this area. It was noted in the 1980s that the remains of the vertical cast-iron butterfly valves to control the air flow into the flue, operated from above via iron rods protruding through the second storey paved walkway by Decker Mill, survived at the back of the boiler beds (RCHME and GMAU 1989).

The excavated area also contained the remains of the flue and associated features that had connected the 19th-century boilers to the extant chimney. Between the boilers and the chimney was a broadly rectangular structure that represented the well-preserved foundations for a fuel economiser.

The remains of the flue from the boilers were exposed beneath a thin covering of loose overburden at the eastern end of the excavated trench. The walls forming the sides of the flue survived to a maximum height of 0.6m, and were set 1.05m apart. Each side wall incorporated three courses of bricks, forming a width of 0.37m. The inner face of each wall was composed of refractory bricks, whilst the remaining courses were built of standard bricks, although incorporated both machine-pressed and hand-made varieties. There was no surviving evidence for the original height of construction, nor for the form of capping.

The base of the flue rose slightly to the north-west on its approach to the economiser. The base was composed entirely of refractory bricks, some degraded, aligned along the length of the flue. At its junction with the economiser, the base of the flue was traversed by an iron plate, fixed down by two iron bolts. It seems likely that this iron bar was the remnants of a mechanism that regulated the flow of gases entering the economiser. The plate was left *in-situ*, obscuring the underlying bricks. However, it seemed to overlie a butt joint between the flue and the economiser, suggesting these two elements to be of slightly different dates.

The foundations of the economiser survived to a height of 1.54m, and enclosed a rectangular space measuring some 6m x 1.47m (Plate 35). The floor was composed entirely of refractory bricks, which were all sooted and some were quite soft and degraded. The internal faces of the side walls were 0.5m wide, and were composed of refractory bricks whilst the remaining elements comprised standard bricks, reflecting the technique used in the construction of the flue. The inside edges of the upper course of bricks were chamfered at an angle of $c 45^{\circ}$, implying that the economiser had rested upon this course.

The southern wall contained two rectangular apertures, each measuring 0.48m by 0.44m and 0.4m deep. At the rear of each aperture was a circular iron housing, which had seemingly retained pipework between the economiser and the channel to the south.

The 0.33m wide strip between the southern wall of the economiser and the wall of the stair tower was investigated by means of a manually-excavated sondage. A concrete surface was revealed to lie at a level slightly lower than the floor of the economiser. This channel is likely to have contained the bottom branch pipe for the economiser.

At the western end of the trench, the side walls tapered inwards asymmetrically towards the 1.12m wide, rubble-filled flue at the base of the chimney. The base flue was situated at a height of 0.53m above the base of the economiser foundations.



Plate 35: The excavated remains of the economiser

4.4.5 Phase 6 (1898 – c 1948)

It is uncertain precisely when the Old and Decker mills engine house went out of use for its intended purpose, although this is likely to have occurred during the early 20th century. It is shown to have been in service on a Mather and Platt fire services plan in 1902, but had been removed by 1930, when a deposited building plan (20244) shows the engine house as converted to warehousing. It would seem probable that the removal of the engine was associated with the construction of the electric sub-station.

The building was not demolished, but once the engine had been removed, was converted to a warehouse and workshop. A structural repair also appears to have been undertaken, with a refacing of the upper part of the south elevation, above the entablature beam. This may reflect damage caused by the removal of the engine.

The major alteration in fabric during conversion was the insertion of internal floor levels, formed of concrete, supported on I-section RSJs. The first-floor level appears to correspond to, what was probably a temporary timber floor, within the earlier building, with two further floor levels inserted above. Access between the floors was afforded by an L-shaped timber staircase in the south-western corner, with a single-skin stretcher bond, extruded brick wall.

The western gable was severely remodelled, with the insertion of full-height double doors to each floor, positioned between the large sandstone bearing blocks of the Phase 5 structure. A dormer roof housing a hoist was also added at the top of the elevation, housing a 5cwt electric hoist on an iron I-beam bolted to the lintel and supported at the east end by another iron beam. Below this is a series of slots in the concrete floors, with removable timber boards to allow the hoist to travel into the floors below. The south side of the elevation has a rough joint linking it to a short length of wall, which butts the chimney and has an inserted doorway on the south side, with a reused timber lintel.

The top three courses in the north elevation appear to be added, suggesting the roof has been raised, and parts of the next six courses also appear to have been replaced. The central roof truss also cuts the arch of a Phase 6 window in the southern elevation, demonstrating the later alteration to the roof. It is unclear whether the trusses, which stylistically appear consistent with a mid-19th-century date, were re-used, or whether the present roof structure date completely from Phase 6. It is likely that the raised skylight along the ridge relates to conversion to warehousing, with the lack of natural light into the altered structure.

Across the upper part of the first floor, or the eastern elevation is a row of projecting brick corbels. These post-date the blocking of the doorway, as one cuts through it. They apparently supported the western side of a pitched roof, which may represent alterations to, or re-roofing of, the boiler house to the east at this time. Further inserted pieces of iron and stone to the north may also be related.

Two rows of I-section RSJs also project slightly, or have been cut flush with, the southern external elevation of the Phase 5 structure. None appear to block Phase 5 apertures, and so several may relate to the roof of the economiser, which was a slightly later structure. It is unlikely that all relate to Phase 5 structure, suggesting that some remodelling occurred on the southern side of the engine house during later phases.

The date at which the last steam engine to power Old and Decker mills was removed is uncertain, although cartographic sources indicate it to have been between 1902 and 1930. However, it seems that the boilers remained in use until the 1950s, providing the steam for the engine that powered New Mill, and possibly also for heating purposes. During this late period, the coke fuel for the boilers was provided by Beatties of Manchester (S Roberts pers comm).

The engine house changed function during Phase 6, the boiler house to the east continued in use, probably into Phase 7, and it is likely that its associated economiser also remained in use. It is likely that these joists may then represent alterations to the structure of the economiser, rather than its removal and replacement.

4.4.6 Phase 8 (Post-1950s)

Several modifications were made to the engine house after its conversion to a warehouse. These appear to relate to its subsequent use as workshops, after the closure of the cotton mills during Phase 7. Vast amounts of paint on several of the internal walls, and signage on the north external elevation, demonstrate that the building was used latterly by a sign manufacturer.

Structural changes relate to the insertion of toilets, on the north elevation, in the position of the dog-leg in the internal wall. This itself was cut back by 0.1m for 2.25m to allow the positioning of toilet cubicles alongside the wall. Rectangular casement windows were inserted into the northern elevation at first and second floor level to light and ventilate these toilets.

Partitions within the eastern end of the third floor appear to relate to offices associated with this late usage. An east/west-aligned zigzag single skin brick wall formed the edge to the stair passage south of the loading doorway, on the second floor, probably allowing clean access to the top floor offices.

It is not known when the boilers were removed, although the building was still standing in 1985, when it was photographed as part of the Greater Manchester Textile Mill Survey. By this date, the building was being used as a receptacle for waste materials, including cloth cut-offs. It had been demolished by 1990.

The engine house has since been repurposed as a residential apartment.

4.5 *New Mill*

4.5.1 *Introduction*

New Mill was erected as a single unit adjacent and parallel to Jersey Street, and for this reason was referred to originally as Jersey Mill. It was built to a height of eight storeys (including a basement), and measured 193½' (58.98m) by 46½' (14.17m), representing the largest building within the Murrays' complex. The development of New Mill commenced during Phase 2, and seems to have been largely completed before the erection of either the Murray Street or Bengal Street blocks had begun. The dimensions of New Mill broadly mirrored the combined Old and Decker Mills structure, reflecting its primary function as a cotton spinning factory. It seems likely, however, that the basement at least had been used for preparatory purposes.

New Mill is orientated approximately east/west along the south side of Jersey Street, which forms the northern boundary of the Murrays' complex. The main mill structure presently comprises five floors and a basement, and is of a single build. The original structure comprised eight storeys (seven above ground level, and a basement) of 22 bays, representing one of the largest mills in Manchester at that time. Access to all floors within New Mill was originally via a round stair tower, situated approximately mid-way along the courtyard-facing elevation.

The mill structure basically survives in its original form, with a projecting heating tower to the west of the stair tower, and a rectangular chimney connected with the associated engine house to the east. A toilet tower was added to the southern elevation of the mill during the 20th century and remodelling of the eastern bay (Bay 22) was undertaken, initially for use as a rope drive, and latterly as a stairwell, with associated projecting entrance from Jersey Street at the eastern end of the north elevation.

The principal fabric of the mill is brick, faced in Flemish bond on the external west, north (front) and east elevations, and English Garden Wall bond on the external south (courtyard) elevation. The internal walls were also faced in English Garden Wall bond. The upper parts of all elevations were rebuilt in English Garden Wall bond during the early 20th century, with a sandstone coped parapet projecting slightly above the roof. This is hipped at its eastern end, similar to Old and Decker Mills, but has a sandstone coped gable at its western end. The roofing material is a mixture of Welsh and Cumbrian slate, which has been sealed recently with a bituminous felt cover.

On each floor the ceiling was supported by large-scantling transverse timber beams, supported by a mixture of solid-section cast-iron cruciform columns, and later, hollow cylindrical cast-iron columns. Many of the beams also have channel-section steel joist supports on either side. The flooring consists of multiple layers of timber boards, generally north/south-aligned over east/west-aligned joists. These are almost exclusively underdrawn with lath and plaster, covered with metal sheeting, and on some floors have either plaster, cement or bituminous floor coverings.

4.5.2 Phase 3 (c 1804 – c 1817)

New Mill retains most of its original fabric shell. As with the earlier structures on the southern side of the Murrays' Mills complex, New Mill was constructed of locally-made, mould-thrown brick, bonded with a pale lime and sand mortar. Brick dimensions were generally 9" by 3 $\frac{7}{8}$ " by 2 $\frac{3}{4}$ " (229mm x 98mm x 70mm), slightly less deep than typical bricks of the period, which tended to measure from 4 $\frac{1}{4}$ " to 4 $\frac{1}{2}$ " (108mm to 114mm) deep (Harley 1974, 76). The northern elevation, fronting Jersey Street, and both gable elevations were constructed in Flemish bond, whilst the southern face was in English Garden Wall bond, with rows of headers every five courses. The internal elevations were also apparently constructed in English Garden Wall bond. The structure has tapering wall thicknesses, which not only reduced the load of the structure, but saved a vast quantity of brick. In the lower floors, it is the northern elevation that is the thickest, with the southern elevation slightly wider than the end elevations. The reason for this bias towards the northern elevation is unclear. Within the basement, the north elevation is 3'4" (1.02m) thick, narrowing by 6" (0.15m) at ground floor and second-floor levels to a thickness of 2'4" (0.71m), and by a further 4" at fourth-floor level, to a thickness of 2' (0.61m). The foot of the south elevation, however, is 2'10" (0.86m) thick (the same as the ground floor of the north elevation), and reduces to 2'4" (0.71m) at ground floor level. Unlike the north elevation, it does not have a further reduction at second-floor level, and thus becomes the same as the north elevation from this height, reducing to 2' (0.61m) thick at 4th floor level. The end elevations are typically 2'8" (0.82m) thick at basement level, reducing to 2'4" (0.71m) thickness at ground floor level, and similarly to the south elevation, maintaining this thickness to 4th floor level, where they are reduced to 2' (0.61m) thickness. Thus, from second-floor level, all walls are approximately of the same thickness. The northern elevation also has a central, five-bay wide, single skin projection on the external face. It is probable that this served a structural function, as it is unlikely to have been a purely architectural embellishment.

Externally, the majority of bays have a 4' (1.22m) wide window, 6'2" (1.87m) high to the crown of a shallow brick-cambered arch, similar to those present elsewhere within the complex, and with projecting flat sandstone sills. Unlike Old and Decker Mills, where the windows adjacent to the heating towers are narrow, all the apertures in New Mill are approximately the same width. Evidence from the internal wall faces indicates that the eastern three bays originally had windows, denoted by a rebuild line in the position of the western jamb of the Bay 1 window on first, second and fourth floors, and of the eastern jamb of the Bay 3 window on the first, second and third floors. Although no evidence for similar jambs was observed in the eastern three bays of the mill, evidence for a re-facing of the wall, associated with the construction of the Bengal Street Block, was observed from the first floor upwards, implying that the eastern three bays also had window apertures originally.

Ground-floor level within the original structure correspond (within 4" (0.10m)) with the ground floor levels in Old and Decker Mills, c 6' (1.83m) above street level. Each floor was divided into 22 bays by large-scantling, chamfered timber beams, supporting the floor above. These were of Northern European softwood, with several exhibiting Baltic timber shipping marks, similar to those in Old and Decker Mills.

Bay widths are of a uniform size, but are significantly narrower than those in Decker Mill; bay widths in New Mill are typically 8'3" (2.52m) wide as opposed to 8'7" (2.62m) in Decker Mill. Both end bays are asymmetrical, the western bay (Bay 1) is wider at the southern end, reflecting the offset angle of Murray Street from Jersey Street, whilst the eastern bay (Bay 22) is wider at its northern side, as Bengal Street is parallel to Murray Street. Bay 1 is also wider than average, measuring 8'9" (2.67m) along the centre-line of the mill, whilst Bay 22 is narrower, measuring only 7'6" (2.29m) wide, at the same point. This would suggest that the bay widths of *c* 8'3" (2.52m) were established first, possibly laid out from the centre of the structure, and that the end bays were adjusted in length to meet the frontages of Murray Street and Bengal Street.

The original columns supporting the timber beams in New Mill have all been replaced. However, six cast-iron load-transfer boxes, or 'crush boxes', survive on the beams of Bays 10, 12, 15 and 17, on the 4th floor and Bay 21 of the basement, demonstrating the position of the original columns. Compression marks on the beam soffits of the fourth floor also indicate the position of further boxes in Bays 9, 15 and 16. The boxes were formed as a single box casting, and therefore had to be slid onto the beams from the end, prior to the beams being built into the long-walls of the structure. These load-transfer boxes would have supported both the column head of one floor level, and the base of that above. Their purpose was to transfer the vertical load from the floors above the timber beam, which rested on the base-plate of the box but was free of the top-plate, therefore avoiding crushing damage to its fibres. The majority of boxes were removed subsequently by breaking the cast iron, but those that survive indicate the position of the original columns, the majority of which were situated 14'9" (4.50m) from the north elevation, 14'3" (4.34m) from the south elevation, with a central space of 13'3" (4.04m) between the columns. The surviving load-transfer box in the basement, however, is positioned only 13'8" (4.17m) from the north elevation, due to the increased wall thickness of the external walls below second-floor level.

It is noteworthy that load-transfer boxes were not used during the construction of either Old Mill or, more interestingly, Decker Mill, the erection of which immediately preceded that of New Mill. However, it would appear from documentary sources that load-transfer boxes were used during the later construction of the Bengal Street Block, and were incorporated into the design of later columns inserted into the Murray Street Block.

It has been suggested previously that the single row of cruciform columns that survive on the fourth floor represent the repositioning of original columns (Plate 36). However, the size of these column heads is more consistent with those in the Murray Street Block, which fit into a 3½" (89mm) wide socket in the cap, whereas the socket in the base of the load-transfer boxes on the 4th floor of New Mill are significantly larger, measuring 5" (127mm).



Plate 36: The cruciform columns on the top floor of New Mill prior to repurposing as apartments



Plate 37: One of the cruciform columns on the top floor of New Mill incorporated into a new apartment

As in the earlier mill structures to the south, the internal apertures of the windows within each bay of New Mill are of differing proportions, ranging from 4'11" (1.45m) wide, to 5'5" (1.65m). The internal window sills are similar to those in Decker Mill, having straight-angled brick sills, as opposed to the curved ones of the earlier Old Mill. The end bays of New Mill also had similar windows, four on each floor, similar to the earlier buildings. The western gable of New Mill retains physical evidence for the window apertures of the original fifth floor.

Access into New Mill was afforded via a circular stair tower, 15' (4.58m) in internal diameter, with 14¼" (0.36m) thick walls. This provided a larger internal space than that serving Old and Decker Mills, with only a similar quantity of brick used, and providing a more stable, load-bearing structure. This represents an early improvement to mill design, and it is interesting to note that the stair tower that was erected subsequently (Phase 4) to serve the Bengal Street Block was of a similar design.

The stair tower was of fireproof construction, comprising sandstone flag steps, floor and ceilings, supported on cast-iron, fish-bellied T-section beams. The tower also had a central C-section shaft, which housed a stand-pipe, cisterns and fire-fighting equipment on each floor, supplied by Boulton and Watt. The main light source within the tower was provided by 4' (1.23m) wide windows, similar to those used throughout the rest of the mill. The stair tower was accessed at ground floor level via a flagged landing above 12 sandstone steps from the courtyard. These were concrete capped subsequently, presumably during Phase 7 or Phase 8, but evidence of the brick risers and rolled lip treads was observed on the top step. The entrance comprised a 4'6" (1.37m) wide, round-arched brick doorway, comprising a double-header arch, with moulded sandstone keystone, supported on projecting springing bosses.

Two further towers projecting from the southern elevation of New Mill form part of the original construction. The eastern, larger tower, located between Bays 16 and 17, formed the chimney associated with the steam power plant. It is unclear whether the hot gases passing through the chimney were utilised to heat the eastern part of the spinning floor, although this would appear likely. The western tower, located between Bays 6 and 7, measuring 4'6" (1.37m) wide and projecting 3'4" (1.02m) from the southern elevation, represents a heating tower similar to those in Old and Decker Mills. No evidence was observed for sandstone hearths on any of the floors, as were present in Decker Mill, suggesting that the heating tower was furnished with a single stove, probably located in the basement.

The original roof structure within New Mill is likely to have had the same basic form as that within Old and Decker Mills. The original roof was most probably hipped at both ends, rather than just at the eastern end, as at present, each with a longitudinal half-truss of similar style to the main roof. Dragon-beams supported the principal rafters of the hip. Each pitch has three butt-purlins, each tennoned and pegged through every truss. The rafters were aligned on 18" (0.46m) centres, and were mainly the full length of each pitch. They were typically 2½" by 3¼" (64mm x 83mm) in section, and nailed onto the purlins and wall plates, differing from those in Old and Decker Mills, which appear to have been birds-mouth jointed to the wall plates.

The wall plates, which sit on the inner face of the external walls comprised relatively short timbers, in comparison with the huge lengths used for the tie beams and principal rafters, spanning up to three bays, jointed by crude bridled scarf joints. Several re-used round-headed Cumbrian slates were observed on both pitches of the roof, suggesting that this was the original roofing material.



Plate 38: One of the queen struts incorporated into an apartment in the roof space of New Mill

The tie-beams of the trusses all display dovetailed joist sockets, demonstrating that the upper floor had a ceiling, rather than being open to the rafters. The fact that the joist sockets stop 3' (0.93m) from each long-wall, revealing that significant loads were not applied to the floor within the eaves, as the floorboards would have been unsupported in this part of the roof-space. This would suggest that the roof-space was not used for warehousing, as only the central section would have been fit for such purposes. The queen struts were set narrower than either Old or Decker Mills, 13' (3.97m), compared with 13'9" (4.19m) in Old Mill and 14' (4.27m) in Decker Mill, despite the increased span of New Mill (16' (4.88m) wider than Decker Mill).

Evidence for the original power transmission within the structure is scant, as later remodelling, particularly that attributed to William Fairbairn, replaced or obscured much of the original apparatus. However, significant elements of the original power transmission survive within the ceiling structure of the fourth floor. Much of the ceiling remains exposed, with the majority of the lath and plaster/metal sheet fireproofing observed elsewhere in the complex, missing. This would appear to have been removed during the usage of the mill, with the exposed ceiling having been covered with many layers of white limewash, maximising the light within the spinning floor.

The ceiling comprised north/south-aligned 10" (0.25m) wide floorboards above 2" to 2⁷/₈" (51mm to 73mm) wide east/west-aligned joists, positioned on 18" (0.46m) centres, the northern one located 6" (0.15m) from the north elevation, with 27 joists per bay. Several display Baltic timber marks similar to the timbers of the roof structure.

A longitudinal 'spine' beam ran the entire length of the fourth floor, offset 6" (0.15m) from the centreline of the mill. It comprised sections of 2" by 5³/₈" (127mm x 86mm) timber beam, attached (presumably nailed, but the jointing was obscured) to the underside of the ceiling joists, butting the transverse beams either side of each bay. Within each bay, this additional joist had a mixture of rebates and sockets, of varying sizes, which all appear to represent housings for features related to the original mules. Many such features, especially the sockets were blocked with lime-based plaster, containing large quantities of horse hair, suggesting an early date of disuse.

The most significant surviving elements relating to the original power transmission comprise six timber-framed apertures within the ceiling of the fourth floor, located within Bays 2, 6, 10, 13, 17 and 21. Each comprised a rectangular void, 32" by 14" (0.81m x 0.36m), located on the southern side of the 'spine beam', adjacent to the main ceiling beam, with a timber measuring approximately 6' by 7¹/₄" (1.83m x 0.18m) along the open side, representing housings for vertical transmission brackets (Plate 39).



