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The New Library of Birmingham, Cambridge Street/ Centenary Square

Assessment of Potential and Updated Project Design

VOLUME 2: APPENDICES

UNIVERSITY OF BIRMINGHAM

REGISTERED IFA ORGANISATION

Appendix 1 Site Information

Location and Geology

The site lies within the city centre of Birmingham on the south side of Cambridge Street, Birmingham between the upstanding buildings of the Repertory Theatre to the east, Baskerville House to the west and Centenary Square to the south, centred on NGR SP 0631 8687.

The underlying geology consists of Bromsgrove Sandstone overlain by glaciofluvial deposits.

The site lies in the middle of a ridge of higher ground running southwest – northeast. The Birmingham and Fazeley canal and redundant Newhall Arm are located to the north, and the Birmingham and Worcester canals located to the west. The early canals are contour canals which skirt around the higher ground on which the site is located.

Immediately prior to excavation the site was tarmac hard standing currently used as a public car park, landscaped raise beds as well as an open public plaza.

Archaeological Background

An archaeological desk-based assessment carried out in October 2006 included historic maps and documents and suggested that there were well-preserved archaeological remains on the site. These included buildings belonging to John Baskerville's house in the 18th century, and the location of the Union Rolling Mills in the early-19th century (later becoming Winfield's). The site included a former canal wharf, and the Union Rolling Mill which became part of Winfield's Cambridge Street Works. Winfield's Brass Works, was one of the largest brassworks in Birmingham during the mid to late-19th century. Items produced at the Cambridge Street Works included metal rolling, gas fitting, brass founding, carpentry, and wire manufacture.

An archaeological evaluation in 2008 comprised four trenches, which were located over potential archaeological structures and deposits identified from cartographic evidence, and to avoid known services. The archaeological evaluation demonstrated good survival of below-ground archaeological deposits relating to the former brassworks and the canal basin constructed to serve the works. The results both correlate with known cartographic evidence, and also provide additional detailed information regarding specific rooms and structures within the works.

Geotechnical test pits undertaken as part of the preliminary site work were also monitored in 2009. The test pits with Centenary Square revealed the survival of a further canal arm as denoted on the historic mapping.

Appendix 2 Excavation Methodology

The proposed development covered two areas (1-2). These stages were outlined in the scheme of work by Carillion (Fig. 2).

- Area 1 involved an area of c 3500m².
- Area 2 involved the excavation of an area of 1350m².

A further stage of machine excavation was undertaken in each area to investigate deep deposits within the outlined areas. These underlying deposits reflected earlier phases and deeply stratified deposits (such as the canal backfill and engine house pit).

The initial excavation was undertaken by machine to the depth of the first significant archaeological layers as outlined in the initial evaluation. All edges of the excavation area were battered at an angle of 45° where necessary.

Topsoil and modern overburden was removed using a 360° tracked mechanical excavator with a toothless ditching bucket, under direct archaeological supervision, down to the top of the uppermost archaeological horizon or the subsoil. Subsequent cleaning and excavation was by hand with archaeological features sampled to define their character, stratigraphic relationships and recover artefactual remains. The excavation area was surveyed-in using an EDM total station and located on the Ordnance Survey National Grid. The features were recorded in accordance with the sampling policy outlined above.

Features were planned at a scale of 1:20 onto a survey undertaken by EDM total station that acted as the base layer for these main plans. Sections and elevations were drawn of significant features at a scale of 1:20. A comprehensive written record was maintained using a continuous numbered context system on *pro-forma* cards. Written records and scale plans were supplemented by photographs using black and white monochrome, colour slide and digital photography.

Due to the significant industrial nature of the site, extensive samples were taken to identify macroscopic industrial residues in accordance with *Archaeometallurgy* (English Heritage 2001) and *Science for Historic Industries* (English Heritage 2006). Focused analysis of specific aspects of the site was also employed. Slags and crucibles were weighed and sampled focusing on their diagnostic value.

Recovered finds were cleaned, marked and remedial conservation work undertaken as necessary. Treatment of all finds conformed to guidance contained within the Birmingham Archaeology Fieldwork Manual and *First Aid for Finds* (Watkinson and Neal 1998). All artefacts have been assessed and included in the current report (see below).

The full site archive includes all artefactual remains recovered from the site. The site archive has been prepared according to guidelines set down by the Archaeological Archives Forum, *Archaeological Archives; a guide to best practice in creation, compilation, transfer and curation* (Brown 2007). The paper archive will be deposited with the appropriate repository subject to permission from the landowner.

Appendix 3 Excavation Results

RESULTS

The following phasing (see Fig. 5) is based upon the primary documentary evidence, stratigraphic relationships identified on site, spot dating of the pottery and the material evidence. Cartographic sources have been used extensively to interpret the archaeological evidence. In the following section all context numbers are highlighted in bold.

The term 'site' refers to the area exposed during the excavations of 2009.

The phasing of the site is arranged by room, building, area and by process related function (see Fig. 6).

Some of the structure headings (eg. *Strip Casting Shop* and *Wire Cleaning and Dipping Shop*) are based solely on their historical definitions (1897 sale catalogue) and their use could not be confirmed archaeologically. Also, the recorded use of the building in 1897, may be one of a number of uses employed throughout its history

The site has been split into six phases based upon the available historical and archaeological information. The earliest phases only have limited or incidental archaeological evidence available. Due to the long life and re-use of elements of the buildings it was not always possible to confirm specific phases. The phases are as follows;

- **Phase 1 1745- The Baskerville Estate**
- **Phase 2 1810/11- The Canals** (Gibson & Shore)
- **Phase 3 1824- The Union Rolling Mills** (Ledsam & Ledsam, Potts, Dixon and Winfield)
- **Phase 4 1840s/50s Winfield's Cambridge Street Works**- major reconstructions.

  Winfield acquired the lease of The Union Rolling Mills (1853)

  The Rolling, Wire & Tube drawing were combined into one operation

  Replacement of the boilers (=engine upgrade 1851/52)

  Bedstead works constructed
- **Phase 5 1900-** Parts of the Cambridge Street Works taken over by ICI metals Ltd and later the Ministry of Munitions.

  Partial conversion of plant to electric power- rebuilding of the muffles

  Rolling Mill plant rebuilt
- **Phase 6 1922**- Beginnings of site clearance for construction of the civic centre.

INTRODUCTION TO THE SITE

The excavation covered an area of *c.* 4850m². Within the site there were the well preserved remains of 19th century industrial buildings and part of the abandoned Birmingham canal network. The greater majority of the site was occupied by the brass working manufactory; the Union Rolling Mills (later Winfield's) and two canals (Gibson's Basin or Arm and Baskerville Basin). Various elements of the brass manufactory were identified including the

main power generation and transmission elements (boiler house, engine house and wheel-race etc) and parts of the mill containing different processes (rolling mill, wire drawing mill, tube drawing mill, and bedstead works). The fragmentary remains of the Broad Street Metal Works and Screw Manufactory were also identified.

TRANSPORT NETWORK AND LANDSCAPE SETTING

The Baskerville Estate (Phase 1)

The development of the site began in the post-medieval period, with the construction in 1745 of Easy Hill house, by John Baskerville, the renowned printer and typesetter. Prior to this, during the medieval period, the site lay within an area of farmland (as shown on the 1553 conjectural Map of Birmingham, Bickley and Hill produced *c.* 1891[1]). One residual sherd of green glaze pottery (**1456**) was dateable to this period.

At the time of its conception (early 19th century) the site was situated between good road and canal networks upon land previously known as the Baskerville Estate (c.1745). The site itself was located between Broad Street on its southern side (laid out in the medieval period and shown on the 1553 conjectural Map of Birmingham) and Cambridge Street on its northern (constructed between 1778 and 1795). Easy Row lay along its eastern side (laid out in the medieval period and shown on the 1553 conjectural Map of Birmingham) and on its western side was Baskerville Place (constructed between 1819 and 1824-25). There was a good local canal network in place by the late 18th century (1768-72), but there was no direct access to the railway.

Historical evidence

1745 John Baskerville's, Easy Hill house property first appears on Bradford's plan of Birmingham of 1750 followed by Thomas Hanson's maps of 1778. These plans show a group of buildings to the south east of the excavation area, with a well laid out set of gardens to the west of the house.

1768-72 Outside of the excavation area, the maps show that the Birmingham Canal (Newhall Branch), which loops around the site on its north, west and south sides, was in place by the later 18th century having been constructed in 1768-72 (Foster 2005, 142), the location of this would have been an incentive to the development of the area.

Archaeological Evidence

There was no evidence of structures relating to this early period and many of the buildings relating to Easy Hill (Baskerville) house would have lain to the east, outside of the excavation area. The excavation area is likely to have been located upon the extensive back gardens of this property and the open land surrounding this. Any outbuildings relating to this early phase were removed due to the extensive developments undertaken in the early 19th century.

Several residual sherds of blackware? (17th-18th century) were identified across the site. Many of these came from the lowest levels of overburden deposits and a potential fragmentary cobbled surface on the northern side of site (**1456**). There was also a disturbed buried topsoil (**1546**) (containing a large quantity of broken garden pots), located at the

[1] This is a conjectural map of Birmingham produced in 1891 by Bickley and Hill based on the written records of the 1553 Borough Survey. It relies on later historical maps, predominantly Westley's 1731/2 Map and Prospect for its topographic basis of the town.

southernmost end of the excavation area, south of the Baskerville basin which could have been associated with this period.