Plate 39: Framing for the vertical transmission on the top floor of New Mill

Flywheel scars on the soffits of adjoining beams in Bays 5, 9 and 13, demonstrate the use of horizontal wheels at the base of the vertical shafts. A flywheel scar was also observed in a similar position in Bay 13 of the third floor. Two pairs of bolt holes, and several rebates in the adjoining beams represent the remains of fixings for sole plates relating to the vertical transmission. It is noteworthy that the three vertical transmission shafts to the west of the central stair tower were positioned on the eastern side of ceiling beams, whilst those to the east were on the western side. The remains of several cast-iron base-plates, presumably relating to Phase 3 line-shaft hangers, were also observed. Those in Bays 1, 10, 12 and 20 were broken, whilst that in Bay 9 had a complete base-plate, cruciform-shaped in plan, with a broken cruciform-section shaft projecting from it. All were located within the vicinity of the central 'spine beam', but varied between north and south of the beam. Bolt holes, most probably relating to similar line-shaft hangers were also observed in Bays 1, 4 and 19.

The number of vertical transmission shafts suggests that the original mules were driven from below. Conversely, it is unlikely that the vertical transmission boxes observed on the fourth floor relate to main drive-shafts, providing power vertically through the mill, as early line-shafting power systems relied almost exclusively on a single, or occasionally two vertical shafts. Vertical transmission between floors was most likely to have occurred in the proximity of the stair tower (Bay 12), where the main drive-shaft would have entered the mill from New Mill Engine House. Although this area was much remodelled during Phase 4, some evidence of the original drive-shaft remains *in-situ*.

The positioning of the flywheel scars associated with vertical transmission on the fourth floor demonstrate that the horizontal drive-shaft within the original layout of New Mill was located approximately 2' (0.61m) south of the centre-line of the mill. This layout appears to mirror that of Old and Decker Mills during the same period. Given that the engines were located on opposite sides of Old/Decker and New Mills, this demonstrates that, relative to the position of the engine, and hence the main drive-shaft, horizontal line-shafting was positioned in the same place in both buildings.

Many features observed above ground-floor level within the internal northern elevation appear to represent the layout of spinning mules, most probably within the original structure. The features include cut-outs in the northern elevation, presumably in order to accommodate larger machinery. The shape of the cut-outs show clearly the profile of the end of a spinning mule, and indicate that the mules were arranged in pairs, one per bay, for the entire length of each floor above the ground floor. At ground floor and basement level, the internal elevations did not have machinery rebates, suggesting these floors to have had a different function. It is most likely that preparatory processing was undertaken on the ground floors, and may suggest a similar arrangement in Old and Decker Mills, where no physical evidence for differences in machinery between various floors survived.

It is noteworthy that there is no evidence for the provision of toilet facilities within the original construction of New Mill. It is possible that such facilities were provided in the area immediately to the south of the mill, although this has not been confirmed.

Shortly after the completion of New Mill in 1804, work was commenced on completing the quadrangle of the Murrays' complex. The construction of New Mill steam plant and the Murray Street and Bengal Street blocks was finished during 1806, together with a canal basin within the courtyard. This work had several structural impacts on the original design of New Mill, where the Murray Street and Bengal Street blocks were butted onto its southern elevation; the windows of the three bays at each end of New Mill were covered by the new buildings to a height of four storeys. The solution, in both cases, was not only to block the windows, but also to re-face both internal and external elevations at the junction of the new structures. The main reason for this more complex solution appears to relate to the inclusion of further heating flues within the wall thickness of the remodelled wall. A significant increase in the thickness of the re-faced wall can be observed in Bays 2 and 3, presumably due to the insertion of the flue. To the west of the flue, within Bay 1, there is a 5" inward step in the external skin of the south wall, in the position of the eastern jamb of the original windows, reducing the wall thickness back to its original level. The original construction of the south elevation of New Mill was, by no means, straight, and the step in the wall face represents the position where the original wall, at the western end of the mill, was butted by the much straighter built Phase 3 rebuilding of the wall around the heating flue.

Projecting timber vents into these flues, similar to the upper vents into the heating towers within Old and Decker mills, were observed in Bay 2 on the 1st and 4th floors, and within Bay 21 on the second, third and fourth floors. The 9" (0.23m) wide timber vents were top-hung, and projected 2¾" (70mm) beyond the internal elevations at the base of the ceiling beam height. The top of each vent projected ¾" (20mm) from the brick wall-face, suggesting that the internal elevation had a plaster covering at this early phase. Visual inspection of the flue apertures was only possible from the ground floor on the Murray Street Block face of the wall, and revealed that small vents were located off the flue into New Mill. A blocked segmentally-arched brick aperture, 2'4" (0.71m) wide, was observed at first-floor level, above that in the ground floor of the Murray Street Block, with a slightly wider, similarly constructed feature observed at second-floor level. The ground-floor aperture, which may have housed the stove, was remodelled to form a hatch, or doorway, during later phases.

Physical evidence for the heating flue at the Bengal Street end of the south elevation is not readily apparent. The construction of a new engine house at the northern end of the Bengal Street Block, and the installation of an associated rope-drive in the eastern bay (Bay 22) of New Mill during the late 19th century (Phase 5) required substantial remodelling of this area, presumably removing significant elements of the heating flue. It would also appear that the wall was refaced, as was that adjoining the Murray Street Block. However, the remains of a segmentally-arched aperture, presumably a door, survive in the external ground floor wall face of New Mill, with a similarly arched aperture offset to the east at first-floor level. Nothing survives of the arch of a door aperture at second-floor level, directly above. It would appear from these door positions that the heating flue was offset to the immediate east of the first- and second-floor doorways, the location of the ground-floor doorway possibly suggesting a larger stove aperture at this level.

The doorways into the Bengal Street Block, observed at ground and first floor levels are contemporary with its construction. The second-floor doorway is of a similar style to that below, but has been extended vertically, or refaced during blocking, removing the segmental arch, whilst the third-floor doorway is significantly wider, although located vertical above the two below. It is possible that all represent original apertures into the four-storey Bengal Street Block, with the upper two having been remodelled subsequently.

Communication between New Mill and the Murray Street Block was facilitated by a doorway at basement level, situated 5' (1.52m) from the eastern elevation of the Murray Street Block. This was later blocked, as were doorways on the three floors above, located flush with the eastern elevation of the Murray Street Block, slightly east of that in the basement. The remains of a segmental or cambered brick arch survived above the blocked doorway on the second floor, whereas elsewhere the lintels were flat timbers.

Following the massive expansion of the complex during this phase, Murrays' Mills are recording as containing 84,300 spindles and 1215 operatives. This appears consistent with the estimated mule sizes and spindle counts for Old and Decker Mills, particularly when considering that the slightly later New Mill, on the northern side of the complex, would have housed larger mules than those in Old and Decker Mills, as it was 20" (0.51m) wider than Decker Mill. It is probable that the carriage length of the mules operating within New Mill was approximately 37' (c 11.3m), which would equate to around 324 spindles on each mule. The mules were arranged in opposing pairs, with 11 pairs per floor, equating to c 7100 spindles per floor. Spinning appears to have been undertaken on the upper six floors, which gives an approximate total of 42,750 spindles operating in New Mill. It is noteworthy that the neighbouring mill of McConnel and Kennedy was operating 85,000 spindles with considerably fewer operatives (1020), reflecting the larger size of their mules (Crompton Statistics 1811, quoted in RCHME and GMAU 1989, 6).

4.5.3 Phase 4 (c 1817 - Mid-19th Century)

Phase 4a: this phase comprised an internal re-orientation of New Mill, similar to that observed within Old and Decker Mills. This involved the replacement of the double row of columns with a single row, positioned slightly to the north of the centre-line of the mill, 22' (6.71m) from the southern elevation. However, unlike in Old and Decker mills, there is limited survival of columns from this phase, with only those used on the fourth floor, to the east of Bay 2, remaining. These were cruciform section solid cast-iron variants of 4½" (114mm) section, similar to those present within the Murray Street Block, but of a more substantial section. Examination of the column foot was not possible during this stage of the project, but the cap appeared very similar to those used on the first floor of the Murray Street Block, which appear to have been later insertions. These similarities, and documentary evidence pertaining to similar columns thought to have been used within the Bengal Street Block, might suggest a common designer or foundry.

Both the column type and engineering methodology used during the internal re-orientation of New Mill differ markedly from that applied to Old and Decker Mills, where hollow cylindrical columns of a much greater section were used. Several different types of column were identified in Old and Decker Mills, each supporting a ‘span bracket’, designed to replicate the support of the original double row of columns by effectively reducing the span of the timber beam carried above. The span of New Mill is slightly wider than that of Decker Mill, but no additional support for the more slender, solid-section, columns was deemed necessary.

It is not clear precisely when this internal re-orientation was undertaken, or in what sequence, with relation to the similar remodelling of Old and Decker Mills. It has been assumed previously that the work was undertaken by Fairbairn and Lillie in *c* 1817, in conjunction with similar remodelling of Old and Decker Mills. However, the two are so markedly different that it seems unlikely that they were undertaken concurrently, and by the same engineers. In the account of Fairbairn and Lillie’s work, there is no mention of moving columns in either mill (Smiles 1876), although Fairbairn was responsible for a similar, but more complex project of column replacement in the neighbouring McConnel and Kennedy’s mills at a later date (Fairbairn 1866).

The actual process of column replacement was much simpler than that adopted in Old and Decker Mills, where the use of span brackets interfered with the line-shafting. In New Mill, the row of new columns was positioned to the north of the existing line-shaft, and the original columns need not have been moved until the replacements were supporting the load of the beam. The simplicity of the process, and the similarity with Phase 3 columns observed within the Murray Street Block, suggest the replacement of columns in New Mill may predate that in Old and Decker Mills.

Gas lighting was certainly installed within the Murrays’ complex by 1819 (Sun ins. pol. 945442/11937), and it would appear unlikely that this was only in one of the two large spinning mills. The gas supply system used within New Mill may have been broadly similar in design to that used in McConnel and Kennedy’s mill in 1809. This had been manufactured and installed by Boulton and Watt, and comprised a network of $\frac{3}{4}$ ” (19mm) pipes attached directly to the beams, fed by a reservoir inside a gasometer house (MS 3147, 3/478/19; MS 3147, 3/478/21). However, the paucity of records pertaining to gas distribution systems at Murrays’ Mills within the Boulton and Watt archive suggests that they are unlikely to have been responsible for the installation of any such system. Conversely, the inclusion of a gasometer building to the south of Little Mill on the plan of *c* 1822 implies the use of gas within the Murrays’ complex by this date, but may also explain the different systems within the two large spinning mills within the complex. It is possible that the gas supply from the gasometer passed through a tunnel under Bengal Street, probably emerging adjacent to New Mill. Two T-section cast-iron beams across window apertures within Bays **16** and **17**, on the 2nd and 4th floors of New Mill may represent inlets for the gas supply, and each have sockets for housing pipes within the original castings. Old and Decker Mills are located much further from the gasometer building, and the gas supply would also have to cross the canal arm from the Rochdale Canal.

There is good evidence within New Mill for the modifications to the power transmission systems associated with the repositioning of the columns during this period. The most visible surviving element of this alteration was the installation of a new vertical shaft, located immediately to the west of the entrance to the stair tower, within Bay 12. The original drive-shaft from the engine through the basement of the stair tower was retained, but a new cast-iron carrier beam was inserted to reduce its unsupported length. A new footstep bearing and bevel gears were installed within the basement, with supporting brackets (also incorporating bevel gears for power transfer into each room) *in-situ* on the ground, first, second and fourth floors. All are of slightly different design, although the reason for this remains uncertain. That on the fourth floor is most complete, retaining the housing for the horizontal shaft into the room. An area of rebuilding was also observed in this location on the third floor, suggesting that a similar bracket was removed subsequently.

Evidence for line-shafting associated with the new power system is difficult to distinguish from that associated with later modifications, as the system remained in use until the late 19th century, when it was replaced with a rope drive. The broken foot of a line-shaft hanger was observed on the third floor, on the base of the ceiling beam between Bays 3 and 4, with bolt holes for similar hangers observed on the beams between Bays 2 and 10. These correspond to a bearing box containing an end-bracket at the northern end of the western elevation. A similar hanger foot, with partial survival of the shaft, was also observed by the southern elevation, on the beam between Bays 1 and 2 on the ground floor.

Two large, square bearing boxes towards the southern end of the east elevation on the third and fourth floors appear to represent power transmission from the rope drive across Bengal Street and into Little Mill (Plate 40). They would also have housed the eastern end of the horizontal line-shaft within New Mill.

A large, 2'6" (0.76m) diameter bearing box in the eastern elevation at fourth-floor level, in a corresponding position appears to have been used to transfer power across Bengal Street into Little Mill, and has been suggested as a contemporary feature. A similar box, located immediately to the south of the south-central window in the east elevation of the third floor, appears to have a similar function, and has a corresponding T-section end-bracket housing in the western elevation. The bearing box appears to have been cast to house the southern end of a carrier beam across the window to the north, suggesting a further line-shaft in this position.

A similar beam, although not attached to the end-bracket, was observed across the window in the western elevation, also in a similar position within the basement, and across the window to the north on the second and third floors. That on the second floor had a bearing box forming part of the casting at its southern end the end-bracket within being very similar to that at the northern end of elevation on the third floor. Rebuilding observed at the southern end of the eastern elevation on the first and second floors probably relates to the position of further bearing boxes, housing the ends of the horizontal line-shaft along the southern side of the mill.



Plate 40: Bearing box for line-shafting associated with Little Mill on the third floor of New Mill

Several T-section, fish-bellied, cast-iron beams, located within the ceiling of the fourth floor, within Bays 6 and 17, have also been associated with this remodelling of the power system. Each bay contains six beams, all inverted, with those in Bay 6, and the north and south examples in Bay 17, being closed-web, the remaining four in Bay 17 open-webbed (Plate 41). The closed-web beams all bear a stamp 'M 309 D' followed by a number, which appears not to be sequential, and have semi-circular 3" (76mm) diameter rebates in the top of the rib. The open web-beams bear the initials 'A & G M', relating to Adam and George Murray. Cast-iron, L-section beams were observed across the windows in the north elevation, positioned 5' (1.53m) above floor level, with that in Bay 17 having a 'M 309 C9' stamp. Similar beams within Bay 16 of the third floor, stamped 'M 309 B9', and second floor stamped 'M 309 A9', suggest that they were actually associated with hoists in the southern elevation, of uncertain date, but with external platforms dating to Phase 6.

Whilst this major overhaul of the power transmission system would have greatly improved the efficiency of the mill, the basic layout appears to have remained constant throughout these early phases of the structure, with 11 pairs of transverse mules per floor. The reason for changing the mules, and the associated power system, during this phase was likely to have been the introduction of self-acting mules by Richard Roberts by 1830 (Catling 1986, 115-16). In 1834 George Murray stated in a Parliamentary Paper that most of his mules were of 324 spindles (PP(HC) 1833 (450)). This demonstrates that the mules were still oriented transversely, as it would only be possible to arrange five mules of this length longitudinally per floor, which would equate to a total of only 20 mules per floor, as oppose to 22 mules per floor using a transverse layout.



Plate 41: Open-web carrier beam, fourth floor, Bay 17

Phase 4b: between 1824 and 1831, a single-storey structure, known as the ‘Blowing Room’ was constructed in the angle formed between New Mill and the Murray Street Block. The building was constructed at the basement level of the Murray Street Block, marginally lower than that of New Mill, and had access afforded via three steps at the eastern end of the adjoining wall. Its accepted name ‘Blowing Room’ suggests that it functioned as a primary processing area, where the raw imported cotton was broken out of its compressed, baled state.

The Blowing Room had structural impact within New Mill, both in terms of its construction, and also to allow integration within the complex. The two western cellar-light windows in the position of the Blowing Room, within the basement of New Mill were blocked, flush with the external face, to the depth of a single brick (9” (0.23m)). The eastern window was narrowed on its eastern side, by means of a splayed jamb, and remodelled to form a doorway into the new structure. This comprised a fireproof double-door, positioned flush with the internal wall of New Mill, with three rendered, presumably brick-built, steps down into the Blowing Room. The presence of steps, rather than a ramp, suggests that the doorway was used only for personnel access, rather than for materials transport.

A doorway inserted at second-floor level between New Mill and the Murray Street Block also appears to relate to the improved communication between the structures in the north-west corner of the complex at this time. It was located in the western bay, and comprised a metal sheet-clad sliding door, manufactured by ‘Fireproof Doors Ltd, London’. The doorway had a flat lintel, differing from the Phase 3 doorway on the same floor between the two structures, which had a segmentally-arched brick lintel. The door remains *in-situ*, but was blocked subsequently on the Murray Street Block face.

A secondary episode of column replacement appears to have taken place on the fourth floor of New Mill during the latter part of this phase, or possibly during Phase 5. This comprised the replacement of the western two columns, with 4” (0.10m) hollow, cylindrical cast-iron columns, each with a detached cap, bolted to the soffit of the original ceiling beam. These columns are similar in style to those used in the Phase 4 structural remodelling in the southern part of the Murray Street Block, but without the decorative astragal. These two columns differ markedly in style from the later Phase 6 mass replacement of columns, and appear to represent the replacement of individual failing columns, rather than an episode of mass replacement.

4.5.4 Phase 5 (Mid-19th Century - 1898)

There is little documentary evidence for alterations to the fabric of New Mill during this phase. Nevertheless, the internal structure underwent significant remodelling during the late 19th century relating to the addition of a new steam engine at the northern end of the Bengal Street Block. Few details are available regarding this late engine, although its installation clearly necessitated the rebuilding of the three north end bays of the building. The proportions of the demolished former engine house suggested that it had contained a vertical-type engine, whilst two prominent pilasters with stone cornices facing the yard suggested a date towards the end of the 19th century.

This engine drove a rope drive system, located on its northern side, which provided power transmission into New Mill via a rope race in the eastern bay (Plate 42). This replaced the engine located within New Mill Engine House, and re-orientated power transmission within the structure. The previous system, which ran successfully for almost 100 years, was based on power from the engine being transferred to the machinery via a primary vertical shaft, located in the central bay (Bay 12). Power was taken from this vertical shaft within each floor via a system of horizontal shafts, to drive the machinery.

The huge innovation of the rope drive was that it removed the need for a primary vertical shaft, with power instead being transferred directly from the engine house to a horizontal, longitudinal, shaft on each floor. This greatly reduced the power loss caused by gearing in the previous shaft system, and also increased the space and light on the working floor, as the number of horizontal shafts and associated wheels, drums and pulleys was reduced. Another great advantage was the use of multiple steel cables, known as ‘ropes’, on each drum, which allowed transmission to continue in the event of a breakage of one of the individual cables.

Evidence for the rope drive was observed in both the south and east elevations of New Mill. The remains of high, rectangular bearing boxes survive at ground through fourth floor levels, towards the eastern side of the eastern bay (Bay 22) of New Mill, within the south elevation. These represent the apertures for the ropes from the rope drive. At basement level, a smaller bearing box in the northern elevation is offset to the west of the elongated boxes above, and represents the position of the horizontal rope into the basement of New Mill. The upper boxes are taller than that to the basement due to the angle of the ropes to the upper floors, where they passed more obliquely through the external wall.



Plate 42: The rope race at the eastern end of New Mill following the removal of the mid-20th-century stair in 2017

At basement level, between bays **21** and **22**, an additional 6½” (165mm) diameter hollow cylindrical cast-iron column was inserted, 3’ (0.91m) south of the main column. A bracket on its north face houses a 3’ (0.91m) high cast-iron carrier beam, with a 22” (0.56m) wide mounting on its upper surface, 8’6” (2.59m) above floor level (Plate 43). This aligned with wall scars and projecting bolts in the west elevation (Bay **1**), which appear to relate to a carrier beam across the south central window, housing a terminal bearing for the line-shaft. Bolt holes were observed through the beams of all bays, with paint scars on the Phase 6 channel-section flitch plates, suggesting that line-shaft hangers were positioned on every beam.



*Plate 43: Additional column and carrier beam, New Mill basement, Bay **21***

Also within the basement, an I-section steel beam was inserted 10’ (3.05m) above floor level, in the south elevation of Bay **22**, to create a 5’8” (1.75m) wide access between the basement and the base of the rope drive at the northern end of the Bengal Street Block.

A document relating to the number of spindles and skilled operatives within the Murrays’ complex during this time shows that the number of spindles remains fairly constant, but the number of operatives is significantly reduced. This suggests that the early transverse-aligned mules within New Mill were replaced by longitudinal mules, most probably reducing the number of mules per floor from 22 to eight. Given the dimensions of New Mill, this would not have led to an increase in production, as in many later structures, but would have increased cost efficiency, as the number of skilled spinners could have been reduced by almost two-thirds.

A small rectangular structure projecting from the southern side of New Mill in Bay 8 represents the only toilet tower associated with New Mill. It is possibly shown on the Ordnance Survey plan of 1893 (although its position is similar to the eastern part of the 'Blowing Room', as shown on the earlier edition plan of 1853), and the rebuilding of the upper 11 courses suggests that it was reduced in height with the main structure of New Mill, dating it prior to Phase 6. The tower was constructed of extruded red brick, frogged 'BC', most probably referring to the local Bradford Colliery, in English Garden Wall bond, roughly keyed at each floor into the earlier fabric of the mill.

Each floor has a pair of tall, narrow, 6' (1.83m) by 2' (0.61m) windows in the southern elevation, with projecting sandstone sills and glazed brick lintels, with two projecting glazed brick string courses at third- and fourth-floor levels. The tower was divided internally by a central partition wall, separating the cubicle on the western side from the cloakroom to the east. Cast-iron louvred vents in the east and west elevations, on each floor, serviced both elements. Evidence of the two-light window frames, with top-hung ventilators, survives at basement level, covered with metal bars on the external face to protect the glass. The tower is significant in that it represents the addition of cloakroom facilities into New Mill, the late date suggesting that similar facilities were probably located previously in the Bengal Street Block, as those in the Murray Street Block and Old Mill would have been too far away.