The Canals (Phase 2)

The location of the Birmingham canal (Newhall branch, constructed 1768-72) which ran southwest – northeast and skirted the higher ground on which the site is located, stimulated investment in the area. Thomas Gibson laid out his canals and wharfs within the site in *c.*1810 (see below), joining then to the Newhall canal to form the north. They were conceived to stimulate industrial activity and generate revenue from leasing the land.

Development around the canals in general was rapid, and by 1840, on a two mile stretch of the Birmingham and Fazeley canal there were 124 wharfs and canalside industries (Crowe 1994, 74). It is noted by Crowe (1994) that big industrial towns had many public, private and company-owned wharfs and basins (*ibid.*). Later, these two canals (Gibson's Basin or Arm and Baskerville Basin) had a long passage made between them that became known as Baskerville/ Attwoods passage (constructed between 1824-25 and 1855. This united Baskerville Place with Easy Row.

Historical Evidence

1810 Thomas Gibson and Shore acquired the Baskerville estate with a view to opening it up for industrial development. They acquired the *'Bowling green'* and the Baskerville property at Easy Hill and during 1810 were advertising property to let, that included the former Bowling Green *(Aris's Gazette 1810).*

The *'Bowling green'* itself was located to the northeast of site, this later became the location of the Crescent Wharf, this linked the Birmingham canal (Newhall branch), to the canals created by Thomas Gibson.

1811 Subsequent to the purchase of the land, canal basins were constructed. Gibson's private branch was cut during 1811 and wharves, spoil and earth were advertised for sale in June 1811 (Aris's Gazette 1811) (the other became known as Baskerville Basin) construction continued through 1812. The construction of these canal arms enabled Gibson to let Wharves

These basins were laid out in the letter F and the channel from the Newhall branch passed under a Cambridge Street at a bridge, and a lock (Gibson's Deep Lock) was placed close to the south side of this bridge. Later much of this section was built over to cover the canal and became a tunnel. The water was raised by a steam engine placed in Gibson's Rolling Mill that was beside the lock and faced Cambridge Street.

1819 The 1819 'map of Birmingham' shows the area marked as *'Wharf'* but does not show any detail of the canals. It is unlikely they were still under construction at this period and their omission may be due to the cartographer not surveying their exact position.

1922-25 These canals continued in use until their decline in the early 20th century. During 1922-25 Baskerville Basin was filled in to make way for the Hall of Memory and the adjacent gardens (Shill 2006).

1936 Gibson's basin was retained to serve Winfield's rolling mill, until in 1936 it was backfilled when Winfield's relocated, in part due to Birmingham Corporations plans for a new civic centre. During this time the rolling mills were pulled down and the land cleared. These plans for a civic centre never fully came to fruition (Shill 2006).

Archaeological Evidence

Gibson's Arm

The Gibson's Arm Canal (Plate 2) was located north of site between the two sides of the Cambridge Street works, it was aligned northeast – southwest. The two canal walls were of a different nature, suggesting that restructuring and upgrading had occurred during its lifetime. The base was determined to be approximately 4.3m below the current ground surface at approximately 139.7m AOD, and lined with puddle clay at approximately 4m depth. It was approximately 6.5m wide (21.32ft) and a length of 43m was preserved within the site. There was severe truncation of the northern wall which has affected the following interpretation. Successive rebuilds were evident in the northern wall and a distinctive re-facing was defined by two different types of brick. The inner core, and primary construction 1810-11, (**1206/1209**) was constructed of hand-made, 8½ x 4 x 2¾ inch orange and dark red bricks set within an English bond. The re-facing (**1145**), which probably occurred around the 1840s/50s, during the period of major rebuilding, was identified by the use of 9 x 4¼ x 3 inch engineering bricks, set in an English Bond. The bricks used were like those used for the fabric of the bedstead works.