The Phase 5 refenestration observed elsewhere in the complex also applied to New Mill, where window frames of identical style to those in Old and Decker Mills were inserted, comprising nine-light timber-framed casements with horizontal pivots in the central lights. As in the earlier structure, padding was required around several of the window frames in order to fit them into the irregular-sized apertures.

As with Old and Decker Mills, a fire escape was installed within New Mill, shortly after the programme of refenestration. It is noteworthy that New Mill only has a single fire escape, located in Bay 4, whilst the smaller Old and Decker mills structure has a pair of escapes, presumably due to the internal dividing wall between the two mills. That attached to New Mill is more similar in style to that on Decker Mill, with similar cast-iron corbels at ground-floor level, although with slightly more elaborate examples above, containing the design 'AS Co' within the lattice (Plate 44). Many of the corbels also bear a stamp '7700 R'. The cast-iron staircase in is poorer condition than those elsewhere within the complex, with many elements missing or badly decayed.



Plate 44: Detail of fire escape corbel

4.5.5 Phase 6 (1898 – c 1948)

This phase relates broadly to the ownership of the site by the Fine Cotton Spinners' and Doublers' Association Limited, which took control of A & G Murray Ltd in 1898. Modifications to the mill complex during this period included the electrification of the mills. This appears to have had a delayed impact within New Mill, given the late 19th century conversion of the power system to a rope drive. This appears to have continued in use until at least 1926 (Manchester City Council Planning Department 1926), probably representing the slow changeover to electricity, where some machinery was powered by line-shafts attached to electric motors, whilst others remained attached to the rope drive. Indeed, oral testimonies gathered during the fieldwork strongly suggest that the boilers continued to power the engine at the northern end of the Bengal Street Block until after World War II.

The most significant alteration of the early 20th century within New Mill was the reduction in height of the structure, from eight to six storeys. As with Old and Decker Mills, the precise date is unclear, but the work was likely to have been undertaken during a similar period, with that on Old and Decker Mills being completed by 1903. It was certainly complete by 1909, when an engraving of the Murrays' complex was published by the Fine Cotton Spinners' and Doublers' Association Limited. During the reduction in height, the roof structure appears to have been altered, with the western wall being reduced by one storey less than the others, to produce a gable end. The windows within this gable wall were blocked within the new roof-space, suggesting that it was not used as a working floor, more likely being used for storage.

The trusses within New Mill appear to have been re-inserted into their original positions, with chiselled assembly marks from 'III' to 'XIX' observed in ascending order from Bays 4 to 20, on the western, upper, face of each truss. As in the earlier Old and Decker Mills, the tie beams of the original structure also act as ceiling beams for the sixth floor. This meant that relocating the trusses as complete entities produced an extra horizontal beam, as the 4th floor ceiling beam remained *in-situ*. In the majority of bays (Bays 2, 3, 4, 5, 7, 8, 9, 13, 14, 17, 18, 19, and 21) the solution was the same as that used in Old and Decker Mills, with short timber posts, located at approximately $\frac{1}{3}$ span points, propping the truss tie beam from the ceiling beam below. This was bound with wrought iron stirrups, fastened with gibs and cotters. It is noteworthy in these truss types, that the propping posts (or puncheons) sit directly on the floor beams of the fifth floor, demonstrating that the roof-space retained a floor, and also that the trusses could be repositioned with minimal disturbance to the floor below.

Additional re-used ceiling beams were laid between the fourth-floor ceiling beams and the tie beams of the repositioned trusses in the remaining bays (Bays 1, 6, 10, 11, 12, 15, 16, and 20). As with the posts of the other trusses, these were laid directly onto the floorboards of the fifth floor, with longer wrought-iron stirrups jointing the three beams together. It is unclear why the two different approaches were used; the full-length ceiling beams were most probably seen as a stronger solution, although heavier and more difficult to position, and these may have been used in preference, where suitable members could be reclaimed from the floors above.

It is most probable that further alterations to the majority of the roof trusses were undertaken concurrently with their relocation to the fifth floor. Within each truss, the original queen struts, which were set 13' (3.97m) apart were cut away, flush with the collar, and replaced with cast-iron struts (with the exception of Bay 16), set slightly wider, at a spacing of 16' (4.88m). Each strut comprises a single cast member, formed in cruciform-section, measuring 7 $\frac{1}{8}$ " (181mm) on its north/south axis and 4 $\frac{3}{8}$ " (111mm) on the east/west axis (Plate 45). At its top, this joins an L-section head, formed to fit in the angle between the principal rafter and collar, with the flat inner end of the strut-head positioned directly below the surviving top segment of the original timber queen strut. All the cast-iron struts are identical, with the exception of those in Bay 16, with the northern struts aligned with the upper face of each truss, and the southern struts reversed, and therefore, aligned with the eastern, lower, face of the truss. The truss on the eastern side of Bay 16 differs, in that the cast-iron replacements for the original queen struts comprise only the heads, with the cruciform-section struts missing. These have not been removed subsequently, shown by the completeness of the heads, and the slightly different proportions between the two 'heads' in Bay 16 suggest that a new mould was made to cast each of the members, which were effectively used as hanging knee-braces. New timber struts, of similar scantling to the other truss timbers, were inserted outside the original struts; 4' (1.22m) on the north pitch and 3' (0.91m) on the south side. These were tenoned directly into the soffits of the additional timbers bracing the principal rafters, and were jointed with cast-iron stirrups.



Plate 45: Cruciform-section queen struts

The reduction in height of the mill appears to have coincided with a major campaign of internal structural strengthening, as in Old and Decker Mills. The detail differs between the two structures, in that there was a much greater replacement of columns within New Mill, but whilst many of the original timber ceiling beams were removed from Old and Decker Mills and replaced with steel I-section beams, those in New Mill were simply strengthened with supporting steelwork. Column replacement was undertaken from the basement to the third floors, using similar closed-cap hollow cylindrical, double-flanged columns to those associated with Phase 6 elsewhere in the complex. On the third floor the caps directly supported, and projected beyond, the ceiling beams, whilst on the floors below, the caps formed the base of load-transfer boxes, which formed the feet of the columns above. On the ground to third floors the columns were of 5" (0.13m) section, whilst the taller columns in the basement, although similar in proportion to those above, were of 8" (0.20m) section. The supporting steelwork for the original timber beams was in the form of two channel-section beams flitched either side of the original member. An 'LSW' stamp was observed on the vast majority, the rolling mark of Leeds Steelworks, which was producing steel sections between 1888 and 1928. It is noteworthy that the load-transfer boxes, associated with the replaced columns, easily accommodate the additional steelwork, strongly suggesting that this was a contemporary project.

An addition to the eastern end of the northern elevation, on Jersey Street, also dates this phase. It comprises a 2½ storey brick projection from Bay 22, in extruded brick, bonded with cement mortar in English Garden Wall bond, and is first shown on a deposited building plan of 1909 (Manchester City Council Planning Department 1909), as a 'cage hoist'. It projects only 2' (0.61m) from the original façade and has a flat concrete roof. A doorway, at street level in its northern face, has a concrete lintel bearing the inscription 'Jersey House', and also has a projecting concrete canopy above. The later deposited building plan of 1926 (Manchester City Council Planning Department 1926) shows the projection as two bays wide, with a central partition, but there is no evidence within the fabric to suggest that the southern part was ever constructed.

Within the eastern bay of the mill (Bay 22) several cast-iron beams, inserted into both the east and north elevations also appear to relate to the cage hoist. At ground-floor level, a T-section cast-iron beam was located within the northern window aperture of the east elevation, 6½" (0.16m) below the lintel. The ⅞" (22mm) section beam had two rectangular bolt holes, 8" (0.20m) apart, positioned within the face, either side of the strengthening rib to the rear, which presumably secured a housing for a pulley wheel, or guide, associated with the hoist, and also strengthened the structure across the window aperture. A similar beam positioned in the window in the north elevation had two strengthening ribs, at one-third separations, with two bolt holes, 6" apart, positioned centrally between the two ribs. This beam presumably also had strengthening properties and also supported a housing for cables associated with the hoist. At first-floor level, a similar T-section beam was also observed across the upper part of the northern window in the eastern elevation, but with a single strengthening rib, positioned 8" (0.20m) south of centre. This beam has two pairs of bolt holes; one on an 8" (0.20m) spacing, centred around the rib, with a further pair, 8¼" (0.21m) apart, centred 18" (0.46m) to the north of the rib.

A further beam, positioned 18" (0.46m) below lintel height across the window in the northern elevation, is of slightly narrower section ($\frac{3}{4}$ " (19mm)) and bears a different stamp ' 76 F ' in the centre of its face, suggesting a different manufacturer. It has two strengthening ribs, similar to that in the north elevation at ground floor level, with a pair of rectangular bolt holes, 6" (0.15m) apart, centred around each rib. No evidence for beams associated with the hoist was observed at 2nd floor level, whilst a T-section beam projects 2" (0.05m) from the east elevation, 1' (0.30m) south of the north window in the eastern elevation, on the 3rd floor. Given its location, it is most probable that this relates to the top beam of the hoist, and was most probably cut short, to its present length, with the removal of the hoist in Phase 7.

These cast-iron beams relate to the hoist. Most hoists and elevators of the 19th century were powered by steam engines, either directly or through some form of hydraulic drive. During the early 19th century, hydraulic plunger elevators were used in some European factories (Sterling Elevator Consultants, nd). In this type the cage was mounted on a hollow steel plunger that dropped into a cylinder sunk into the ground. Water forced into the cylinder under pressure raises the plunger and car, which fell by gravity when water is released. The next development was in use in Britain by 1835 (*ibid*). In this case the hoisting rope passed over a belt-driven sheave, or pulley, to a counterweight travelling in guides. The downward pull of the two weights held the rope tight against its sheave, creating sufficient adhesive friction, or traction, between the two so that the turning sheave pulled the rope along. In 1903, Otis (USA) introduced the gearless traction electric elevator, which could be employed in buildings of any height and operated at much higher speeds than steam-powered elevators. In a gearless traction machine, six to eight lengths of wire cable, known as hoisting ropes, are attached to the top of the elevator and wrapped around the drive sheave in special grooves. The other ends of the cables are attached to a counterweight that moves up and down in the hoistway on its own guide-rails. What remains unclear at New Mill, is whether the hoist was driven by the steam engine, via the rope drive, or used the new gearless traction technology, driven by an electric motor. Cases can be argued for either option: the rope drive would provide power at no extra cost, but the eastern end of New Mill was linked to the newly-constructed New Little Mill (1909), the first cotton spinning mill purpose-built for electric power (Williams and Farnie 1992). This demonstrates that the technology for an electric hoist was in place within the Murrays' complex during this phase.

The doorway in the north elevation of the new tower marked the first external access into the complex that was not controlled through the gatehouse within the Murray Street Block. Access was presumably directly into the hoist cage, and was, therefore, unlikely to have been a personnel entrance; however, the small size of the external door would not have lent itself to loading goods, especially raw materials, such as bailed cotton.

The addition of the hoist appears to relate to a change in use of the eastern end of the basement, and was probably associated with the erection of New Little Mill, constructed after a fire in 1908. A Plan of 1902 (Mather and Platt 1902) shows a single tunnel between the basement of New Mill and Little Mill, but during the rebuilding, an additional tunnel was added, clearly shown on the deposited building plan of 1926 (Manchester City Council Planning Department 1926).

Whilst the position of the earlier tunnel is somewhat vague, it is more likely to be that to the south, suggesting that the new tunnel was directly linked to the cage hoist. Both tunnels would appear to be that between the Bengal Street Block and Little Mill, as only this tunnel is shown on the Ordnance Survey plan of 1849; they were constructed of white, tile-glazed brick, both being brick-blocked subsequently. By Phase 6, the southern tunnel led directly into the rope race, but appears to have been constructed for both personnel and to allow access to water supply from the 6" (0.15m) Town Main water supply, running down the centre of Bengal Street. After the construction of the rope race it was presumably of less use as a personnel tunnel, presumably prompting the construction of a new tunnel to the north during the rebuilding of Little Mill. It is most probable that the earlier tunnel was also used to run electricity cables from the substation in the Bengal Street Block to New Little Mill.

Within Bay **20** a north/south-aligned one brick-thick, white tile-glazed wall, was constructed, with an eastern return, 10' (3.05m) from the north elevation. This was later demolished, east of a door jamb located by the return of the wall, but the deposited building plan of 1926 suggests that it continued to the east wall of New Mill. Three large windows, of nine-lights, 12-lights and 15-lights, within the surviving partition, with steel window frames and moulded glazing bars, ensured light from the main part of the basement, and a 5' (1.53m) wide doorway afforded access. The area was bounded from the rope drive on its eastern side by a similar, one brick-thick wall, immediately to the east of the columns between Bays **21** and **22**, elements of which, including two bull-nosed, tile-glazed brick door jambs, survived the Phase 7 insertion of the stairwell in the northern part of Bay **22**. The area was tiled with 6" (0.15m) black and white tiles, demonstrating the fashion for architectural detailing in the Edwardian period, particularly associated with engine houses, but generally lacking from the *in-situ* remains within the Murrays' complex.

Towards the latter part of Phase 6, steelwork pertaining to two hoists was added to the southern elevation of New Mill in Bays **6** and **17**. Both comprised 6" by 4 $\frac{3}{8}$ (153mm x 111mm) I-section steel beams, projecting through the elevation either side of the original window apertures, with a similar beam projecting from the bay to the east, forming an external hoist platform. The remains of keying for one brick-thick side walls on the eastern sides of the external platforms were clearly visible externally. Within each hoist bay, two transverse cast-iron 1" (25mm) section channel-section beams, were located flush with each face of the elevation, 5' (1.53m) above floor level. Each had mounting housings on their upper surfaces, similar in style to the beams used in the cage hoist in Bay **22**. Both hoists had central projecting I-section steel beams, of similar section to those forming the platforms, centrally above the fourth-floor apertures, which would have carried the hoist apparatus, presumably electric motor-driven hoists similar to those observed in Old Mill Engine House and the Murray Street Block. The hoist in Bay **6** accessed the structure on the 4th floor only, whilst that in Bay **17** serviced the first to fourth floors.

4.5.6 Phase 7 (c 1948 - 1950s)

This phase relates to the end of textile manufacture within the Murrays' Mills complex, when the Fine Cotton Spinners' and Doublers' Association Limited conveyed the mill complex to two or more separate companies. Unsurprisingly, there was no expansion of the mill complex during this phase, although modifications for access purposes were undertaken within New Mill.

In 1948, a lift shaft was constructed in Decker Mill. A similar lift-shaft, constructed in New Mill, within the northern part of Bay 12 is presently undated, but the similarity in style and materials would suggest that it was broadly contemporary. It was constructed of 20th century extruded brick, in English Garden Wall bond, with bull-nosed corners, and was 2.50m in diameter, with a 2.00m internal shaft. A 1.50m wide doorway in the southern elevation had horizontal folding shutters to all floors. Above the fourth floor the lift shaft houses the decayed headgear, and projects through the roof, where it has a concrete slab flat-roof and a window in the northern elevation with concrete lintel and projecting concrete sill. Internally, a timber ladder from the fourth floor into the roof-space afforded access into a short timber stair into the top of the lift shaft via a low door with flat concrete lintel.

It is not entirely clear when the rope race in Bay 22 went out of use. It is marked on the deposited building plan of 1926 (Manchester City Council Planning Department 1926), but was certainly out of use by the early post-war years as a deposited building plan, dated 14th March 1950, proposes its conversion to a stair tower (Manchester City Council Planning Department 1950). This conversion comprised a one brick-thick stair-wall partitioning the northern half of Bay 22 and containing a timber dog-legged stair with brick spine wall. The western wall of the staircase incorporated the eastern Phase 6, channel-section, steel flitch plate and the original timber beam dividing Bays 21 and 22. The stair, which ran from basement to fourth-floor level, not only occupied part of the rope race, but also completely occupied the Phase 6 cage hoist, previously located in the northern part of the bay. The access from Jersey Street was retained, and was the reason for the siting of the stairs in this location, affording access to all floors directly from outside the mill. Each floor had a doorway at the southern end of the western elevation, and a central window in the southern elevation.

4.5.7 Phase 8 (Post-1950s)

Whilst the majority of Phase 8 activity relates to the abandonment of New Mill, several minor structural changes occurred after the cessation of spinning, during the building's use as a series of individual workshops. These were in the form of stud and plasterboard partitions, generally concentrated in the eastern end of the mill, demonstrating that the Phase 7 stair-well had become the main access into the structure following the dividing of the complex into smaller independent units. All window apertures within the southern elevation of the stairwell were blocked, showing that security and privacy were key issues during this phase.

After the abandonment of the structure in the late 20th century, all the cellar-lights on Jersey Street, Murray Street and Bengal Street were blocked with clinker block, with brick vents allowing circulation of air through the abandoned structure.

4.6 *New Mill Engine House*

4.6.1 *Introduction*

The documentary evidence pertaining to New Mill Engine House is superior to that relating to Old and Decker Mills. The structure was apparently constructed concurrently with New Mill, to contain a 45hp crank engine, with an associated boiler house for three wagon boilers constructed to its eastern side. The chimney for the boilers was attached to the fabric of New Mill, between bays **16** and **17**. The original engine was replaced during Phase 4, and the engine house expanded in late Phase 5 or early Phase 6 following the removal of this replacement engine.

Prior to the implementation of the repair work in 2005, the New Mill Engine House was the most poorly preserved within the Murrays' complex, having a collapsed roof and severely damaged floors (Plate 46).



Plate 46: View of the derelict New Mill Engine House in 2004

4.6.2 Phase 3 (c 1804 – c 1817)

The original New Mill Engine House was a sub-rectangular structure, measuring 50' (15.25m) in length, by 16'9" (5.11m) wide. It was constructed of mould-thrown, hand-made brick, similar to those in the adjacent mill, in English Garden Wall bond. *In-situ* fabric of the original structure, within the eastern elevation, suggests that the structure may possibly have had a single-pitched roof, sloping down to the south, from a height of c 24' (7.32m) at its northern side, despite the proposed structure shown in the original Boulton and Watt drawings having a pitched roof (MS 3147, 5/364), which also showed the building as approximately 15' (4.58m) shorter. Centrally within either end elevation were tall arched windows, 5' (1.53m) wide, 11'6" (3.51m) high, below a triple-skin, round, brick arch. That in the eastern elevation appears to comprise different coloured brick, but that in the western elevation is the same as the surrounding elevation, suggesting that both originally matched the main body of the building. Access into the engine house was proposed from within the stair tower of New Mill, although it has not been possible to verify this during the current phase of the project. There appear to have been no openings within the exposed face of the eastern elevation, the flywheel axle and driveshaft being located within the junction with the stair tower.

Nothing survives of the original boiler house and flue, although the aperture for the steam pipe, from the wagon boilers into the engine, survives to the south of the window in the eastern elevation, just above sill height. The flue from the boilers led into the square section chimney, located between Bays 16 and 17. It would appear similar in construction to that associated with the earliest engine house on the complex, located between Old and Decker Mills. The chimney butts the external face of New Mill, although was of broadly contemporary construction, and had access into the flue at 3rd floor level, on the western face, through a fish-scale pattern cast-iron grill. As with the original chimney serving Old and Decker Mills, it is unclear how far above roof level the chimney originally projected.

The original driveshaft entered New Mill, at basement level, through the stair tower, immediately to the west of the C-section central stone column, identical to that in the slightly earlier Old and Decker Mills stair tower, also housing fire-fighting equipment supplied by Boulton and Watt. This part of the stair tower remains inaccessible, but more detailed recording will be possible after initial consolidation.

4.6.3 Phase 4 (c 1817 - Mid-19th Century)

Although drawings for a new engine for New Mill were supplied by Boulton and Watt in 1829, this engine appears not to have been commissioned. However, the engine was replaced prior to 1849, with a coal wharf also attached to its southern side, as shown on the Ordnance Survey 60": 1 mile map.

Limited excavation inside the engine house in 2017 revealed that the large stone foundation beds for the engine survived *in-situ* (Plate 47).



Plate 47: The engine foundation beds exposed in New Mill Engine House

It is quite possible that a large cast-iron strengthening plate and two horizontal straps around the chimney, relate to the structural re-organisation of New Mill during this phase. The two straps are located at basement window level, and rebuilding within the internal jambs would suggest that they were not original features. Similarly, the cast-iron plate, attached to the southern side of the chimney at ground level, does not appear integral to the original construction.

4.6.4 Phase 5 (Mid-19th Century - 1898)

The Ordnance Survey 25": 1 mile map of 1893 indicates that the boiler house associated with the original engine had been demolished. This demonstrates that the engine was redundant, and presumably, that the new engine at the northern end of the Bengal Street Block had been constructed. Although the chimney is located adjacent to the new engine, the lack of boilers mean that it too was redundant, steam being supplied by a pipe from the newer boilers associated with the Phase 5 Old and Decker Mill Engine House.

4.6.5 Phase 6 (1898 - c1948)

The plan of the Murrays' complex produced in 1902 for the installation of the automatic sprinkler system (Mather and Platt 1902) shows the engine house enlarged to its present size. The south wall appears to be retained as an internal partition, with the structure extended to the edge of the canal basin, which is not shown, suggesting that it had been infilled by this time.