The southern wall of the canal (**1068**) was constructed entirely of this type of brick, being that these are on the bedstead works side it appears as if this wall was entirely rebuilt during this period of construction (1840/50s). There was a lowered loading bay on the northern (Rolling Mills) side (**1146**). There were also two reinforced steel girders set into this which may have been the location of a crane. The location of the canal footbridges can be surmised from reference made to them on the Ordnance Survey mapping. These footbridges would have allowed pedestrians access to the two sides of the complex. The western end of the canal (**1499**) was shortened between 1889 and 1897. The back of the canal was altered to stop at the back of the muffle building and was constructed in a concave shape to match the front end of a canal boat. A further loading bay was created (**1500**) where an additional crane was perhaps located. A set of steps (**1496**) led down onto the loading bay, from the Tube drawing Mill. The rest of the canal was known to have been backfilled in 1936 during demolition for the proposed civic centre. The difference in height (AOD) between the canal arm identified in the evaluation, and the Newhall canal to which it joined gives some idea for the reason for the additional depth of the canal in this area. The difference in level of the canal towpath on the Newhall Arm of the Birmingham and Fazeley Canal (138.4m AOD as ascertained from the data from the Ordnance Survey 1st Edition) and within the site at Cambridge Street (approximately 144m AOD) suggest a difference in surface level of 5.5m.

It is known from documentary, cartographic, and photographic evidence that there was a lock (Gibson's Deep Lock) in the canal located under the present Baskerville House building. However, locks in general raise water levels between 1.8m to 3m (http://www.canaljunction.com/canal/lock.htm), so the additional depth of the canal arm within the site may be due to the water level being significantly lower than the adjacent ground level. It is possible that there was a roofed-in wharf with cranes to allow shipments to be accessed to the level up to 4m below.

Baskerville Basin

The Baskerville Basin (Plate 6) canal was located approximately 47m to the south of Gibson's Arm canal. It was aligned northeast – southwest parallel to that of Gibson's Arm Canal. Unlike Gibson's Arm canal, there appeared to have been very little alteration of the wall construction and it represented the original 1810-11 building fabric. The canal walls (**1539**, **1540**) were constructed of hand-made, 9½ x 5 x 3 inch red bricks set within an English bond. The canal was 6.6m (21.65ft) in width and a length of 35m was preserved within the site. The walls survived to a depth of 1.2m. The base of the canal was lined with yellow–brown puddle clay (**1559**). A black contaminated material made up of settled industrial material (**1560**) sat upon the clay base. Above this was the demolition backfill from the period 1922-25 (**1547**), containing building rubble and material evidence dating from the period.

BRIEF HISTORY OF THE UNION ROLLING MILLS -LATER WINFIELDS (Phase 4 & 5)

Investment in the transport network made the site a profitable location for development and following the introduction of the canal wharfs, industrial buildings began to occupy the former Baskerville estate. The construction of the Gibson's canals meant materials could be imported and finished goods exported, via the wider Birmingham canal network, to be sent further afield. The road network, supplied the workforce, labour, and supported the canals in the delivery of goods and materials.

In 1824 a piece of vacant land was leased from Thomas Gibson (Lease 1st October 1824), that lay between Cambridge Street and Gibson's Arm Canal. The lessees were Daniel Ledsam, Joseph Ledsam, William Potts, Matthew Dixon and Robert W. Winfield and they used this property to set up the Union Rolling Mills.

In 1829 the Union Rolling Mills was occupied solely by Winfield and his company located at the Cambridge Street Works became known as R.W. Winfield & Co (Winfield's *Prospectus for formation*). The Cambridge Street Works were considerably expanded and continued to be used for brass rolling. The main items produced were brass tubes and bedsteads. During the 1840s or 1850s the land the other side of Gibson's Arm Canal was developed by Winfield as the bedstead works. In 1853 Winfield acquired the lease of the Union Rolling Mills (Birmingham Library Archives). At this time Winfield combined the rolling, wire and tube drawing plant into on operation. The bedstead works buildings, constructed south of Gibson's Arm Canal were in place by the time the Piggott Smith Map was produced (Piggott Smith 1855). During its height Winfield's won a series of awards for its metallic products including:

Grand Council Medal, London 1851
Prize Medal, London 1862
Gold Medal, Paris 1867
Prize Medal, Vienna 1873
Gold medal for Chandeliers and Gas Fittings,
Gold Medal for Metallic Bedsteads, Furniture etc,
Gold Medal (Rappel) for Art Metal Work and;
Bronze Metal for Tubes, Metal, Wire etc, Paris Exhibition 1878

Winfield's stained glass department was also recognised and won awards including;

Gold Medal, Paris 1878
Gold Medal, Bradford 1882
First Prize, York 1879
First Prize, Sydney 1880 (Dent 1894)

After the death of Robert Winfield in 1869 the company went through a variety of partnership changes and in 1887 the company was trading by the name of Winfields Limited. Parts of the Cambridge Street Works were sold off separately after 1898 and during the early 20th century there was changed ownership. 1922 saw the end of production and beginnings of site clearance.