The new extension to the engine house was constructed in slightly darker hand-made brick, in English Garden Wall bond, suggesting the 'BC' frogged brick observed in several other structures within the complex during this phase. The end walls were raised to 1st floor height, with gables above, and three simple collared trusses (shown in section on a deposited building plan of 1926 (Manchester City Council Planning Department 1926)), supported on sandstone pads within the internal wall faces, supporting a pitched Welsh slate roof. Windows inserted into each of the five bays at basement level, and all but the central bay on the ground floor, were similar in style to those elsewhere in the complex, with cambered brick arch lintels and projecting sandstone sills. The 1st floor windows project up to the eaves above sandstone sills, with a projecting I-section 14" (0.36m) by 6" (0.15m) rolled steel joist, similar to those used to support the inserted first floor, projecting above the central bay. The apertures below, on the 1st and ground floors were of similar style to the windows, but extended below, forming doorways for the electric motor hoist attached to the projecting steel beam.

The expansion of the engine house also extended to the east, with a single storey, sub-rectangular structure, shown on the 1902 plan (Mather and Platt 1902) as housing the 'Nº 3 Auto Fire Pump' with 'Suction Tank over'.

The deposited building plan of 1926 details the conversion of the western part of the upper floor into a first aid room and office, with new access from immediately to the west of the stair tower, and two new windows in the western gable. An associated section through the building describes the basement as a 'waste cellar', but has no annotation for the ground floor. The proposals appear to have been not quickly undertaken, as the 1927 revision of Goad's Insurance Plans describe the structure as 'Bobbin store....waste basement...2 (storey) + basement'. The proposals were implemented, with the new windows in the western gable having flat sandstone lintels, similar to those in Doubling Mill (c 1842). The internal partition to the first floor was also installed, suggesting that the hoist went out of use at this time, although both survived to the abandonment of the structure in Phase 8. A staircase accessing the ground floor doorway on the southern side of the structure, still *in-situ* at the time of the RCHME survey (RCHME and GMAU 1989), but subsequently dismantled, would also appear to date from this time.

4.6.6 Phases 7 and 8 (c 1948 – post-1950s)

Little appears to have altered from Phase 6 until the time of the RCHME survey in 1989, apart from the demolition of the pump shed, attached to the eastern elevation, some time after the Ordnance Survey map of 1969. However, a subsequent fire led not only to the removal of the roof, but also the rebuilding of the gables to flat parapet walls, presumably for safety reasons, but matching the style of the Old and Decker Mill Engine House, which has a hipped roof.

4.7 *Murray Street Block*

4.7.1 *Introduction*

The Murray Street Block is orientated approximately north/south along Murray Street (formerly Pit Street), which lies at an angle of eight degrees beyond perpendicular to Union Street. It is, therefore, not perpendicular to Old and Decker Mills to the south, but is instead aligned perpendicular to New Mill, adjoining its northern end. The block comprised four structures; the Murray Street Block, a 'Blowing House', an 'Air Raid Shelter' and a 'Lean-to Garage'. The main building may be further subdivided into Murray Street South Block, Murray Street North Block, and Murray Street Link Block, although these elements all appear to originally have been of a single build.

The original structure comprised four storeys of 20 bays, with access through the block into the central courtyard, via a two-storey arch in the tenth bay from the southern end, immediately south of centre. Access to the building itself was afforded via doorways in the western elevation either side of this arch. North of the arch, the structure had a basement level, similar to Old, Decker and New mills to the north and south. The Murray Street Block was extended several times on the eastern face, primarily with an increase in depth of the structure to the south of the arch, and later by the addition of ancillary buildings onto the eastern face of the northern, and to a lesser degree, southern parts of the block.

The principal fabric of the entire Murray Street Block is brick, faced in Flemish bond on the external west (front) elevation and English Garden Wall bond on the external east (courtyard) elevation. The internal walls are also generally faced in English Garden Wall bond. Several of the apertures in the west elevation have sandstone dressings. The original building survives to four storeys at the southern end, with a hipped roof to the original structure at its southern end, and a gable at its northern end with projecting brick and sandstone copings either side of the archway bay. The extension to the eastern side of the South Block has a separate pitched, hipped roof. The structure comprising the North Block had been reduced to two storeys in the 20th century, finished with a flat roof, although the top two stories were reinstated in 2006-07 (Plate 48).



Plate 48: View of the Murray Street Block in 2007, following the reinstatement of the top two storeys

On each floor the ceiling is generally supported by transverse timber beams, supported by a mixture of solid-section cast-iron cruciform columns, and later, hollow, cylindrical cast-iron columns. The flooring consists of multiple layers of timber boards, generally east/west aligned over north/south-aligned joists. These are almost exclusively underdrawn with lath and plaster, except in the basement of the northern part of the building, where the ceiling of the main body of the mill is of bricks, supported on I-section cast-iron beams, and the extension to the east (the 'Blowing Room'), where the ceiling is of later brick-arched construction.

4.7.2 Phase 3 (c 1804 – c 1817)

Despite much alteration, the Murray Street Block retains a significant portion of original fabric. Cartographic evidence, provided by a Boulton and Watt plan, shows that the original structure was completed by c 1806, and the results of building investigation within New Mill have indicated that the Murray Street Block was a later addition than New Mill, itself dated to 1804 on the same plan. As with the earlier structures forming the Murrays' Mills complex, the Murray Street Block was constructed of locally-made, mould-thrown brick, bonded with a pale lime and sand mortar. Brick dimensions were generally 9" by 3⁷/₈" by 2³/₄" (229mm x 98mm x 70mm), slightly less deep than typical bricks of the period, which tended to measure from 4¹/₄" to 4¹/₂" (108mm to 114mm) deep (Harley 1974, 76). The western elevation, fronting Murray Street, was constructed in Flemish bond, whilst the eastern face was in English Garden Wall bond, with rows of headers every five courses. Wall thicknesses throughout the original build appear to be consistently c 20" (0.51m).

The original construction of the Murray Street Block butted the Phase 1 toilet tower projecting from the north-west corner of Old Mill, thereby completing the external wall of the courtyard. This comprised the construction of a matching toilet block, removed subsequently, at the southern end of the Murray Street Block, as shown on the Boulton and Watt plan of c 1806. The southern end of the western face can clearly be seen as rebuilt, where the toilet tower was removed. On the southern elevation, a wall scar for the blocking of the toilet tower was observed, 4'6" (1.45m) from the west side at ground-floor level, narrowing to c 3'4" (1.03m) at first- and second-floor levels. Internally, 2'9" (1.32m) wide brick-blocked doorways into the toilet tower survive at first- and second-floor levels, with a low (2'4" (0.71m) high) double-skinned, brick-arched aperture at the base of the southern internal elevation. This is likely to represent access to the base of the toilet tower, presumably to empty a simple earth closet.

At its northern end, the Murray Street Block was butted onto the slightly earlier New Mill. Partial remodelling of New Mill appears to have allowed the keyed construction of the new building, although late repointing of the junction obscures any detail. Below ground floor level a 7" (0.18m) wide rebate may have been part of the original construction to house the downpipe of the original rainwater goods. The feature has late concrete infilling.

Externally, the majority of bays have a 4' (1.22m) wide window, 6'2" (1.87m) high to the crown of a shallow brick-cambered arch, similar to those present elsewhere within the complex, and with projecting flat sandstone sills. However, several bays have different windows and door apertures, reflecting varied use of different areas within the structure, compared with the uniformity of the spinning blocks (Old, Decker and New mills). Bay **10** marked the entrance to the courtyard through the Murray Street Block, having a brick archway 12' (3.66m) wide and 15'6" (4.73m) high. The arch itself is a shallow, three-centred arch, allowing the maximum width possible for load height and, although it was later heavily remodelled, it is shown to span the entire bay on the earliest plan of the Murray Street Block.

The internal layout of the original structure is somewhat obscured, due to heavy remodelling during subsequent phases. The northern part of the structure, north of the archway on Bay **10**, has a 14' (4.27m) deep basement, 8' (2.43m) below street level, similar to those in Old, Decker and New mills. Access to the ground floor was afforded by both the stair from the courtyard, and by a stair in the western part of Bay **11**. The position of access to the upper floors of the Murray Street North Block appears to have been via New Mill, at the northern end of the adjoining wall. To the south of the arch in Bay **10**, a door in the western elevation led into the lower ground floor of the southern part of the block. All the internal partitions appear to be inserted, with none of the internal walls keyed into the external elevations.

Several-floor levels remain to the south of the corridor in Bay **9**. The original floor level of the southern five bays, at least, appear to be that still present in Bays **4** and **5**, but it is unclear what the original floor level would have been in Bays **6-8**. Bay widths are more consistent than in Old Mill, and are narrower than in Old, Decker and New mills, suggesting a different function. Bays were typically 8'6" (2.59m) wide, with narrower bays (6'6" (1.98m) and 7' (2.13m)) at the southern and northern ends, where it infilled the gap between Old and New mills. The bay with the arched entrance (Bay **10**) was significantly wider (13'3") to allow vehicles into the courtyard, with narrower 7' (2.13m) bays (**9** and **11**) either side. All the present staircases are inserted features, but evidence of a possibly original stair position was observed in Bay **8**.

Street-level window apertures survive along the length of the western elevation, and the majority of the eastern elevation, although several have later remodelling. In the northern part of the block, the windows provided light to the deep basement, which appears to have had a flagstone floor. A recessed aperture in the southern elevation of this basement, blocked by a later loading door, suggests that the original structure also had a cellar-light in the south elevation. In the north elevation, a 3'8" (1.12m) wide doorway, with rebuilt jambs, leads into the basement of New Mill, and although remodelled, it is probable that this door was an original feature that provided the main access into the basement.

Ground-floor level is consistent throughout the original structure, and corresponds with the ground-floor levels in Old, Decker and New mills, c 6' (1.83m) above street level. The floor appears to have been supported on rectangular-section 8 $\frac{7}{8}$ " by 2 $\frac{3}{4}$ " (225mm by 70mm) pit-sawn timber joists, spanning from the long-walls on 1'6" (0.46m) centrings. These were overlain by at least one layer of north/south-aligned timber floorboards. There is no surviving physical evidence for the original staircase position for access from street level to the ground floor of the Murray Street South Block. However, a 3'2" (0.91m) hatch cut through the western end of a joist in Bay 8 of the lower ground floor may possibly represent the position of an internal ladder/stair.

No evidence of original partitions was observed within the northern part of the Murray Street Block. However, the presence of an oriel window within the eastern elevation, with an external stair to the north, implies that part of the ground floor of the North Block contained offices. The window, located in Bays 11 and 12, had been badly damaged by the insertion of a lift shaft into Bay 11 during the 20th century (Phase 6), but was repaired in 2007-07.

Internally, the window is panelled with decorative beading, incorporating recessed circles at either end. It is possible that this panelling is a later alteration, as it is identical to that in a similar window in Bay 7 of the Phase 4 extension to the eastern side of the Murray Street Block. The arch to the north of the oriel window (in Bay 13) also appears to be of original construction, and comprises a double row brick arch. The present stairs to the east are late (Phase 8), but are likely to have replaced an original staircase, first shown on the detailed Ordnance Survey map of 1849. Similar arched openings were observed in the eastern wall of the original construction of the South Block in Bays 6 and 7. These suggest the former presence of two doorways, or more probably one doorway and a loading hoist, within the eastern side of the Murray Street South Block.

Several apertures were observed in areas of exposed brickwork of the eastern and northern elevations of the Murray Street North Block. In the eastern elevation, a 2' (0.61m) high 13" (0.33m) wide aperture with single-skin brick arch was observed 18" (0.46m) north of the window in Bay 14, at a similar height to the window sill. The feature has later blocking in mould-thrown brick, bonded in a pale lime/sand mortar, and is partially covered by a later partition. This seemingly represents an aperture for power transmission. A wider, arched aperture, of similar construction, measuring 4' (1.22m) high and 2'5" (0.74m) wide, survives at ground-floor joist level, located centrally between the windows of Bays 17 and 18. Again, the feature would appear to relate to power transmission to the ground floor of the Murray Street North Block.

A further aperture, positioned centrally in the northern elevation of the ground floor, appears to form the base of a flue, located within the wall thickness of the dividing wall to New Mill. The feature was 3'9" (1.14m) wide and 7' (2.14m) high, but appears to have been enlarged to form a doorway between the Murray Street Block and New Mill at ground-floor level. Examination of the flue from below suggests that small vents were located off the flue into New Mill. Within the southern elevation of New Mill in this position, top-hung angled timber apertures survive, just below ceiling level, which presumably housed the vents.

A blocked 2'4" (0.71m) wide, segmentally-arched brick aperture was observed at first-floor level above that in the ground floor, with a slightly wider, similarly constructed feature observed at second-floor level above. It is probable that these features are more representative of the form of the original aperture at ground-floor level. Within New Mill, the jamb of an original window in the south elevation of Bay 1 was observed, demonstrating that New Mill originally had window apertures in the south elevation, prior to the construction of the Murray Street Block. Examination of the external fabric, and that within the Murray Street Block, strongly suggests that the southern three bays of New Mill were externally re-faced during the construction of the Murray Street Block, allowing the insertion of the heating flue within the former window aperture of Bay 2.

Apart from the wall-scar on the southern external elevation of New Mill, the first floor of the Murray Street Block survives only in the southern ten bays, the northern part of the four-storey structure having been removed during the second half of the 20th century (Phase 8). The arrangement of the southern part of the block appears to have originally been similar to the floor below, but with only 10' (3.05m) of the eastern wall surviving. This had a later doorway inserted into it, obscuring any detail of a possible window in Bay 1. Windows similar to those elsewhere in the complex were observed in each bay of the western elevation, except above the arch in the wider Bay 10, where there was a larger horizontally-oriented window, which appears to have been inserted during Phase 4.

A first-floor doorway at the western end of the southern elevation led into the toilet tower located to the south-west of the present structure. A window to the east, similar to those in the western elevation, appears to be an original feature. The timber lintel of a further window was observed further to the east, but the aperture beneath was not visible below the present wall-finish. The original floor supports for the second floor were not visible, apparently having been replaced with larger scantling beams to each bay during the construction of the extension on the eastern side during Phase 4. The internal cross-walls, either side of Bay 10 butt the western elevation, suggesting that the first floor was originally one room.

The second floor of the Murray Street Block is very similar to the first. The original layout appears similar, with only the southern ten bays surviving. As with the first floor, the cross-walls butt the external elevations, suggesting that they were later insertions. The ceiling of the surviving second floor differs from that below, in that it forms the under-drawing of the roof trusses above. It is probable that the present truss structure is original. This comprises braced king-post trusses jointed with iron fittings, as in Old, Decker and New mills. The king-posts, which clasp the ridge board, have jowled heads, butted by the principal rafters, which have butt ended purlins trenched into them. The southern end of the roof is hipped, behind a parapet wall, with dragon beams across the corners of the southern elevation. A central, longitudinal timber across the southern bay, forms the tie beam of the hip truss. Each bay has 3" by 2" (76mm x 51mm) rafters, on approximately 14" (0.36m) centrings, overlain by 2" by ¾" (51mm x 19mm) laths on 8" (0.20m) centrings.

Phase 3b: it would appear that, shortly after the initial construction of the Murray Street Block, the floors were deemed unsuitable and required strengthening. This was undertaken in different ways in the southern and northern parts of the block, possibly at slightly different times, and probably reflecting different usage of the two areas of the building. The floors in the southern end of the building were strengthened by the insertion of slender, cast-iron cruciform columns, at lower ground, ground and first floor levels. These supported a north/south-aligned spine of T-section fish-bellied cast-iron beams, jointed over the column caps. Each 3½" (89mm) section of lower ground-floor column has a square section cap and base, the base fitted into a square pocket of a cast-iron baseplate, cut into a sandstone pad, whilst the cap slid into a cast, two-piece pocket formed at the ends of the T-section beams above. At ground- and first-floor level the column bases differ, in that the foot of the shaft bifurcates around the original transverse joist, to rest on thin timber packings above the fish-bellied spine beams. At first-floor level, the column cap fits into a pad to a transverse timber bridging joist, but this would appear to be a later replacement of the cast-iron T-section longitudinal beams observed on the floors below. The columns were positioned at each bay division, with the southern five positioned on the centre-line of the building. The northern three columns were, however, positioned 2' (0.61m) to the west, probably reflecting the layout of particular machinery in the early structure.

A different approach to strengthening the structure appears to have been adopted in the northern part of the Murray Street Block. Rather than inserting columns, the open floorspace was maintained by the use of truss bars, attached to every seventh ceiling joist, supporting a central longitudinal spine beam. The wrought-iron bars were connected to L-shaped brackets, attached to the joists and the external walls. The truss bars supported a central spine beam via cast-iron pads, through a central rebate of which the bars passed. The bars were then tensioned at either end by tightening nuts outside eye-loops on the L-shaped wall brackets. Nothing appears to remain of the original ceiling structure of the basement.

The plan of Murrays' Mills dated *c* 1822 shows a 'shed' and one storey 'oil house' at the southern end of the Murray Street Block, butting the toilet tower, and projecting slightly beyond the eastern elevation. Whilst they do not appear on the earlier plan of *c* 1806, they were quite possibly constructed during Phase 3. No direct evidence of either structure survives, and the 'oil store' must have been demolished prior to the extension to the eastern side of the southern part of the Murray Street Block during Phase 4. However, several blocked features visible in the south external elevation may relate to the 'shed'. A 4'6" wide (1.37m) and 3'4" high (1.02m) blocked rectangular aperture, 11' (3.36m) from the west end of the southern elevation quite possibly represents a hatch or access from the 'shed' into the basement of the Murray Street Block. Similarly, a 2' by 13" (0.61m x 0.33m) cast-iron bearing box to the east may represent the supply of power into the 'shed', perhaps to drive machinery associated with a workshop, such as a lathe.

4.7.3 Phase 4 (c 1817 – Mid-19th Century)

Phase 4a: whilst major internal re-orientation of Old, Decker and New mills were undertaken during the earliest part of Phase 4, there is little direct evidence of similar alterations within the Murray Street Block. The first of two major episodes of expansion to the Murray Street Block can be dated to between Swire's map of 1824 and Banks and Co's map of 1831, and comprises the erection of a single-storey structure, known as the blowing room, on the eastern side of the Murray Street North Block (Figure 2).

The building was constructed at the basement level of the Murray Street Block, marginally lower than that of New Mill to the north, and to a height of ground-floor level, allowing the inclusion of cellar-lights in the eastern and southern elevations. The structure incorporates the only example of brick-arch fireproof construction within the Murrays' Mills complex.

However, the use of rolled steel joist in the ceiling indicates this to have been a later insertion, removing all traces of the original ceiling, which may not have been fireproof, and was probably similar to that in the Murray Street Block. It had been suggested that rolled wrought iron beams had been used in the ceiling of the Blowing House (Donald Insall Associates and Structural Perspectives 2002), although close inspection during the building's demolition in 2017 confirmed that they were actually of steel (Plate xxx).



Plate 49: The site of the Blowing Room following demolition in 2016, showing the stubs of the rolled steel joists embedded in the Murray Street Block and New Mill

Access to the Blowing Room was afforded from both New Mill and to the Murray Street Block. A 7'4" (1.93m) wide brick-arch doorway in the eastern elevation appears to have provided access to the courtyard, presumably via a flight of steps, although there is some evidence to suggest this may have been a later insertion. Light was provided by three cellar-lights in the southern elevation, and probably two in the eastern elevation, although the blocked evidence of the southern window is all that survives.

Phase 4b: sometime between 1831 and 1849 the southern part of the Murray Street Block underwent a large-scale expansion, with the addition of a 7'6" (2.29m) wide extension along the length of the eastern elevation, to the full height of the structure. It was constructed of more orangey-red brick, in English Garden Wall bond, with its northern bay curving to meet the inner face of the archway through the Murray Street Block in Bay 10. This appears to have been the culmination of a period of architectural enhancement to the Murray Street Block, and presumably also the Bengal Street Block on the opposite side of the courtyard.

The most striking feature of this remodelling is the arch on the external face on Murray Street, which was refaced with rusticated, slightly projecting ($1\frac{1}{2}$ " (38mm), chamfered sandstone voussoir dressings above similarly chamfered sandstone quoined jambs. Detailed examination of the arch showed that many of the original bricks forming the western elevation had been cut, and that similar bricks were re-used to infill the indented quoins of the arch, which was cut through the external face at the outer diameter of the quoins. The inner face of the arch had also been rebuilt below first-floor level, in the same orangey-red brick as the eastern extension to the Murray Street South Block, which butts its southern end. This arch had projecting sandstone pads at the springing points of the arch and also had a moulded sandstone keystone, but was otherwise constructed in brick (Plate 50).



Plate 50: Rebuilt inner arch of the Murray Street Block (Link Block), Bay 10

Either side of the external archway, the street-level doorways, each 4' (1.22m) wide and 9'6" (2.90m) high, affording access to either side of the building, were similarly refaced with chamfered sandstone surrounds. It is unclear whether these apertures formed part of the original construction of the Murray Street Block, or were inserted at the time of the remodelling of the western façade. It is also unclear whether the northern doorway was cut by the ground-floor window above, or whether the sandstone quoins of the arch were cut to fit around the existing window aperture, which would appear more likely (Plate 51).



Plate 51: Cut quoin stone of the doorway in Bay 11 of the Murray Street Block

Two bays either side of the doorways (Bays 7 and 13), the ground floor windows also have dressed sandstone surrounds, with stepped voussoirs and quoins, unlike the door apertures below. The quoins extend to the top of the street level cellar-light windows, with the area between the ground floor sill and street level lintel infilled with an angled sandstone panel. The lintel of the southern window has been removed and replaced with a curved cast-iron lintel (Plate 52), providing additional physical evidence for the architectural details to be later insertions.



Plate 52: Inserted cast-iron lintel, west external elevation, Bay 7 of the Murray Street Block

Above the main archway (Bay 10), the first- and second-floor windows on the western elevation are very different from those elsewhere within the complex, being horizontal, as opposed to vertical. Each comprises central nine-light windows, similar in proportion to the standard windows, flanked on each side by flat sandstone columns, which forms the mullion to a vertical, three-light window either side. The window surrounds project beyond the wall face, and have decorative mouldings, with rain hoods above and a sandstone freeze between the window, which has a central rectangular recess for a plaque.

On the eastern face, the windows above the archway were constructed in a style similar to the remainder of the structure, but were significantly wider, measuring 5'6" (1.68m), compared with the 4' (1.22m) standard width. As with the arch below, bricks of the original fabric have been cut, and rebuilds around the window apertures are visible internally, demonstrating the windows to be later insertions.

A 4' (1.23m) wide aperture in the eastern elevation of Bay 9 appears to be contemporary with the construction of the eastern arch into the courtyard. This suggests that personnel entry into the courtyard was via a corridor along the southern side of the arched entrance, but the 1849 Ordnance Survey map clearly shows a curved passageway from Bay 9 in the west elevation, to Bay 7 in the east. Above this doorway in the eastern elevation an oriel window was constructed at ground level, similar in appearance to that within Bay 13 of the original build. However, the method of construction differs, with the window sill supported on a lath and plaster partition, itself supported on curved, fish-bellied, inverted T-section cast-iron beams (Plate 53), which extend along the eastern external elevation of the extension to both the north and south. It remains unclear whether the style of the window copied that of the Phase 3 window in Bay 13, or whether that was replaced or re-panelled to match the new window in Bay 7. The area of the extension to the north of the oriel window is clearly marked on the 1849 Ordnance Survey plan as 'Lodge'. Access was presumably afforded from the courtyard, below the oriel window.



Plate 53: Constructional detail of oriel window, Bay 7 of the Murray Street Block

Within the new extension, the southern part, within Bay 1, formed what appears to have originally been a stair-tower, with evidence of scar of the stair. A bull-nosed brick doorway with a brick arch in the eastern elevation afforded access from the courtyard, whilst internal access appears to have originally been from the northern side, with blocked doorways surviving at ground-, and second-floor levels.

Original access to the first floor is uncertain, and it is not clear whether the southern three bays of the lower ground floor were reduced in floor level at this time, to allow access to the stair-tower, or whether this was a slightly later alteration, during conversion to a hoist. The floor was dropped by c 5' (1.53m), with the column bases supported on concrete blocks. That in Bay 3 appears to survive in its original concrete form, whilst those to the south appear to have been re-dressed/rebuilt, most probably during alterations undertaken in Phase 6. A central, brick-arched aperture in the southern elevation would appear contemporary with the change of floor level, extending to the full depth of the wall. Its exact function is unclear, but presumably afforded access to the Phase 3a 'shed' located on the southern end of the structure, which appears to have been expanded, recessed slightly from the eastern elevation, and projecting approximately a full bay width to the south, as shown on the Ordnance Survey map of 1849.

At lower ground and ground-floor levels, the original eastern wall of the Phase 3 structure was retained within the extension, with several of the windows blocked, and others remodelled into doorways. However, at first- and second-floor levels, only the southern 10' (3.05m) of the original wall was retained, forming the western wall of the hoist-shaft. To the north, support was provided by a longitudinal spine beam supported by hollow cylindrical cast-iron columns to each bay, aligned with the original east wall below (Plate 54). The 9" (0.23m) wide, rectangular-section spine beam comprised several members, and although the joints were not easily accessible, they appear to be either butt-jointed or face-half scarf jointed above the columns. The tie beams of the original trusses and the bridging joists of the first floor appear to have been lap-jointed into the spine-beam, but again, detailed inspection of the joints were not practicable.



Plate 54: Replaced cylindrical columns, second floor of the Murray Street Block

One of the spine beams (within Bay 6 on the second floor) has an intricate Baltic timber mark on its western face, demonstrating a similar origin for the timbers used in the remodelling of the Murray Street Block to those used in Old and Decker mills and New Mill. The columns are 4½” (114mm) cylindrical section, with ⅜” (10mm) thick, ¼” (6mm) projecting rounded bead moulding (astragal) 7⅛” (181mm) from the separate T-shaped cap, which supports both the spine-beam, for a length of 16” (0.41m) and 1’ (0.30m) along the beam from the original structure to the west. The caps are rebated c¼” (6mm) into the chamfered tie-beams of the second floor, and all are secured by hand-made irregular square-headed bolts.

The second-floor spine beam supports the valley between the original pitched roof, and the separate pitched roof of the extension, which comprised simple lap jointed rafters. It was originally hipped at both ends, with a sandstone-capped parapet, similar to that of the original construction, but the southern hip was removed during Phase 6 remodelling of the hoist. Rainwater exited from the valley via a spout and hopper at the southern end of the roof, just below window lintel height, which presumably replaced the rainwater goods of the original structure. An *in-situ* cast-iron downpipe survives, which continues below ground, presumably exiting into the convex-edged sandstone drain in the south-eastern corner of the original structure within Bay 1. A central drain for the valley between the two roofs was also constructed within Bay 5, comprising a timber shuttered 7” (0.18m) wide, rectangular-section channel, projecting 15” below the ceiling, and venting into a hopper in the external elevation, at a similar height to that in the southern elevation. The channel was lead-lined, with the excess lead projecting from the western end of the timber shuttering.

At second-floor level in the southern elevation of the extension is what appears to be an original, Phase 4, window (Plate 55). The aperture is of similar proportions to those elsewhere within the Murrays’ Mills complex, but the window frame was not replaced during the Phase 5 refenestration. It comprises six rows of six lights, each with timber glazing bars.

As with the earliest phase, little evidence survives of the internal layout of the Murray Street Block at this time. The curved passage from Murray Street to the courtyard, shown on the Ordnance Survey plan of 1849, predates most of the present internal divisions within the southern part of the structure.

The east/west aligned brick partition walls present in the western part of the Murray Street Block either side of Bay 6 at lower ground floor (street) level, may well date from this time, surviving in truncated form. It is also probable that the internal dividing walls either side of Bay 10, at first- and second-floor level, date from this period, being constructed of mould-thrown brick, bonded in pale lime mortar, and probably consistent with the re-modelling of the South Block. Both walls butt the outer elevations and had central doorways at first-floor level, with additional offset doorways at second-floor level located 5’6” (1.68m) from the western elevation, that in the northern elevation replacing the central door. The offset position of these doorways may be related to centrally positioned power transmission brackets within the roofspace of both north and south elevations of Bay 10.



Plate 55: An original window in the Murray Street Block

4.7.4 Phase 5 (mid-19th Century - 1898)

Evidence of activity within this phase relates to internal re-orientation of the existing structures, rather than a phase of expansion as witnessed during the earlier 19th century. The Ordnance Survey maps of 1849 and 1893 show very little difference in the outline plan of the Murray Street Block. The main difference is the removal of the ‘shed’ at the southern end, and the addition of a structure of similar size to, and adjoining the eastern side of, the toilet tower. Surviving evidence within Old Mill suggests this to have been an extension to the toilet facilities.

Prior to the enlargement of the toilet tower, however, a refenestration of the whole complex appears to have been undertaken. This certainly occurred throughout the entirety of Old, Decker and New mills, although it may have been more selective in the Murray Street and probably Bengal Street blocks, where only the windows of the standard-sized apertures were replaced, with the notable exception of the second floor window in the south elevation of Bay 1.

The major internal remodelling within the northern end of the Murray Street Block involved strengthening work being undertaken to both floors and the Blowing Room. New fireproof ceilings were installed in both the basement and the Blowing Room, using different technologies. That in the Blowing Room comprises shallow (5” (0.13m) high) brick arches, 5’ (1.53m) wide, supported on seven east/west aligned I-section beams, and therefore later than the original construction prior to 1831. To the north and south of the outer I-section beams, the brick arches were aligned north/south, to infill the space to the outer walls. The ceiling of the basement of the Murray Street North Block is also of brick construction, but comprises flat rows of bricks supported on the flanges of inverted T-section steel beams. These act as bridging joists (29 per bay) and are lap-jointed into 4” (0.10m) section joists at each bay interval, which span the basement. Each is centrally supported by a 5½” (0.14m) diameter hollow, cylindrical cast-iron column, with filleted astragal and double-flanged head. On the ground floor above, similar, but shorter columns were inserted at each bay division to support the central, longitudinal spine beam, replacing the earlier system of truss bars.

An internal reorientation of the ground floor of the northern part of the Murray Street Block appears to have coincided with the introduction of columns, which changed the structure from an open room, to a series of divided bays. It remains unclear whether features representing a power transmission system relate to this phase, or had become redundant at this time, although the continued use of metal sheeting over the lath and plaster ceiling, and the retention of such features, would suggest the former. The original brick-arched apertures most probably associated with power transmission within the original structure, appear to have been blocked during this phase, and replaced with a 13”² (0.33m) cast-iron bearing box, located between Bays **19** and **20**, 2’5” (0.74m) below window lintel height. Two gallows brackets for drive pulleys survive in the eastern part of the room, within Bays **17** and **18**, with the timber framing of a further bracket in Bay **15**. That within Bay **18** retains a slender pulley, grooved for a cable rather than a belt.

Whilst this suggests that some form of light machinery remained in use during this period, it is likely that the timber/lath and plaster partition within the eastern half of the room, from the oriel window in Bay **12** to the northern end of Bay **14**, dates from this period. The doorway in the southern elevation of this partition shows architectural detail, with a bolection moulding surround. Unfortunately this is a relatively undiagnostic style, becoming popular from 17th century (Brunskill 2002, 176) to the present day (Chudley and Greeno 1998, 524). The door in the western wall of the partition has a panelled surround, with embossed flower designs to the corners, markedly different from the style of the earlier oriel window. A further stud/lath and plaster partition in the western part of Bay **13** also probably dates from this period, suggesting that the southern end of the Murray Street North block was used primarily as offices, with access between to the central archway. The majority of the windows of the North Block reflect the more polite architectural style, comprising 16-light balanced sash windows with panelled reveals and a flat projecting sill, above a moulded dado rail which encircles the room. Examination of several areas of brick wall exposed below some of the windows demonstrated that the window apertures were reduced at this time, with the lower 14" (0.36m) being blocked before the thick 1½" (38mm) horse-hair plaster was applied.

Power was certainly required in the basement and Blowing Room, where initial preparation of the cotton continued to be undertaken. A large 4'4" by 2'1" (1.32m by 0.64m) cast-iron bearing box located at the southern end of the adjoining wall, 1' (0.30m) above the floor, appears to have been the main power transfer between the two rooms during this phase. To the north, 5' (1.53m) long angled single skin 'cheeks' were added on the Blowing Room side of the doorway from the basement of the Murray Street Block, with a second fireproof door at the eastern end. A sliding fireproof door flush with the west wall of the Blowing Room, slid through the southern cheek, stopping immediately to the north of the bearing box.

Further re-orientation of the interior of the southern part of the Murray Street Block was also undertaken during this phase. The passage along the north side of Bay **9** appears to date from this period, and a rebate was cut at its western end to house the substantial panelled entrance door when fully opened. An entrance at the eastern end of its northern side also seems to be of a contemporary date, and had dressed sandstone quoins, not chamfered as the earlier refaced doorways in the western elevation, and with a flat sandstone lintel, with curved lower face. This presumably led to the present staircase, positioned in the quadrant at the north-eastern end of the Phase 4 extension, giving access to the ground floor of the extension above. This required the blocking of the lower ground floor windows within Bays **8** and **9**. Lath and plaster partitioned washrooms and offices within the ground-floor extension also relate to this period.

Access to the first floor of the main part of the South Block was afforded by a new staircase, entered within Bay **7** of the eastern extension. This had an associated brick built passage, with flagstone floor, linking the corridor along the northern side of Bay **9** to the extension within Bay **6**. It is noteworthy that this stair had no access to the ground floor, suggesting a clear division of function between the ground floor and upper floors, strongly suggesting the use of the ground floor of the South Block as offices.

The original staircase at the southern end of the Phase 4b eastern extension was remodelled to form a hoist. Unfortunately, Phase 6 rebuilding of the hoist removed any physical evidence for this hoist, which appears to have used the same access points as the earlier stair.

Two timber ceiling beams at first floor level within Bays 6 and 7 of the South block were also partially replaced during this phase. The original beams appear to have been cut immediately above the offset cruciform columns, with new members butt-jointed to the eastern end, spanning the gap to the longitudinal spine beam. It is highly unlikely that these were replaced during the Phase 4 construction of the extension, as both exhibit circular saw marks, suggesting a late 19th- or early 20th-century date for the repair.

4.7.5 Phase 6 (1898 – c 1948)

Alteration work was undertaken throughout the Murray Street Block during the early/mid-20th-century. Possibly the earliest evidence from this phase was the installation of a Mather and Platt fire-fighting sprinkler system in 1902, as shown on a surviving service plan. Whilst the system has been modified subsequently, several apparently original features were retained. The most important of these features is the ‘Christmas Tree’, located in the south-west corner of Bay 9, located on the 9” (0.23m) main intake from Murray Street. A further ‘Christmas Tree’ located in the south-east corner of the basement, within Bay 11, is likely to be of a contemporary date, and acted as the controller for the northern part of the Murray Street Block. The associated hydraulic alarm bell survives *in-situ* within Bay 12 of the ground floor.

Prior to the publication of the revised Ordnance Survey map in 1922, the structure added to the eastern side of the toilet tower was removed. The structure, which was only constructed in Phase 5, may possibly have been misrepresented on the earlier Ordnance Survey plan.

The major structural remodelling undertaken during this phase included the construction of a single-storey building above the Blowing Room. Described as the ‘Canteen’ on a plan dated to 1950, it comprised a L-shape plan, formed of two units in appearance, but of a single extruded brick build in English Garden Wall bond. Fallen bricks were observed to exhibit a ‘BC’ stamp within the frog, probably relating to the nearby Bradford Collieries. The larger, southern, part of the structure comprised three bays, open to the roof, with jowled, braced king post trusses, similar to those in the original part of the Murray Street Block and Old/Decker Mill Engine House, supported on 18” (0.46m) wide 4½” (0.11m) projecting brick piers. The northern pitch of the hipped roof is supported in the eastern bay by a return of the east elevation, whereas to the west it is carried on an I-section RSJ, cut into the eastern elevation of the Murray Street Block. This RSJ formed the lintel of a wide doorway, probably open, providing access between the two parts of the structure. The northern part was divided by a return of the northern elevation of the southern part, forming a 6’ (1.83m) wide office to the east. The gabled pitched roof was carried on stop-chamfered king-posts with a single butt-ended trenched purlin to each pitch, as opposed to two in the southern part. The eastern gable housed a standard nine-light window with a central pivoting light, as observed throughout the complex, with an ‘Ediswan’ ventilation fan, produced in London, above.

The Ediswan tradename was created in 1883, when the Edison Electric Light Company Ltd, and Swan United Electric Light Company Ltd, merged to form the Edison and Swan United Electric Light Company Ltd. The name became synonymous with domestic kitchen appliances and lighting bulbs, so it would appear probable that the fan was associated with a kitchen appliance, suggesting the structure was built as a canteen. Annotations, and the position of the doorway into the Murray Street Block in Bay **19**, shown on the Proposed First Aid Room deposited building plan of 1926, implies that it was constructed prior to this date.

The new structure partially blocked many of the sash windows in the eastern elevation of the ground floor of the Murray Street Block, with those parts of the window apertures below the level of the roof blocked flush with the external face. The window frames were retained internally, whilst the window in Bay **19** was remodelled into a doorway within the gable end of the northern part of the canteen. The valley between the two roofs had a drainage gutter around the hip of the southern part of the canteen fixed into the external wall of the Murray Street Block.

Further alterations appear to have been undertaken within the Blowing Room, with the addition of two pairs of north/south-aligned 10" (0.25m) by 6" (0.15m) I-section RSJs, supported on double-flanged 6½" (0.17m) diameter, hollow cylindrical cast-iron columns. This created three lateral bays within the structure, and may have been undertaken in association with the construction of the Canteen above, in order to support the increased weight it would have produced within the brick-arched ceiling. A small pulley wheel was attached to the soffit of one of the beams in the southern bay, demonstrating the continued use of shaft-driven machinery at this time.

A number of alterations were carried out at the south end of the North Block. A hoist tower was added at the southern end of the eastern elevation. Its western side was partially formed by 33" (0.84m) the original east wall of the Murray Street Block, south of the oriel window, whilst the remainder was constructed of extruded brick build in English Garden Wall bond. Fallen bricks were observed to exhibit a 'BC' stamp within the frog, as in the 'Canteen' to the north, indicating that the bricks were produced at the Bradford Colliery brickworks during the late 19th and early 20th centuries.

The installation of the hoist tower removed the southern part of the oriel window in Bay **12**, whilst the remainder was retained, to the east of access into the hoist in its northern elevation. External access was afforded to the hoist at all levels, although the upper, fourth, storey was completely removed in Phase 8, and only the sill of the first-floor opening remains. The hoist cage remains *in-situ*, constructed by and Messrs. Jackson and Ogden of Oldham, whilst the headgear has been removed.

In the southern elevation of the North Block, a new opening was created for the movement of goods into the building from the archway. An earlier, presumably original, aperture, located south of the centre of the building, was blocked with extruded brick, similar to that used in the construction of the hoist tower, and a new opening was created to the immediate west of the hoist tower. It was fitted with double panel doors and had associated steelwork within Bays **11** and **12**, forming a gantry, comprising 'Lancashire Steel Corporation' stamped I-section RSJs, suggesting a date of post-1932.

It is at present unclear whether alterations associated with the archway through the Murray Street Block were undertaken contemporarily with this remodelling, or whether it was of slightly earlier date. The work comprised the installation of a new hoist crane and the insertion of a weighbridge under the archway. The weighbridge, supplied by the local Manchester firm of William Hodgson, was installed within the cobbled surface of the entrance, with access to the mechanism, below ground, from the southern bay of the Murray Street North Block. An entrance from the archway, through a steel door and down a cast-iron stair into the basement, may have been a related insertion. In the northern elevation of the Murray Street South Block, a wide window and door were inserted, creating a weighhouse within the western room to the south of the passage in Bay 9. The hoist was located on the first floor, above the archway and had double battened flap doors inserted into the floor, opened by chains secured to the floor either side. The central entrance in the southern elevation was remodelled at this time, presumably for the 'Vaughan' ½ ton electric crane, also built by a local Manchester company. The crane was carried on an 8" (0.20m) by 4" (0.10m) I-section RSJ, extending into the northern part of Bay 8, and supported on two transverse 9" (0.23m) by 4" (0.10m) RSJs, cut into the external walls, within Bay 10. A steel tubing ladder to the second floor, in the south-east corner of the Link block may have replaced a ladder associated with the alterations undertaken during this phase.

Further hoist alterations were undertaken at the southern end of the Murray Street Block, with the replacement of the hoist in the south-east corner of Bay 1. The work, according to a plaque within the cage, was undertaken by William Wadsworth of Bolton, in 1932. The orientation of the hoist was altered, with the external access blocked, and internal apertures all opening into the western face of the shaft. The eastern part of the earlier shaft became redundant, and was partitioned from the shaft, with a personnel tunnel, into which there is no longer access, inserted at second-floor level, into the toilet tower of Old Mill. A small rectangular tower, with a flat roof, and a casement window in the western elevation (Plate 60) was inserted above the shaft, cutting the original hipped roof. The earlier opening in the northern side of the hoist shaft was retained at second floor level, with a ladder to the west of the doorway affording access to the headgear within the tower above.

Within the basement, a channel built along the northern side of the southern elevation in the reduced level of the internal lower ground floor was observed. This internal drain was formed of edge-laid 'BC' stamped brick, and led into a sandstone-edged drain, immediately to the west of the hoist. The presence of the 'BC' bricks implies a Phase 6 date for the channel, which appears to have taken external waste water into the main drain below ground level, but it may represent the repair of an earlier feature of similar function.

At ground-floor level, within Bays 3 and 4 of the Phase 4 extension on the eastern side of the Murray Street Block, a straight timber stair was inserted, across the windows, to afford access to the first floor. This may reflect changes in the usage of the hoist in Bay 1, which may previously have been used to travel between ground and first floors, as no staircase was provided between these floors during the Phase 5 remodelling.

4.7.6 Phase 7 (c 1948 – 1950s)

This phase relates to the end of textile manufacture within the Murrays' Mills complex, and comprised the last structural additions to the Murray Street Block. The larger of these, referred to as the 'Air-Raid Shelter', abutted the eastern side of the Murray Street North Block, and was of single-storey machine-made, red brick construction, in English Garden Wall bond, with a flat bituminous covered roof (Plate 56).

The internal concrete ceiling was supported by 1' (0.30m) by 6" (0.15m) RSJs, with Lanarkshire Steel stamps and British Steel marks. It is referred to as an air raid shelter on the Land Registry plan of 1950, but does not appear on any Phase 6 plans. Whilst internal, presumably brick, partitions were removed subsequently, its appearance and construction technique would appear most unsuitable for the purpose of an air-raid shelter, especially as government guidelines concerning air-raid shelter construction (Colliery Guardian 1939) suggested the preferred use of basements (of which there are many within the complex). The structure is not shown in an aerial photograph of the complex taken in 1948 (541/25/16 May 48).

Access into the northern part of the Murray Street Block was via the repaired/replaced Phase 4 stair in Bay **13**. Access was also afforded into the canteen, via a passageway along the northern side of the structure, with steps into the canteen to the west of the cellar-lights of the Blowing Room, flush with the Murray Street Block.