POWER GENERATION AND TRANSMISSION

Power for the Union Rolling Mills (later Winfield's), including the rolling, tube, wire mills and warehouses, was generated by a beam engine located within a purpose built engine house in the rolling mill. Steam for the engine cylinder(s) was provided by large boilers, the exhaust fumes of which were drawn through a series of flues to a large purpose built chimney. The arrangement of water pumping was not clear in the archaeological record, but it is known that water was pumped into the boilers via the main engine and later, by the boiler feed pump. The engine and boilers were subject to a variety of upgrades throughout their lifetime and although all traces of the machinery had been removed, possible evidence of restructuring was represented in the fabric of the building foundations.

The engine (which saw a succession of technical upgrades) was a condensing beam engine, which drove fly wheel connected to a series of spur wheels within the 'Wheel Race(s)'. These spur wheels were connected by shafting to the rolling mill rolls, wire mill drawing benches and tube mill drawing benches, among other machinery. It is also very likely that the engine doubled as a pump to supply the boilers with water. The arrangement of the pumping machinery also saw technical upgrades.

The Boiler House- Phases 3 & 4

Boilers (Phase 3 1824- Union Rolling Mill)

Historical Evidence

1824 During 1824 a piece of vacant land was leased from Thomas Gibson that lay between Cambridge Street and the Gibson's Arm Canal. The lessees Daniel Ledsam, Joseph Ledsam, William Potts, Matthew Dixon and R.W. Winfield used this property to set up the Union Rolling Mills (Lease 1st October 1824). At this time it is likely that three boilers were in use as in 1847 they were advertised for sale (Birmingham Gazette and Journal Jan, Feb and Mar 1847).

Archaeological Evidence

The foundations of the primary phase of boilers were made up of three rectangular bases situated within thick external and central dividing walls. The bases themselves (**1359**, **1363** & **1386**) were of roughly the same dimensions (1.6 x 3.1m) and they were equally spaced, the central dividing walls being 2m apart. Overall the bases were incorporated into a rectangular structure 12.2m (40.02ft) in length x 5.2m (17.06) in width. They were located in what might be termed the Boiler House which as a structure was orientated northeast to southwest.

The external walls (**1260**, **1358**, **1361**, **1382**, **1387** & **1388**) were 1-1.5m thick and had been built in stages, probably around the *in situ* boilers. The brick settings were integral to the functioning of the boilers as flues were required to be located beneath. The bases were likely to have supported cylindrical Cornish type boilers. This type of boiler is illustrated in contemporary pictures. The southern side of the boilers was the location of the ash pits, one of which survived (**1389**).

The bricks used in the construction of the boiler bases were handmade, red 9 x 4¼ x 3 inch bricks set in an English bond. The floor surface was constructed of the same type of bricks. The western most base (**1363**) survived to a significant height and was the most complete. Plinth bricks had been used in its construction around the upper edge.

During 1851/52 the boiler house was upgraded and the three boilers were replaced with two. The westernmost boiler base (**1363**) became filled with general brick rubble before being covered over by a brick floor surface (**1180**). The other two boiler bases became incorporated into the reconstructions.

Boilers (Phase 4 1851/52- Winfield's)

Historical Evidence

1847 *'Three boilers and a 95 horse power steam engine'* were advertised for sale in the Birmingham Gazette and Journal (Birmingham Gazette and Journal Jan, Feb and Mar 1847).

1851/52 Four years after the three boilers were advertised for sale, Boulton and Watt were hired to supply the mill with new boilers. Their letter book mentions that *'one of the new boilers will be finished this week, and the other in the following one'*. This work included the removal of the *'pieces of the old boiler'* and bricklayers *'clearing out all the defective parts of the old foundations'.* (Boulton and Watt Letter Book 123, sep 1851)

1897 In the sale catalogue of 1897 the two boilers were described as *'Double flue firing boilers by Edwin Danks of Oldbury 23ft long by 9ft diameter'*. Associated with these were their brick settings (27ft x 25ft) Details relating to the sale plan note ' *Two boiler settings for lancashire boilers and protection shed over fire holes'.* These are also seen in the accompanying sale plan (Scott v Winfield 1897). It appears therefore, that between 1851/52 and 1897, there was a further replacement of the boilers.

Archaeological Evidence

The boilers were upgraded during 1851/52, and this meant the total reorganisation of the bases. The upgraded boilers were of a Lancashire type, these were a later development (patented 1844), than the Cornish boilers. This type of boiler was more efficient and therefore would have increased steam pressure to the steam engine, which would also have seen an upgrading at this period.

The foundations of the secondary phase of boilers were made up of two rectangular bases situated within thick external and central dividing walls. They had partly re-used the two easternmost bases of the primary phase of boilers. The bases themselves (**1164**, **1165**) were of roughly the same dimensions (1.3m x 7m or 4.26ft x 22.96ft- the discrepancy in the foundation dimensions, with the documented boiler dimensions is due to the fact that these foundations represent the supporting structure for the boilers only), the central dividing wall (**1223**) was 2.5m in width.