A further structure, of similar construction, but with a cat-slide roof, was also erected prior to 1950 against the eastern elevation of the Murray Street South Block (Plate 57). It was located to the north of the doorway in Bay **1**, which had become redundant and blocked during Phase 6, and is three bays wide, with a ramped entrance from the Murray Street Block in Bay **4**. It has a vehicle width door in the northern elevation, with a man-door to the east and a window to the west.

The roof is carried on a single, transverse I-section RSJ, cut into the external wall of the Phase 4 extension on the western side, and supported on an internal 1'6" (0.45m) by 9" (0.23m) brick pier in the eastern elevation. A later corrugated fibreglass sheet roof is attached to L-section steel members above the RSJ. This building was demolished in 2005 as part of the Shell Repair Project.



Plate 56: The putative air-raid shelter prior to demolition in 2005



Plate 57: Single-storey shed prior to demolition in 2005

4.7.6 Phase 8 (Post-1950s)

The most significant alteration of this phase was the removal of the upper two storeys of the Murray Street North Block. It is not clear exactly when this was undertaken, but it is shown as four storeys on a Land Registry plan of 1950, prior to being sold by the Fine Cotton Spinners' and Doublers' Association Limited to Fred Beech & Co Ltd in December 1950, and therefore post-dates the textile manufacturer's ownership of the building.

The external toilet tower at the southern end of the Murray Street Block was also removed after 1950, providing a further access point into the courtyard, for the first time since c 1805. Large timber gates were installed on a brick buttress added to the southern end of western elevation.

Within the remaining Murray Street Block many internal partitions were inserted, mainly constructed of wire mesh and plaster, suggesting an early date within the phase, probably prior to a further change of ownership on 1960.

Within the single-storey shed on the eastern side of the northern part of the block, the internal brick partitions shown on the Land Registry plan of 1950 were removed, and replaced by pairs of channel-section steel stanchions, rivetted back to back, with Colvilles stamps and a crown mark, providing support to the concrete ceiling above.

After the abandonment of the structure in the late 20th century, all the cellar-lights on Murray Street were blocked with clinker block, with brick vents.



Plate 58: The dilapidated Murray Street North Block in 2005

4.8 *Bengal Street Block*

4.8.1 *Introduction*

Much of the developmental sequence of the Bengal Street Block is drawn from the documentary evidence and observations from elsewhere within the complex. Fabric description and analysis has relied heavily upon the work undertaken as part of the Greater Manchester Textile Mill Survey, carried out whilst the vestiges of the building were still standing (RCHME and GMAU 1989), although this was confined largely to photography and no detailed drawings of the Bengal Street Block were compiled (Plate 59). By 2005, the only fragment of the building to survive were the southern two bays, to only two storeys, with a flat roof and 20th-century buttresses to Decker Mill.



Plate 59: The surviving single storey of the Bengal Street Block in the 1980s (GMAU)

The Bengal Street Block was orientated approximately north/south adjacent to Bengal Street, which lies at an angle of eight degrees beyond perpendicular to Union Street to the south. The original structure comprised four storeys of 19 bays, with a shallow basement, similar to that in the southern end of the Murray Street Block, but with the link between the Rochdale Canal and the courtyard canal basin running through the southern end. The structure had later architectural embellishment, similar to that in the Murray Street Block, but with a blind central arch and blind doorways either side (Plate 59). Between c 1822 and 1831 it was raised to six storeys in height, and a circular stair tower was added to the western elevation prior to 1849. It was linked to the mill complex on the opposite side of Bengal Street by two underground tunnels, with a third tunnel providing a link to Fireproof Mill, which had been constructed by the 1840s. By the late 19th century the northern three bays had been rebuilt to form an engine house, with an electric substation added to its western side in the early 20th century.

4.8.2 Phase 3 (c 1804 – c 1817)

Cartographic evidence provided by a Boulton and Watt plan indicates that the original building was completed by c 1806. As with the earlier structures forming the Murrays' Mills complex, it was constructed of locally-made, mould-thrown brick, bonded with a pale lime and sand mortar. Brick dimensions were generally 9" by 3 $\frac{7}{8}$ " by 2 $\frac{3}{4}$ " (229mm x 98mm x 70mm), slightly less deep than typical bricks of the period, which tended to measure from 4 $\frac{1}{4}$ " to 4 $\frac{1}{2}$ " (108mm to 114mm) deep (Harley 1974, 76). The eastern elevation was constructed in Flemish bond, whilst the courtyard, western, face was in English Garden Wall bond, with rows of headers every five courses. The walls were constructed as two brick-depth skins, giving a wall thickness of four bricks (0.51m).

The original construction of the Bengal Street Block butted the northern face of the Phase 2 Decker Mill, with remodelling of the windows of the earlier structure. Whilst the exact nature of the openings was not clear in the surviving wall face it would appear that the windows were blocked, with the eastern ones possible remodelled into doorways between the two structures. At its northern end, the Bengal Street Block was butted onto the slightly earlier New Mill, with the scar of the original pitched roof still visible above second-floor level. It would also appear that the wall was refaced, as was that adjoining the Murray Street Block, with evidence of a further heating flue observed in New Mill. Evidence of a segmentally-arched aperture was observed in the external ground-floor wall-face of New Mill, presumably a door, with a similarly arched aperture offset to the east at first-floor level. Nothing survives of the arch of a door aperture at second-floor level, directly above. It would appear that the heating flue was offset to the immediate east of the first- and second-floor doorways, the location of the ground-floor doorway possibly suggesting a larger stove aperture at this level.

The last two surviving two-storey bays at the southern end of the building (which were replaced in 2017 by the new apartment block) had window apertures at ground-floor level on both elevations, similar in style to those in the Murray Street Block, with the demolition having occurred at the southern jamb of the Bay 3 windows. At lower ground floor level, window apertures were observed only in the western elevation, as the canal tunnel passed through the external part of the block in the surviving bays of the eastern elevation. The tunnel has a shallow three-point centred crown, of single brick thickness, in English bond (Plate 60). A 1 $\frac{1}{2}$ -brick relieving arch in the internal eastern elevation above, appears original, and was constructed to deflect stress from the tunnel crown (Plate 61).

Ground-floor level is consistent with that in the other structures forming the courtyard, c 6' (1.83m) above street level. However, the rectangular-section ceiling beams of the lower ground floor appeared to have been inserted, the northern example cutting the relieving arch of the canal tunnel, demonstrating a replacement of the original internal structure.

A series of excavations, carried out in 2006, 2013 and 2017 uncovered various elements of the former Bengal Street Block. These included the foundations of the buildings, the floor of the basement, and a circular stair tower that had served the building, and part of the canal arm that passed through a tunnel from the Rochdale Canal to the basin in the centre of the enclosed mill yard (Plates 62-63).



Plate 60: The crown of the canal tunnel beneath the Bengal Street Block, infilled with concrete



Plate 61: The relieving arch above the canal tunnel

A north/south-aligned brick wall exposed during excavation clearly represented the original exterior western wall of the Bengal Street Block (Plate 62). The fabric of the wall comprised hand-made bricks set in a crumbly, lime-based mortar, but showed numerous repairs in both hand- and machine-made brick with lime mortar and with hard grey cement. Abutting this wall at its south end, and at the north-western end of the canal wall, was a flat stone-flagged surface, at the same level as the canal stonework, with two stone flag descending 0.65m to the east, down to the main mill floor (Plate 63).



Plate 62: The western exterior wall of the Bengal Street Block excavated in December 2013, showing pipes for the sprinkler system



Plate 63: Flagstones and brick steps excavated in December 2013, looking north-west

The flagstone surface was set on a brick wall rising from the main floor and running north/south with a return to the west, where it abutted the western wall of the building. The surface ended abruptly to the north-east, where two cast-iron pipes ran through the supporting brick wall (Plate 64). The pipes were 0.16m in diameter, with bolted high-pressure flange joints. Both ran beneath the flagstone surface, with one retaining connections that branched off at a higher level to the north and south. Both pipes had been truncated at the north end. It is likely that these pipes formed elements of the sprinkler system that was installed in 1902.



Plate 64: Flagstones and brick steps excavated in December 2013, looking south-west

Excavation in 2016 in preparation of the construction of the new apartment block along Bengal Street also revealed the original eastern wall of the mill, showing that the internal width of the basement was 7.02m (Plate 65). This wall comprised mortar-bonded, hand-made bricks, which survived to a height of *c* 1.18m. The internal elevation retained remnants of yellow painted plaster that obscured the actual bricks, although the wall was faced in English Garden Wall bond.

The main floor of the Bengal Street Block comprised stone flags of varying sizes which terminated at an east/west-aligned brick wall to the north. The flagstone surface had numerous repairs in concrete, and had three stone pads with iron staining set into it in a north/south line. The pads almost certainly represented the bases for cast-iron columns. At the southern end of the excavated surface was a flagstone that retained two cast-iron holding-down bolts in its upper surface. These had almost certainly been intended to secure an item of machinery that had occupied this part of the Bengal Street Block. A large flagstone at the base of the steps down from canal wharf had three small hollows in its surface, one at either side and one in the centre, possibly for a wooden doorframe at the base of the steps.



Plate 65: The eastern wall of the Bengal Street Block exposed during excavation in 2016

At the northern edge of the basement floor was a wall of hand-made bricks. This was aligned east/west, and was two-courses wide, although only one course was visible beyond the flagstones. The wall stepped out to the north by 0.45m at its western end before returning west 1.5m. This was paralleled by a second single-course wide wall, which similarly comprised hand-made bricks, and was situated 2.65m to the north. Between these two walls was a thick deposit of clay, into which a stone-capped brick drain, and two other drainage features had been cut.

At a distance of 2.1m to the north this wall was a large internal partition, and between these two walls was a flagstone and concrete surface. This had been truncated on its west side, revealing a layer of clay below. The surface had a line of flagstones at the north and south edges, both aligned east/west, and the concrete surface between.

The large partition wall was aligned east/west across the central part of the excavated trench, forming a large internal supporting wall. This was actually two walls running parallel, each two courses wide, with a 0.34m wide channel between them. The fabric of the walls comprised machine-made bricks stamped with a 'BC' identifying them as the late 19th-century products of Bradford Colliery, Manchester. Within the gap was a lower line of brick with rough concrete slabs set onto it spanning the width of the channel. A cast-iron supporting bracket had survived set into the channel and it can be presumed that these originally continued all along supporting a 0.16m-diameter high-pressure cast-iron water pipe running along the channel, an end of which could be seen heading out from the western wall of the building into the channel above the concrete slabs and below the sprinkler feed pipes. The two north/south-aligned pipes had been truncated at this point, but had clearly extended beyond this wall originally.

To the north of the partition wall was a concrete floor surface of a probable late 19th-century construction date. Two cast-iron column bases were set into this surface, and were also in line with the other column bases to the south (Plate 67).



Plate 66: Flagstone and concrete setting, a column base and concrete block visible at right side



Plate 67: Partition wall across the basement, with bracket visible right of centre, looking north-east

4.8.3 Phase 4 (c 1817 – Mid-19th Century)

Whilst the plan of c 1822 has an annotation declaring the Bengal Street Block to have four storeys, the engraving of 1831 (Plate 3) clearly depicts six storeys. Physical evidence of this alteration survives in the external elevations of both Decker and New mills. Within Decker Mill, the window apertures of the third and fourth floors were blocked, whilst in New Mill, several blocked apertures of later features can be seen above the height of the original structure.

Excavated remains that may be attributed to this phase include the foundations of the circular stair tower, which was placed towards the southern end of the west-facing elevation of the Bengal Street Block. The foundations of the stair tower survived to a maximum height of 0.85m, and were composed entirely of hand-made bricks, bonded with a lime-based mortar. Two large sandstone slabs within the south-eastern part of the tower represented the bottom steps. Immediately to the west of these steps was a series of large flagstones, which had been laid on top of a matrix of clinker and crushed brick. The flagstones formed a level floor within the western part of the stair tower, and perhaps represented the entrance to the tower from ground level (Plate 68).

Within the centre of the stair tower was a circular structure of brick construction, with an internal diameter of 1.08m. Approximately half of the circumference of this structure comprised large freestone blocks, whilst the remainder incorporated hand-made bricks. The central area was sealed by two large iron plates, which were pierced by an iron pipe of 5" diameter. This pipe extended vertically downwards to the base of the stair tower foundations to a stop end, presumably representing part of the original sprinkler system for the Bengal Street Block. No details of any such system within the block are available within the archive sources, and the manufacturer remains unknown.



Plate 68: The foundations of the stair tower to the Bengal Street Block

Two parallel brick walls, aligned broadly north/south and set 0.75m apart butted the southern part of the central tower (Plate 69). The walls had been cut into the natural clay geology, and survived to a height of 1.10m. An aperture, measuring 0.33m x 0.5m, was identified within the elevation of the central tower, between the two side walls (Plate 69). The precise function of this feature remains uncertain, although it may have been a culvert.



Plate 69: The putative culvert leading from the foundations of the Bengal Street Block stair tower

Other structural remains uncovered during archaeological excavation that can be attributed to this phase include the subways that linked the northern part of the Bengal Street Block with Little Mill and Fireproof Mill on the opposite side of the street. The subway comprised two parallel walls, composed of machine-pressed bricks, set 1.97m apart (Plate 70); the use of machine-made bricks suggests that the wall may have been rebuilt when the late 19th century, perhaps when the new engine house was erected at the northern end of the Bengal Street Block; the northern wall of the subway formed the southern end of the engine house, and was 0.65m wide. Some of the bricks within the lower courses of the subway's northern wall had been roughly hewn out in order to allow for the installation of two pipes during the early 20th century. The remnants of an iron handrail, propped up with rotted wooden planks, survived *in-situ* against the north wall (Plate 70).

The southern wall of the subway was similarly composed of machine-pressed bricks, bonded with a very dark grey cement mortar. The inner face of the wall, however, comprised a single skin of bricks, which was not bonded to bricks behind, suggesting this to have been a later addition. A series of score marks were noted to have been incised into the wall at the entrance to the subway, seemingly as a result of rope friction. These were aligned at an angle of $c 10^{\circ}$ from the horizontal, and may have represented a system of hauling trolleys through the subway. The floor of the subway was exposed at a depth of 1.61m below the ground surface, and was composed of large stone slabs, forming a surface that sloped evenly down to the east. Some of the slabs were missing, implying that the subway had sustained some damage, and possibly partial demolition. However, for the most part, the subway survives intact, and can be assessed from New Little Mill (Plate 71).



Plate 70: Looking east along the entrance to the subway at northern end of the Bengal Street Block, showing sprinkler system feed pipes in the foreground. The remains of the late 19th-century engine house are to the left of the subway

The entrance to the personnel tunnel to Fireproof Mill on the east side of Bengal Street was identified during the mechanical excavation of the Bengal Street Block in 2016. This was not excavated beyond the entrance (Plate 72).



Plate 71: Entrance to the subway from New Little Mill, accessed in 2017



Plate 72: Entrance to the subway from the Bengal Street Block to Fireproof Mill exposed in 2016

4.8.4 Phase 5 (Mid-19th Century – 1898)

Evidence for this phase within the fabric of the Bengal Street Block is related to power transmission. Within the south-eastern corner of the block, at lower ground floor level, a massive cast-iron bearing box was cut into the eastern and southern elevations (Plate 73). It was bolted to a large sandstone pad, situated on a brick pier overlying the canal tunnel and had two horizontal mounting brackets. It would appear that the lower of these formed an end bracket for a horizontal shaft, and was probably associated with a mounting block to the west. The upper mounting appears to have housed a vertical driveshaft bracket, transmitting power to the ground floor.



Plate 73: Cast-iron bearing box on the lower ground floor of the Bengal Street Block

The mounting to the east comprises a stepped, rectangular, extruded brick pier, bonded in dark soft mortar, typical of the late 19th century. This was capped with a 6' (1.83m) by 1'6" (0.45m) sandstone block housing two mounting bolts that ran through the full thickness of the brick pier (Plate 74). A further mounting bolt was set in concrete within the southern elevation. To the immediate west, a 15" wide and 19" deep rebate cut into the southern elevation appears to represent a flywheel or drum rebate. Two large, cast-iron bearing boxes in the western elevation were associated with this housing, and possibly related to a driveshaft from the Old/Decker Mill Engine House.

At ground-floor level, the bearing box in the eastern elevation was capped by a large 5'6" (1.68m) long and 3' (0.92m) high sandstone block, of full-wall thickness. The window above had been blocked, and a rebate was cut into the eastern end of the western elevation, further suggesting the position of a vertical driveshaft in this location.

Two double-flanged, cast-iron hollow cylindrical columns at the northern end of the southern bay, 3' (0.92m) apart in the centre of the structure, also relate to this phase. Both had elongated longitudinal caps, similar to those in the Murray Street Block.

The northern of the two surviving ground-floor beams appears to have been strengthened, with the addition of a channel section flitch plate to the soffit. This may have been undertaken to coincide with the attachment of two transverse T-section, cast-iron beams across the third bay.



Plate 74: Pier for driveshaft housing, lower ground floor of the Bengal Street Block

Several features within the wall scar of the northern end of the Bengal Street Block also relate to this phase. Doorways, wider than those below, were inserted from the Bengal Street Block into New Mill at third- and fourth-floor level (Plate 75). These would have cut through the earlier heating flue, and thus signify its disuse during this period. The remains of high, rectangular bearing boxes survive at ground through fourth floor levels, towards the eastern end of the north elevation. These represent the apertures for the ropes from the rope drive associated with the Bengal Street Engine House, constructed at the northern end of the block. The precise date of its erection is unclear, but two prominent pilasters with stone cornices facing the yard suggested a date towards the end of the 19th century (RCHME and GMAU 1989, 8). The aerial photograph of 1961 (HJSL UK 1961) clearly shows that the engine house did not butt New Mill, demonstrating that the rope race for the new engine was located at the northern end of the Bengal Street Block, rather than in the eastern bay of New Mill. It is therefore likely that the doorways between the two structures were blocked prior to the construction of the rope race, as access into the shaft is unlikely to have been required from all floors. At lower ground floor level, a smaller bearing box in the northern elevation is offset to the west of the elongated boxes above, and represents the position of the horizontal rope into the basement of New Mill.



Plate 75: The eastern end of New Mill, showing features pertaining to the former Bengal Street Block

Evidence from the excavation of the Bengal Street Block concluded that a partition wall, aligned parallel to the eastern exterior wall but set 0.25m to the west, was inserted during this phase. The wall had been laid in English Garden Wall bond, and comprised machine-pressed bricks bonded with a very dark grey mortar. Eight courses of bricks survived, which equated to a height of 0.76m. The upper courses of the wall incorporated a gentle curve, possibly in order to allow an item of machinery to be fitted. The insertion of this partition reduced the width of the basement to 6.77m, and created a 0.25m wide channel along the eastern edge of the building (Plate 76). This survived as a sealed void, and contained a 4½” diameter pipe that appeared to have been supported on an iron wall bracket. This pipe was probably associated with the Mather and Platt fire-fighting equipment installed in 1902.



Plate 76: Wall inserted parallel to the eastern wall of the Bengal Street Block

The original boiler house for New Mill was probably demolished during this phase. Excavation showed that the area of the boiler house contained a thick deposit of demolition rubble, which overlay natural clay subsoil; no surviving structural remains of the former boiler house were encountered. Several large pipes, however, had been laid within the rubble. The largest of these had a diameter of 13” (0.33m), and was aligned broadly east/west across the excavated area, with a c 45° turn at its western end. The pipe incorporated a high-pressure flange joint, which was affixed by six bolts. The eastern end of the pipe connected with the engine house in the Bengal Street Block, and may have represented the steam main from the Old/Decker mill boiler house, which provided the steam for all of the engines within the complex during the late 19th century.

4.8.5 Phase 6 (1898 – c 1948)

Evidence within the surviving fabric for early 20th-century activity within the Bengal Street Block relates to the reduction of height of the structure to two storeys. A proposal to reduce the height of the Bengal Street Block was submitted in August 1930, and it would appear that large angled buttresses were constructed against Decker Mill at the southern end of the block, during this work. It is noteworthy that this was undertaken as a new build, comprising extruded brick in English Garden Wall bond, with a row of headers every four courses, as opposed to five in the original build. The buttresses were capped with joggled sandstone copings, with sandstone pads at either end of the angled construction (Plate 77).



Plate 77: The last surviving two bays of the Bengal Street Block and later buttresses to Decker Mill

A timber-framed hoist at lower ground floor level by the southern elevation probably related to this phase. It provided a means of materials movement between the lower ground floor and the basement of Decker Mill, which is *c* 4' (1.23m) lower. The insertion of the hoist signifies the disuse of the horizontal shaft associated with the large Phase 5 mounting blocks.

Documentary evidence indicates that Mather and Platt Ltd installed a new fire-fighting system within the mill complex in 1902. Surviving physical evidence for was manifested by two parallel iron pipes, aligned north/south adjacent to the western wall of the building (Plate 78). Both of the pipes were of 6" (0.15m) diameter, and one incorporated a high-pressure flange, affixed with four bolts. Both pipes were quite corroded, and whilst neither retained any indication of a lagging material, one pipe had traces of a red lead-based paint. The westernmost pipe rose vertically immediately to the south of steps, and perhaps represented a feed pipe to the upper storeys of the block.