Overall the bases were incorporated into a roughly square structure approximately structure 9m (29.52ft) in length x 8.5m (27.88ft) in width. The external walls (**1202**, **1163**) were 1.3-2m thick as a result of incorporating the walls from the earlier phase. The brick settings were constructed of yellow fire brick. These were constructed in a sloping fashion at the southern end of the base. The southern side of the boilers was the location of the ash pits.

The bricks used in the construction of the boiler bases were a mixture of machine-cut, yellow fire bricks and ordinary machine made, red/grey bricks 9 x 4 ½ x 3 inch, set in a mixed bond. The floor surface was constructed of the same type of bricks.

Built up to these boiler bases and contemporary with their construction, there were a series of yard surfaces (**1160**, **1167** & **1180**). These were all constructed of engineering brick and there were several alterations evident.

On the northern side of the bases there were a series of flues (**1163** & **1346**). Again, these flues contained alterations and rebuilding, suggesting periodic upgrading. This upgrading may have been at times when it was anticipated there would have been increased combustion products entering the flue system- due to larger boilers etc or at a time when the flues needed to be repaired because of their general ware.

The steam pipes feeding into the steam engine from the boilers would have probably been of the flanged type and all above ground. The locations of some of these pipes are present on the 1897 sale of works plan (Scott v Winfield 1897), but no *in situ* evidence remained.

The Boiler Feed Pump (Phases 3 & 4)

Historical Evidence

1897 On the western side of the boilers was a small rectangular structure which housed the boiler feed pump. This was a *'double cylinder donkey pump with cast iron flywheel'* which had a *'wood shed over boiler feed pump'* (Scott v Winfield 1897). This small steam pumping engine was for the sole purpose of feeding the boilers with water and was probably a later addition.

Archaeological Evidence

The structure itself took the form of a rectangular pit structure 4.5m in length x 3.1m in width and 0.85m in depth (**1204**) constructed of handmade red, 8½ x 4 x 2¾ inch bricks set in an English garden wall bond, with an internal dividing wall (**1271**), presumably for the purpose of separating the pit to house the double cylinders. It also contained a fire brick lined base (**1203**). There were two iron settings (**1201** & **1197**), which were the likely locations for the tying down points for the feed pump structure.

The southern wall of the boiler feed pump (**1204**) abutted the northern wall of the most easterly boiler base dated to phase 1 (**1363**). This suggests that the donkey pump was introduced during the lifetime of the original boilers (1824 – 1851/52), and as the structure was present on the 1897 plan, its use must have continued into the boilers second phase.

The Chimney and Flue(s) (Phases 3 & 4)

1897 The chimney was described in the 1897 sale catalogue as the *'mill chimney stack approx 164ft in height and 14ft x 14ft base'* (Scott v Winfield 1897).

The foundations of the main chimney stack were identified (**1465**). The chimney was located outside of the southern corner of the Union Rolling Mill. It was octagonal and had a large fire brick flue (**1270**) running into the base of the eastern elevation. The chimney was identified in the documentary sources, and the dimensions described in 1897 are identical to the foundations exposed. The combustion products from the boilers were carried along the flue to be expelled up the chimney. The chimney also provided draft to these boilers.

The base itself (**1465**) was 4.3m x 4.3m (14ft x 14ft) and excavated to depth of 0.8m (internal). The main octagonal construction was made up of hand-made, 9 x 4 x 2½ inch red bricks set in a stretcher course, with the central circular space being made up of dark red, soot stained brickwork (vitrified fire bricks). A fragmentary brick floor surface (**1464**) surrounded the chimney base.

A flue (**1270**), built into the chimney's eastern foundation was constructed of a mixture of red bricks (of the same type as the chimney) and was covered by a vaulted roof constructed of wedge shaped fire bricks. This flue ran in an east to west direction from the northern side of the boiler bases. There had been much alteration to the flue system probably in part due to the reorganisation of the boilers. At various locations along the length of the flue, the roof had been rebuilt using iron plates.

Any direct relationship between the boilers and these subterranean brick flues was unclear. However it is certain that the flue would have connected directly to the boilers on the northern side of the boiler house. Additional evidence of flue rebuilding was noted immediately north of the boiler house. At this point the flue was split into two separate parts

(**1161** & **1214**). This separation may be related to the upgrading of boilers in 1851/52 when the foundations were known to have been rebuilt.

The Engine House (Phases 3, 4 & 5)

Historical Evidence

1824 Union Rolling mills constructed (Lease 1st October 1824).

1847 The first mention of the steam engine was in 1847 when *'Three boilers and a 95 horse power steam engine'* were advertised for sale (Birmingham Gazette and Journal Jan, Feb and Mar 1847).

1882 Mention of the steam engine is made in 'The Electrician' where it is described as a *'low pressure condensing engine, having a fly-wheel 24 ft in diameter, running 48 revolutions per minute….A belt from the fly-wheel is carried to a camshaft ….which drive the dynamo machines'* (The Electrician 1882).

1897 A comprehensive description of the engine and its components was made for the purposes of the sale of works. It was described as a *'160hp Condensing beam engine- 8ft stroke 48in cylinder-double cast iron beam 26ft by 4 ft crank 26ft long, 5 plunger rods, condenser 6ft by 3 ft diameter, cast iron receiving tank 9ft by 6ft by 8ft in, force pump'*

The rolling mill was also described as having *'two large storage tanks over centre to supply boilers fed by canal water- pumping being done by mill engine'* (Scott v Winfield 1897).

From these sources it can be deduced that the engine of 1897 was of improved efficiency and that horse power had greatly increased from that of 1847. It was also involved in pumping at some point in its history as there is historical reference to pumping *('37ft of cast iron flanged water pipe to well pump under engine'* -Scott v Winfield 1897), which is confirmed in the archaeological evidence. The archaeological evidence for pumping was in the form of large pits beneath, and at the front of engine of which the former was later covered.

1936 In 1936 the engine was due to be scrapped, prior to this it was described *'The beam engine at the Rolling mills was built by James Watt. After 100 years carries on supplying original work of driving power for rolling, tube, wire mills and the warehouse. The driving wheel (26ft in diameter) makes 19 revolutions per minute- the even larger fly wheel (28ft in diameter and weighing 30 tons) revolves 70 times per minute. The engine has been repaired 3 times and just after being built, had a new condenser put in. he engine originally had a wooden beam, which was replaced by a cast iron beam. It now has a twin steel one.'* (Birmingham Gazette 1936)

Archaeological Evidence

The Engine house structure was located approximately 8 metres to the northwest of the boilers and boiler feed pump. The steam pipes connecting these boilers and the engine would have been located above ground and their rough locations are present on the 1897 sale of works plan (Scott v Winfield 1897). The engine house was a purpose built building 7m in length x 5m in width, whose design was dictated by the form of the steam engine contained within. The steam engine of the Union Mills, being of a beam engine type, would have partially relied on the superstructure of the brick engine house to support the beam.

The engine (including the beam supports cylinders and condenser was situated upon the engine base. The engine would have been aligned north to south with the cylinders, condenser and boilers on the south (canal side) and the fly-wheel and driving wheel located in the Mill wheel race on the north-eastern side of the engine, facing the rolling mill.

Nothing of the beam engine had survived, having been scrapped in 1936, however, the foundations of the brick structure within which the engine was sited, had been preserved. The engine house structure had substantial brick walls 0.75m -1.2m thick constructed of handmade red 9 x 4¼ x 2¾ inch bricks set in an English garden wall bond (**1283**).

The southern side of the engine house was the location of the machine base. This base was approximately 2.85m x 3.7m and up to 1.6m thick in places. It was constructed of a mixture of brick, crushed brick and cement. There were two large upright holding down pins, each over 5m in length towards the centre of the base, these would have held the vertical beam supports.

The southern wall of the engine house was difficult to define, the foundations having been truncated by later alteration and demolition, it is clear though that if the beam was 26ft (7.92m) in length (Scott v Winfield 1897) the engine house must have been at least this to accommodate the beam. A gap in the northern elevation of the engine house structure, illustrated on the plan of 1897, may be where the beam came through the building to be attached to the fly wheel in the wheel race. A substantial lump (0.95m thick) of concrete, situated to the north of this opening (**1309**) represents a further section of the machine support structure. The main southern elevation must have been located further south, probably aligned parallel to the main rolling mill elevation (**1163**).

To the north of the engine base there was a large rectangular pit 2.3m in length x 3.6m in width excavated to a depth of 4.4m. This had been backfilled with a dark brown sandy-silt and demolition rubble fill (1357), during the demolition of 1936. A second pit was located beneath the engine base. This pit was rectangular, 1.6 m in length x 3.6m in width, it was also excavated to a depth of 4.4m. The two pits were separated by a shared wall approximately 0.23m in thick and at the base of the pit there was a door for access between them. It is likely that these pits are associated with the pumping mechanism as there is reference to the boilers being fed by canal water with the pumping being done by the mill engine and the well pump under the engine (Scott v Winfield 1897).