Much of the basement had been filled with a deposit of fuel ash and clinker, presumably generated from the boiler house adjacent to Old and Decker mills. This did not contain any visible tip lines or other evidence to suggest that it represented a long period of in-filling. This deposit did not contain any large fragments of bricks, implying that it had been laid as a controlled event, rather than resulting from the wholesale demolition of the Bengal Street Block. It is possible that modifications to the stair tower occurred at broadly the same time. This included the backfilling of the arched-capped passage within the southern part of the stair tower, and the deposition of a thick layer of gas tar over the flagstones within the tower.



Plate 78: Mather & Platt Ltd sprinkler system pipes adjacent to the west wall of the Bengal Street Block

The area of the former boiler house for New Mill, immediately to the west of the Bengal Street Block, was surfaced with flagstones during the final years of the 19th or early 20th century (Plate 79). Incorporated within the build of the surface was a square brick structure, which measured 0.78m x 0.78m. This structure housed a gate valve, which was stamped ‘Mather and Platt Ltd’, and clearly represented part of the sprinkler system documented to have been installed during 1902. The gate valve was connected to a 7” diameter pipe, that was aligned north-east/south-west. Immediately to the north, the pipe turned due east, and continued along the northern internal edge of the subway. Upon entering the subway, the pipe turned through 90⁰ and continued southwards. A second pipe of an identical diameter lay parallel within the area of the subway, although this pipe incorporated a joint to rise vertically against the north wall of the subway. This presumably represented the sprinkler system main feed into the Bengal Street Engine House.

A brick structure exposed at the southern end of the flagstone surface clearly represented the remnants of the electrical sub-station, which had been erected at some point between 1905 and 1926. The exposed remains of this structure comprised two walls that represented the north-western corner of the sub-station, and a further two walls that were the vestiges of an ancillary structure to the north (Plate 80). The western wall of the main sub-station building cut through the edge of the canal wharf, implying that the basin had been backfilled by this date. The main building also contained two *in-situ* multi-strand copper cables.



Plate 79: Early 20th-century yard surface and the Mather and Platt Ltd sprinkler system valve



Plate 80: The excavated remains of the early 20th-century electric substation

4.8.6 Phase 7 and 8 (c 1948 – post-1950s)

The lower corner of the eastern end of the elevation adjoining New Mill was remodelled during this period and strengthened to form a buttress, presumably when the rope race was removed prior to 1961. The main activity related to Phase 8, however, was the demolition of the Bengal Street Block following a fire in 1999. This event was represented in the archaeological record by a surface of compacted rubble, of which fragments brick fragments formed the largest component. The remnants of the stair tower were also demolished at this time, and were sealed beneath a layer of hardcore. The electric sub-station was also demolished at the same time, as this was similarly buried beneath a deposit of modern rubble.

4.8.8 Bengal Street Block Engine House

The following narrative presents some of the results obtained from a trench placed across the north-eastern part of the mill complex, which was targeted upon the site of the late 19th-century steam engine that was connected to the rope drive at the eastern end of New Mill. This engine was demolished in the 20th century, although its character was captured in a photograph taken in the 1960s (Plate 81)



Plate 81: The late 19th-century engine house and early 20th-century electric substation at the northern end of the Bengal Street Block in the 1960s

Phase 5 (mid-19th century - 1898): the remains of the late engine house, installed within the northern part of the Bengal Street Block, were exposed immediately beneath the modern ground surface within the north-eastern part of the trench (Plate 82). The foundations for the eastern wall of the engine house utilised the original eastern wall of the Bengal Street Block, and comprised hand-made, wire-cut bricks set in a lime-based mortar. The wall had a width of 0.52m, and survived to a maximum depth of 2.25m.



Plate 82: Initial excavation of the engine house at the northern end of the Bengal Street Block

The southern wall of the engine house, which also formed part of the subway beneath Bengal Street, was composed of machine-pressed bricks set in a dark grey cement mortar, typically of a late 19th-century construction date. Some of the bricks within the lower courses of the south-facing elevation had been crudely hewn in order to facilitate the installation of the pipes associated with the sprinkler system.

The western wall of the engine house lay broadly in the position of the original west wall of the Bengal Street Block, but extended further to the west. The wall comprised a combination of hand-made, wire-cut bricks and machine-pressed variants, set in a dark grey cement mortar in stretcher bond. It was of variable thickness, and incorporated a rectangular-shaped buttress that comprised blue bricks.

A substantial partition wall, aligned north/south, was exposed across the approximate centre of the engine house (Plate 82). The wall measured 1.32m wide, and survived to a depth of 2.30m, and appeared to have been constructed in two parts. The western component, measuring 0.8m wide, comprised a combination of hand-made and machine-pressed bricks, and the eastern part comprised blue engineering bricks. Situated to the east of this wall was a large rectangular pit, measuring some 2m wide and in excess of 2m deep. This almost certainly represented the position of the rope drum connected to the engine, but had been filled with rubble following the demolition of the engine house (Plate 82).

Initial excavation also exposed the remains of the engine foundation blocks, which were set on two levels (Plate 83). The lower foundation comprised a large concrete block, which was covered by a thin metal plate. Three large threaded bolts protruded vertically from the block, which will have connected with the engine frame. The upper foundation was situated 1.22m above and immediately to the north. This was similarly constructed of concrete.



Plate 83: Foundation beds for the late 19th-century engine

The dimensions of the engine house, and the configuration of the foundation blocks, indicated clearly that it had contained a large vertical steam engine. Whilst it is uncertain as to precisely when this was installed at the Murrays' site, such engines became increasingly popular with textile manufacturers during the 1880s.



Plate 84: The remains of the late 19th-century engine foundations removed fully

4.8 *The Canal Basin*

4.8.1 *Introduction*

The incorporation of a canal basin within the enclosed central courtyard was a unique innovation, representing a new advance in fully integrating a cotton-spinning site with a canal. The close relationship between the canals and the mills in Ancoats soon became a hallmark of Manchester's cotton industry. Canals not only provided the essential infrastructure used for the transportation of goods and water for the steam plant, but also enabled the construction of closely-packed groups of large steam-powered mills (Miller and Wild 2007).

The canal basin remained a key component of the mill complex until the early 20th century, when it was infilled and hard surfacing was laid across the courtyard. This hard surfacing was removed, and the canal basin was excavated during the fabric consolidation works in 2006-07 (Plate 85).

The edge of the canal basin was exposed at an average depth of 0.2m below the modern ground surface. In each area, the remains of the basin were well-preserved, although the installation of the sub-station to the west of the Bengal Street Block had caused some localised damage.



Plate 85: The canal basin during 2006-07

4.8.2 Phases 3 - 4 (c 1804 - 1898)

The south-western edge of the canal basin was represented by a curved alignment of large freestone blocks of yellow sandstone, set into a thick deposit of puddled clay. The stone blocks were each joined by two 0.40m long iron strips set into lead flashing. Small rectangular housings were set into some of the blocks, one of which contained an iron mooring ring. The freestone blocks had an average size of 1.10m x 0.90m. The southern edge of the canal basin in this area was butted by a series of flagstones, forming a yard surface. The flagstones varied in size, and some had been cut carefully to fit the curve of the canal basin. The surface was quite uneven, and the flagstones had evidently sustained some disturbance.

Further elements of the canal basin were exposed immediately to the north of the Old and Decker Mill Engine House. In total, 15 sandstone capping stones, typically 3' (0.92m) square and 10" (0.25m) thick were observed, forming the southern and western sides of the canal basin, each jointed together by two 14" (0.36m) by 2" (0.05m) iron straps set in led within small sockets cut into the surface of each block. The junction between the two sides was formed by means of a smooth 90° curve comprising four capping stones. The capping stones projected 1½" (30mm) beyond the brick-formed side walls of the canal basin. The bricks are mould-thrown, bonded in a pale lime and sand mortar, and were laid in English Garden Wall Bond. A section was excavated along the northern side of the engine house, revealing that the wall continued to a depth of c 2.1m, curving slightly into the basin as it deepened, and with a foundation which appeared to be set up to half a course wider (Plate 86). The basin itself was filled with clinker, presumably from the boilers, to a depth of c 1m, above a dark, waterlogged silty-clay, which contained fragments of timber and two bottles of a late 19th-century date.



Plate 86: A trench excavated within the canal basin adjacent to Old Mill Engine House in 2006

Along the southern side of the basin, outside the Old and Decker Mill Engine House, and projecting slightly into the curve of the south-west corner of the basin, a 13'9" (4.19m) section of capping stones was cut to form a 4" (0.10m) deep rebate on the top of the basin wall. The east and west capping stones of the rebate were both cut, demonstrating that not only was the aperture cut to a specific size, but also that it required considerable effort, not just the replacement of the existing cappings with thinner versions. The rebate appears to be related to loading, and may represent the position of a crane/hoist base. The western 6'8" (2.03m) was subsequently re-filled to original height with 4" (0.10m) thick flagstones.

The north-eastern part edge of the canal basin was exposed within a trench excavated adjacent to the New Mill Engine House. A single layer of large freestone blocks again formed the upper surface, which was seen to overly bricks that formed the wall of the basin. In some instances, slates had been laid between the bricks and the freestone blocks. Iron strips, 0.07m wide, set into the surface, joined some of the blocks together.

A wall lying parallel to the canal basin was exposed at a distance of 0.51m to the rear (north-east). This wall was four courses thick, and comprised hand-made bricks. The gap between this wall and the basin had been packed with redeposited clay, fragmented bricks and mortar, seemingly in an attempt to create an impermeable packing to minimise the leakage of water from the basin.

The remains of the former canal arm were uncovered at the southern end of the Bengal Street Block. This was aligned north-west/south-east from the Rochdale Canal to the reservoir occupying the centre of the mill yard. The canal was 2.44m wide, and flooded with water at a depth of 0.73m below the canal edge. The fabric of the two sides of canal channel comprised hand-made brick with a capping of large stone blocks. The upper surfaces of the stone blocks were tied together with large iron staples.

Some remains of brick wall footings remained at the canal edges, presumably from the low arch of the former tunnel beneath the Bengal Street Block and Decker Mill. On the north-eastern edge of the canal, a tie rod could be seen running through the surviving brickwork, presumably to the other side of the canal arch.

Settings for a canal floodgate were observed within part of the north-eastern edge of the canal, set slightly 0.12m inwards and then curving back out for 2.47m to the north-west (Plate 87). Opposite this, on the south-western side of the canal, was a 0.33m indent, 2.85m in length, with a curved recess in the stonework for the post for a wooden floodgate (Plates 88 and 89). The stonework immediately adjacent to this housing had been repaired in brick.



Plate 87: North-east edge of the canal with curve for gate, looking north



Plate 88: South-western edge of the canal with gate indent, looking west

The north-eastern side of canal wall had a 0.6m thick skin of concrete laid against it. The 0.3m width immediately against the canal wall was flush with the top of the canal stonework, and the 0.3m to the north-east stepped down by 0.16m as a narrow channel. This ran all the way along the inside of the canal wall, and was clearly a later addition, possibly as a form of tanking (Plate 89).



Plate 89: Concrete 'tanking' next to canal wall, looking north-west

Whilst the canal basin was restored in 2007 and filled with water, it was drained subsequently and backfilled in 2016 (Plate 90). New surfacing has been laid across the courtyard, although the position of the basin is marked out (Plate 91).



Plate 90: The drained basin prior to backfilling in 2016

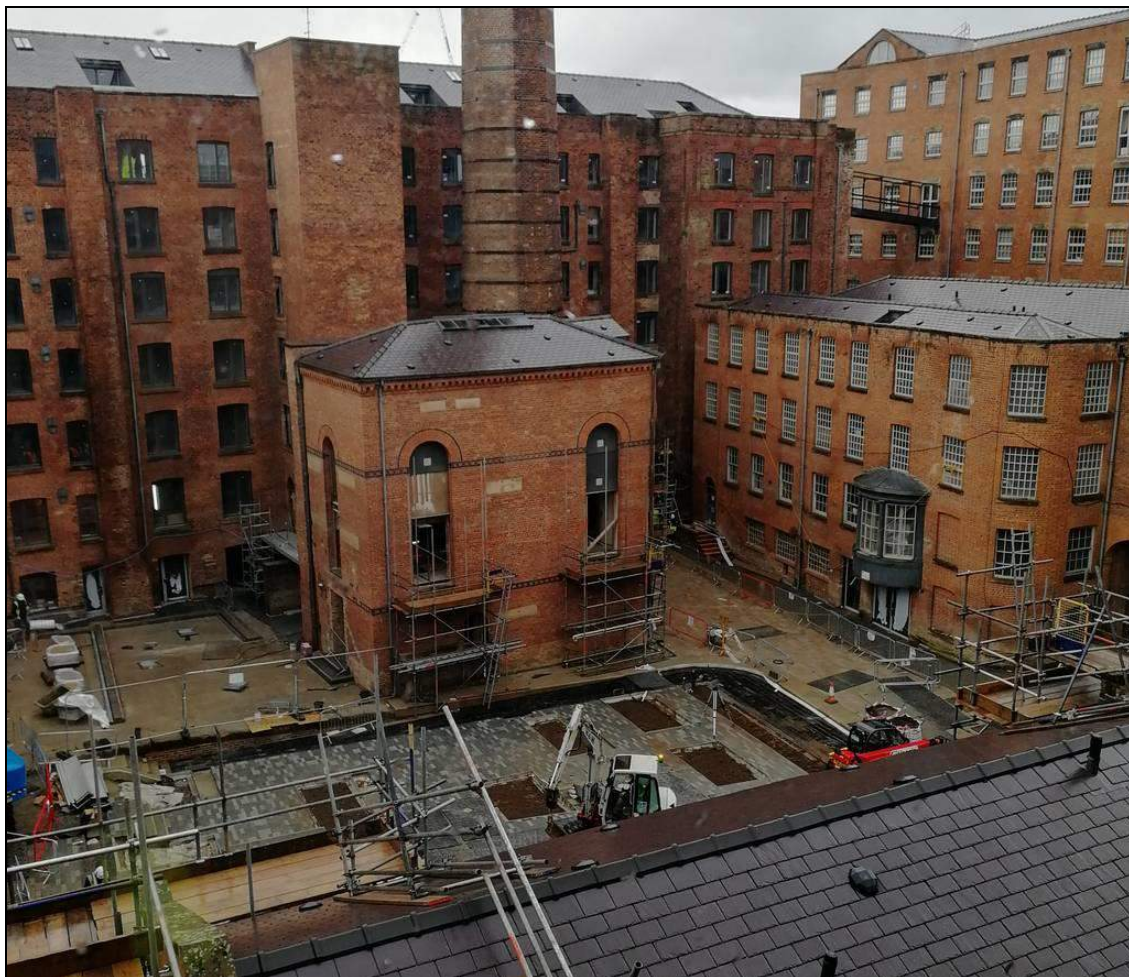


Plate 91: The resurfaced courtyard in 2019

5. Archive

5.1 Archive

The results of the archaeological investigation form the basis of a full archive that has been prepared to professional standards, in accordance with current Historic England guidelines, the *Guidelines for the Preparation of Excavation Archives for Long Term Storage* (UKIC 1990), and current CIfA standards and guidance for the creation, compilation, transportation and deposition of archaeological archive. The project archive represents the collation and indexing of all the data and material gathered during the course of the project. The deposition of a properly ordered and indexed project archive in an appropriate repository is considered an essential and integral element of all archaeological projects by the CIfA in that organisation's code of conduct.

The documentary and digital archive generated from the historic building investigation is currently in the possession of Salford Archaeology. A copy of this report will be submitted to the Greater Manchester Historic Environment Record in digital and hard copy formats, and copies will also be forward to the Museum of Science and Industry in Manchester, which holds a selection of artefacts recovered from the archaeological work carried out at Murrays' Mill in 2005-07. A digital copy of the report will be publicly available on the Archaeological Data Service (ADS) website.

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Appendix 1: Illustrations

- Figure 1: Site location plan
- Figure 2: Site plan showing the main built components
- Figure 3: Elevation of the eastern end of the Bengal Street Block, showing the location of the surviving power features
- Figure 4: Elevation of the eastern end of New Mill, showing the location of the surviving power features
- Figure 5: Elevation of the eastern wall of the former Bengal Street Block at basement level
- Figure 6: Plan of the excavated remains of the engine beds in Old and Decker Mill Engine House
- Figure 7: Plan of the excavated remains of the engine beds in New Mill Engine House

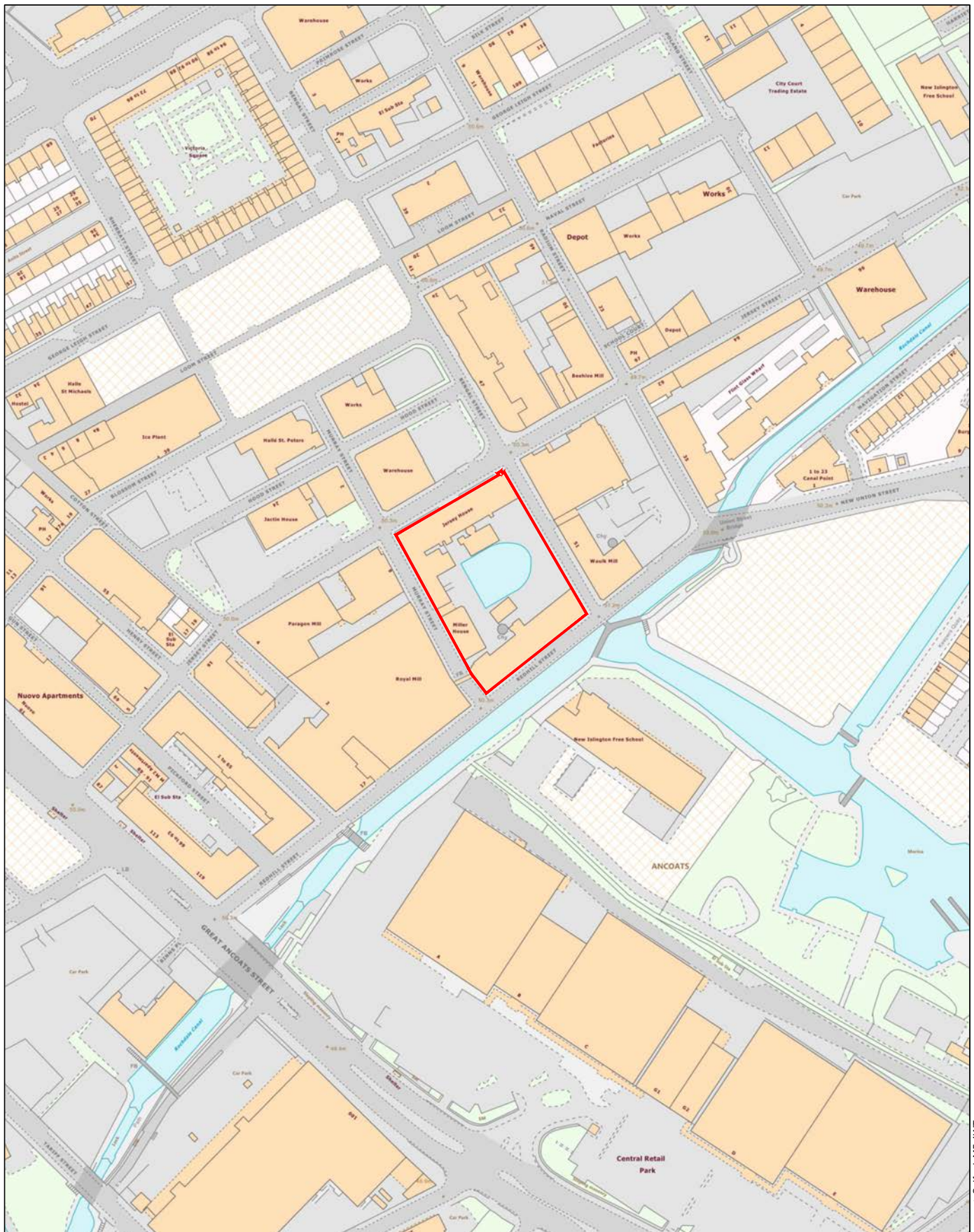


Figure 1: Site Location



Key:

■ Site Location



**SALFORD
ARCHAEOLOGY**

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100 m



Scale at A4 1:2500

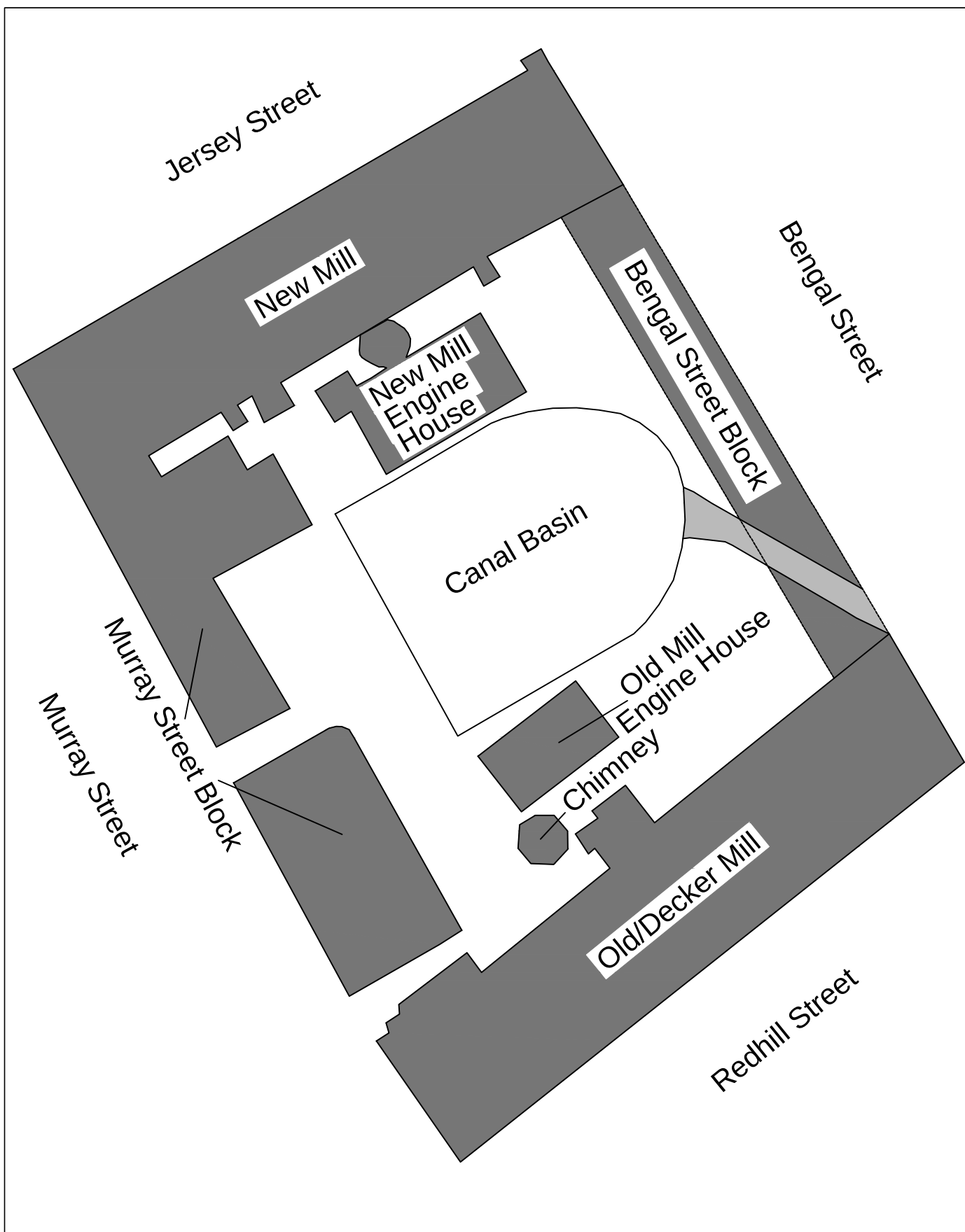


Figure 2: Buildings and Tunnel Footprint



Key:

- Building Footprint
- Tunnel Footprint

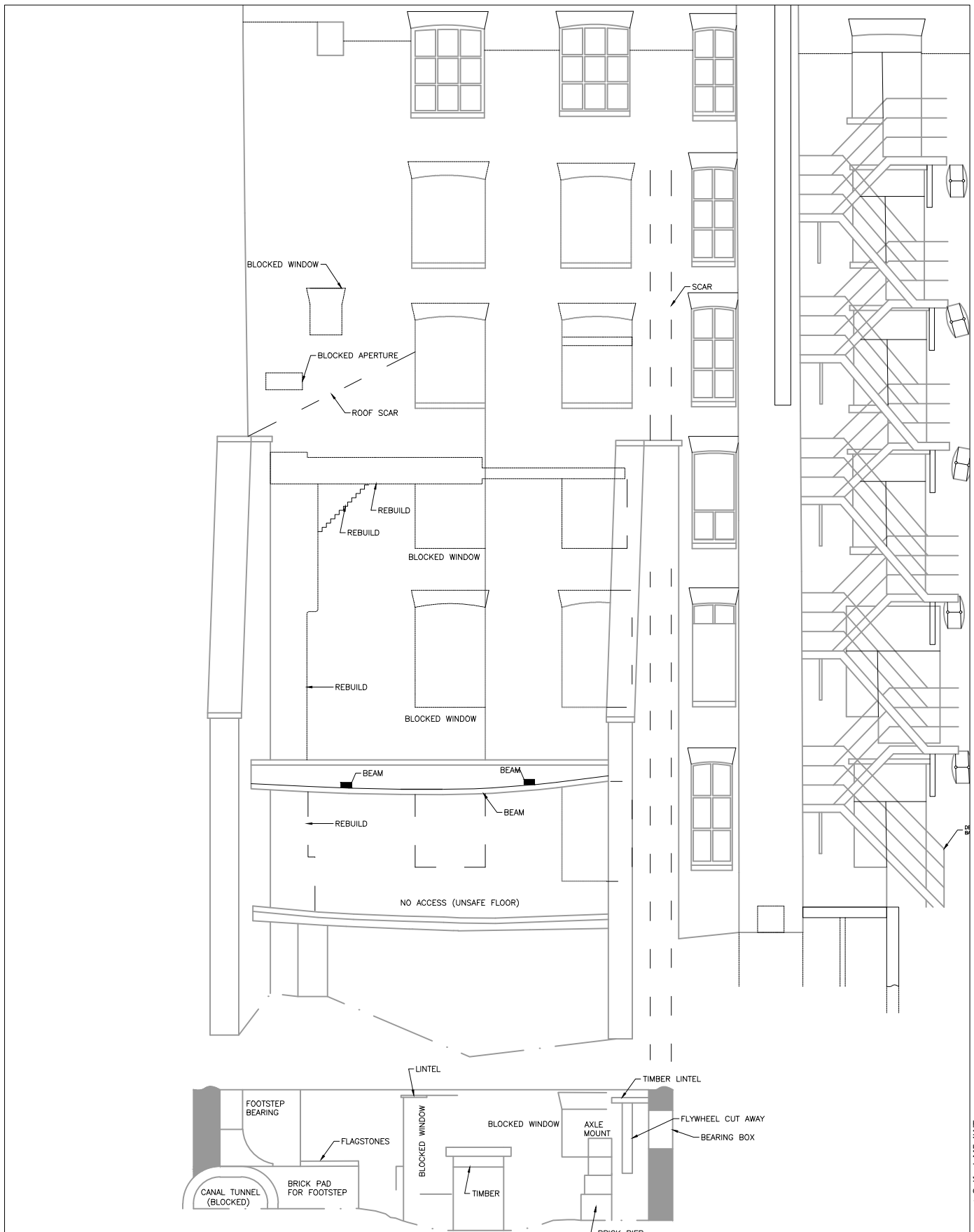


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0 20 m



Scale at A4 1:500



Title:

Key:



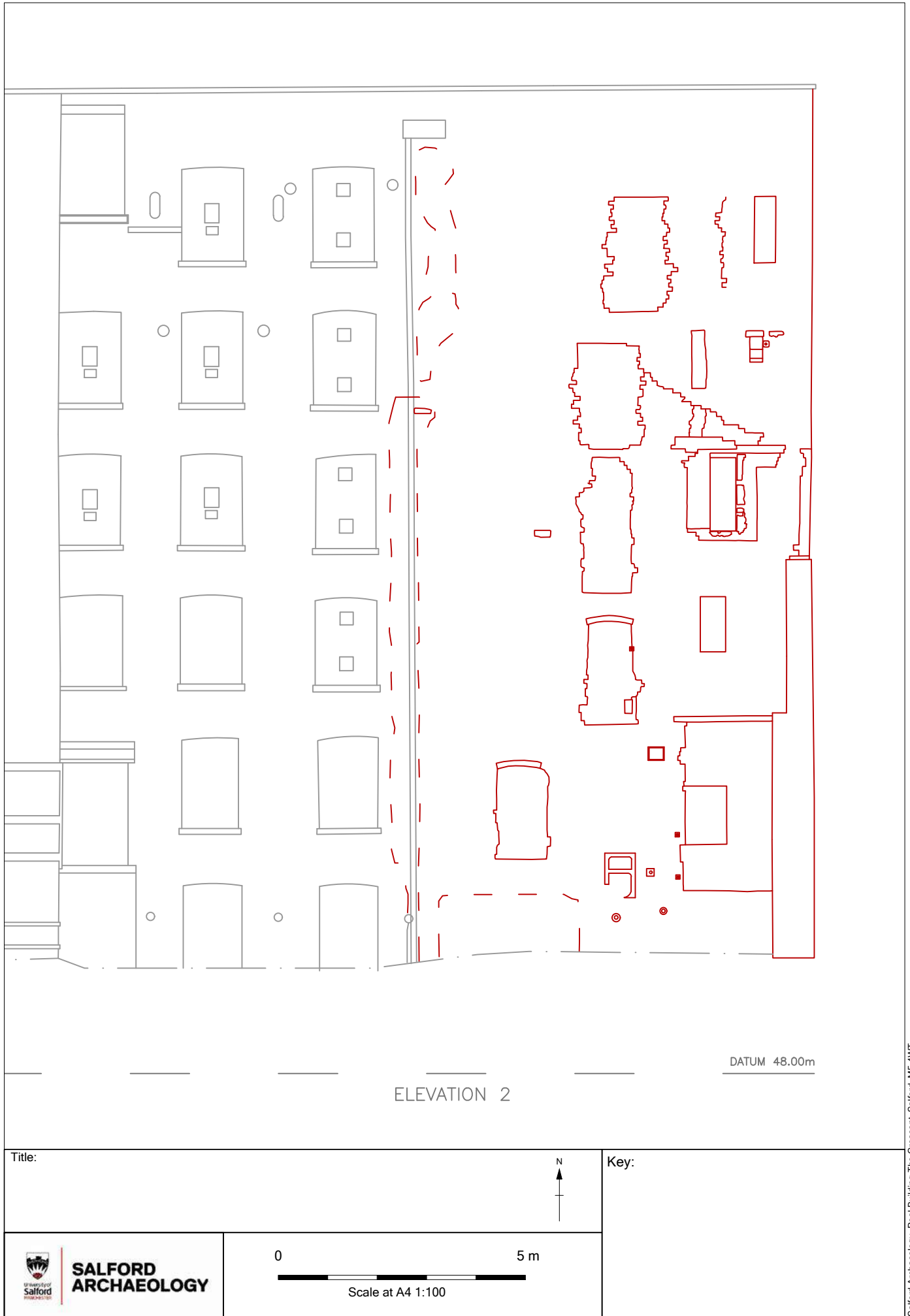
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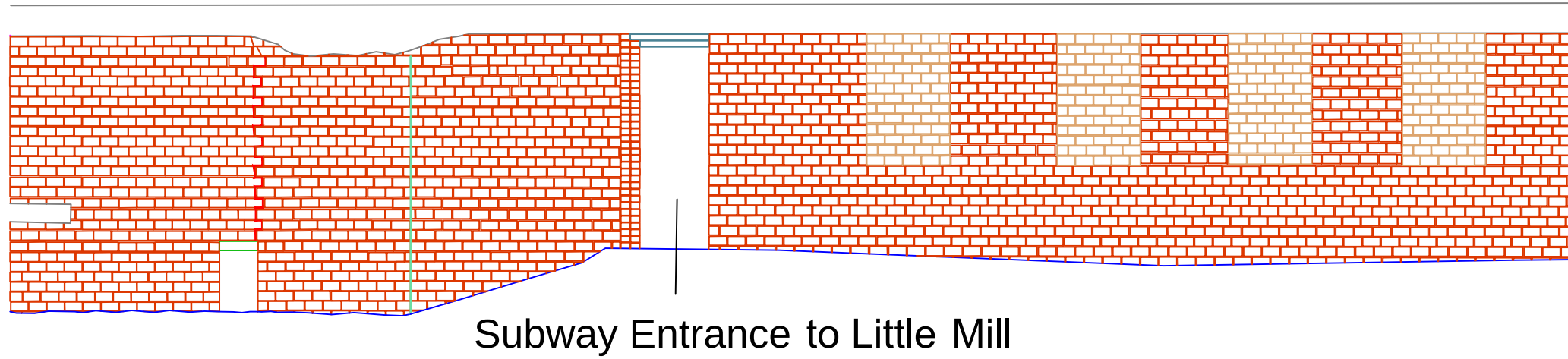
0

5 m

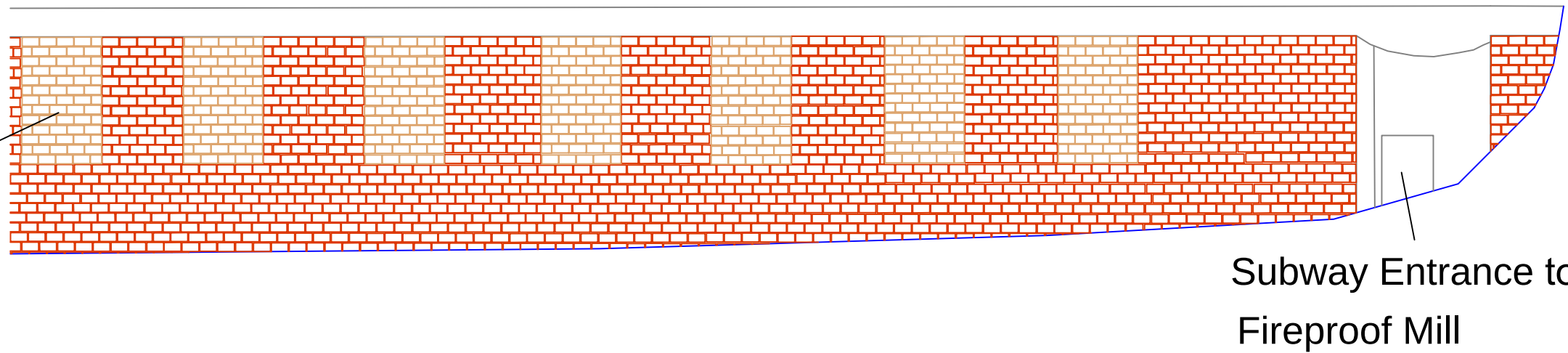


Scale at A4 1:100





Blocked Window



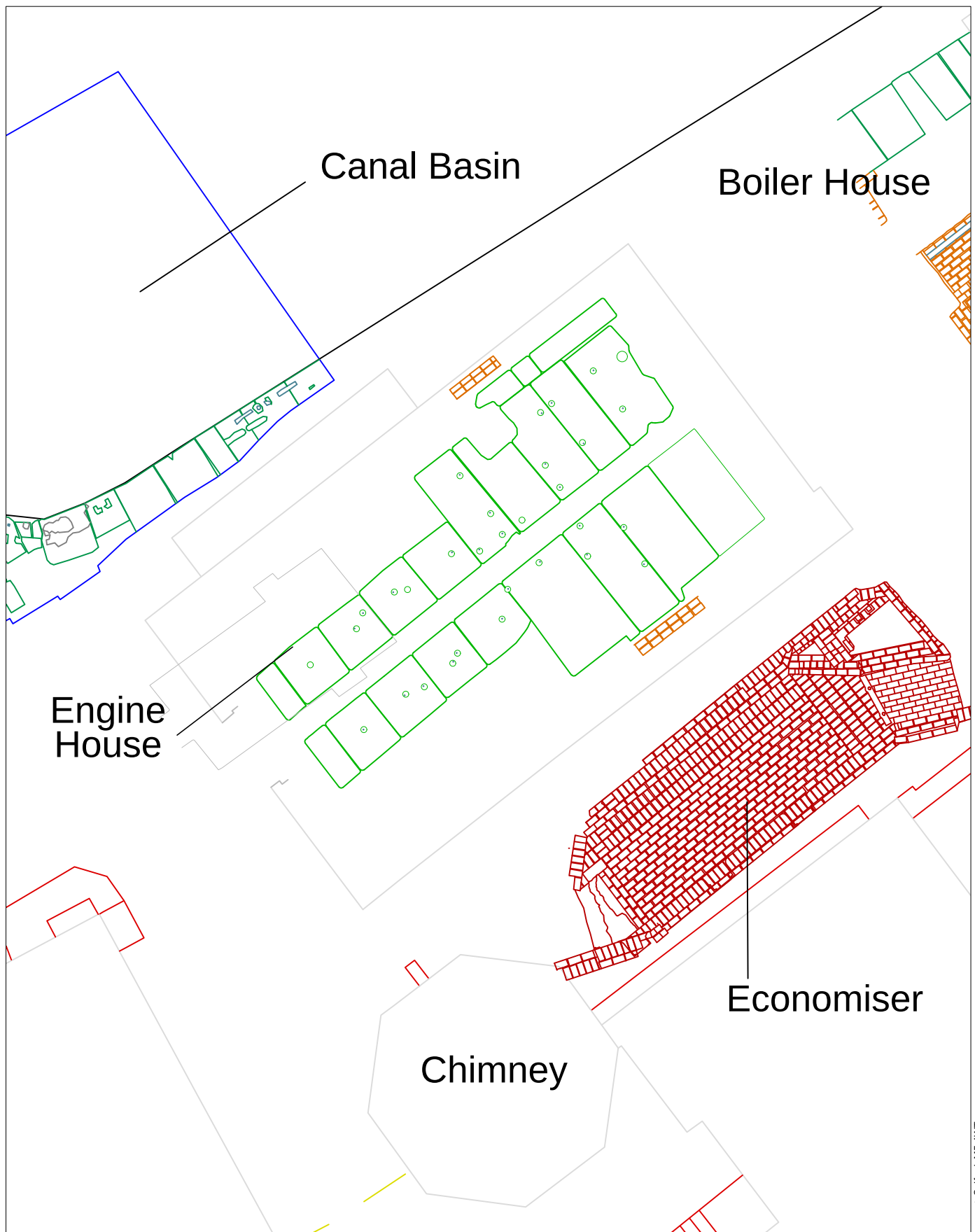


Figure 4:

Plan of Engine Beds in Old Mill Engine House



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0

5 m

Scale at A4 1:100

Key:

- Engine Beds
- Flags
- Brick
- Brick Floor
- Metal
- Concrete

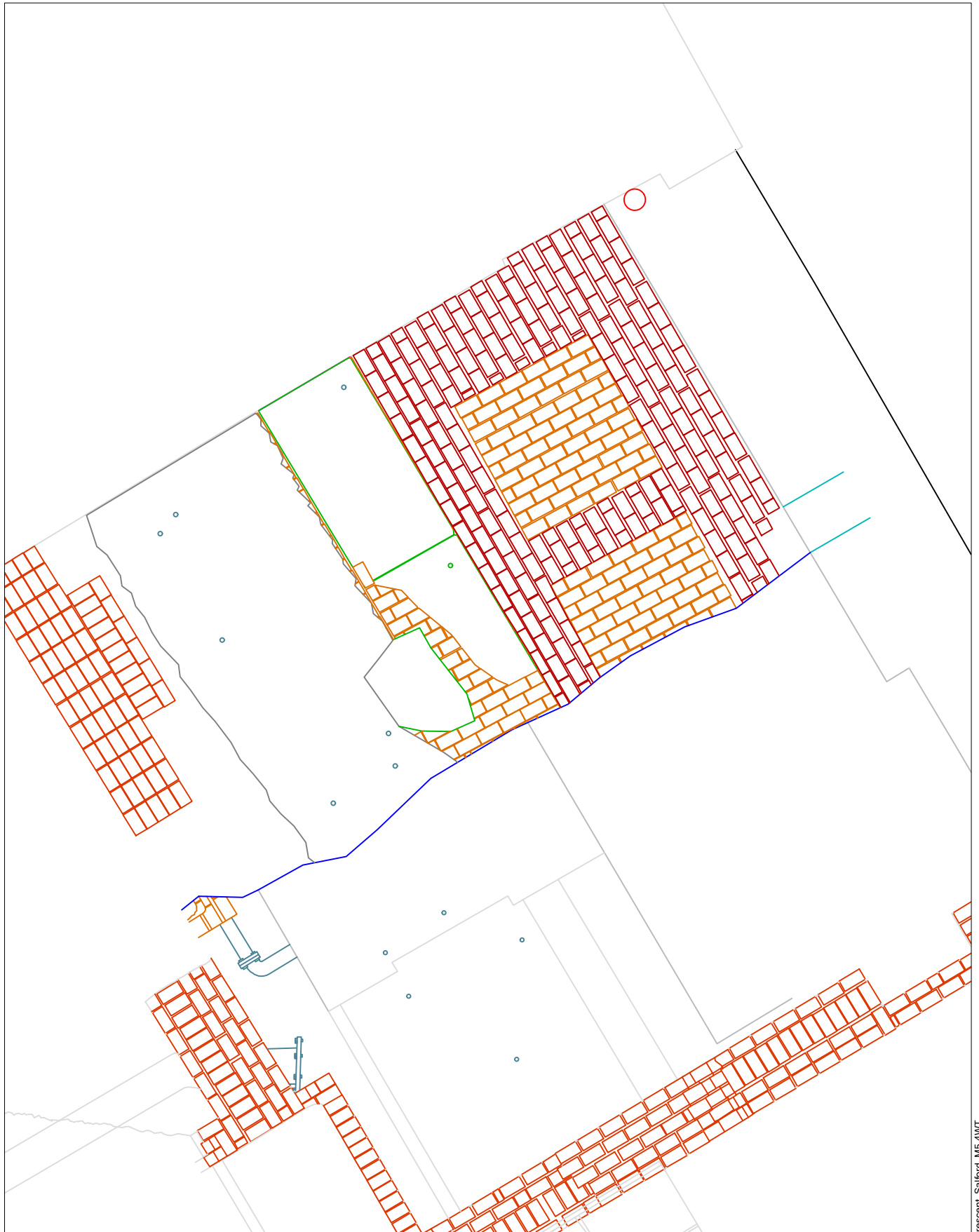


Figure 5:
Plan of the Engine Beds in New Mill Engine House

Key:

- Brick Wall
- Brick Floor
- Brick
- Concrete
- Stone
- Metal
- Recess



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0 2 m
Scale at A4 1:50