The scale of these power generation elements and the investment that they represented meant that they were unlikely to have moved location, or dramatically changed much during the lifetime of the works. Structurally the foundations that have been identified are likely to be the foundations introduced when the Union Rolling Mills were constructed. Elements of the engine itself were subject to periodic change.

The Wheel-Race(s) Phases 3 & 4

Historical Evidence

1897 Located within the wheel-race(s) were fourteen cast iron spur wheels along with their associated shafting, plummer blocks and brasses, cast iron sill plates, holding down pins and brick built foundations. The fly-wheel/ driving wheel would also have been located in this location (Scott v Winfield 1897).

The fly wheel of 1882 (24 ft in diameter, running 48 revolutions per minute) appears to have been upgraded before 1936 when it was 28ft in diameter and weighing 30 tons and revolved 70 times per minute.

The driving wheel was mentioned once in 1936 to be 26ft in diameter and made 19 revolutions per minute.

Archaeological Evidence

The location of a single linear trench is marked by two parallel dashed lines on the 1897 sale plan (Scott v Winfield 1897). It is marked as running in a northerly direction from the north corner of the engine house. The archaeological evidence has exposed three trenches, each

lying parallel to one another, and each located immediately north of the engine house, in the centre of the rolling mill/ wire drawing mill buildings. The trench marked on the plan is the furthest east of these three trenches.

The wheel-race structures were large linear brick built trenches which would have housed the fly wheel/ driving wheel and spur wheels, the purpose of which was to transfer the power generated in the engine to the rolling and wire drawing machines. The power would have been transferred to these machines through the use of directly driven spur pinions connected to these spur wheels.

The location of the fly wheel and spur wheels can be identified by the presence of their holding down pins and cast iron sill plates. These were visible along the original top edge of the mill wheel race foundations. These *'...cast iron sill plates, holding down pins and brick built foundations'* were mentioned in the 1897 sale catalogue (Scott v Winfield 1897). A good approximation can therefore be made as to the exact positions of the fly wheel/ driving wheel crank shaft and spur wheel axles. Broadly, they are aligned with the rolling and wire drawing machine trenches.

For simplicity of explanation each trench has been assigned a letter (A, B & C). Each trench shares a wall with its neighbour and was modified throughout its lifetime. Inevitably, with the constant movement of heavy machinery, the foundations and machinery would have required upgrading.

The easternmost race (A) is the race identified on the 1897 plan and probably housed the spur wheels for the rolling mill. The central race (B) was the probable location of the main flywheel and driving wheel(s) and the westernmost race (C) probably housed the spur wheels for the wire drawing mill.

Voids were present beneath the base of each of these trenches. It is possible that these were connected to a deep culvert, which carried away any liquids which would have accumulated at their base (eg. after cleaning, grease spillages etc). A definitive answer to this question was not possible as this remained unexcavated.

Wheel Race A

Walls; **1252-** eastern elevation. (**Phase 3**)

1354 & **1356**- eastern elevation. **1345**- western elevation. (**Phase 4**)

15m (exposed) in length

0.8m in width

2.2m (maximum) in depth)

Approximately 15m of this mill race was identified. It was the easternmost of the wheel races and began at the southeastern corner of the engine house and continued in a northerly direction beneath the northern edge of the excavation area.

There appeared to be a succession of major modifications of these mill race foundations. The southern end of the mill race nearest the engine appeared to be of an earlier (and probably primary) construction. This was clearly identifiable in the eastern wall which was constructed of handmade red 8¾ x 4¼ x 2½ inch bricks set in an English bond (**1252**). This wall had been rebuilt in a northerly direction using machine–cut 9 x 4 x 3¼ inch engineering bricks set in an English bond (**1354**). A further rebuild, of the same construction materials, was identified at the far northern end (**1356**). The western (and parallel) wall of the wheel race (**1345**) was constructed of these later engineering bricks.

Only part of this wheel race went to a depth of 2.2m, the majority was preserved to a depth of 1.5m. It is likely that there was a larger wheel (perhaps the driving wheel) at this deeper

location. The level of the base of this deepest section is comparable to that of wheel-race B and it is aligned with the bowl shaped base section, interpreted as the location of the fly wheel.

Wheel Race B

Walls; **1345**- eastern elevation. **1305** western elevation. (**Phase 4**)

9m (exposed) in length

1m in width

2.7m (maximum) in depth)

Approximately 9m of this mill race was identified. It was the central wheel race of the three trenches and began at the northern corner of the engine house and continued in a northerly direction beneath the northern edge of the excavation area.

The main walls (**1345** & **1305**) were constructed of machine–cut engineering bricks (9 x 4 x 3¼-3½ inch) set in an English bond. At the southern end of the trench, nearest the engine house, the base was bowl shaped in its construction to accommodate a large wheel, perhaps the fly wheel.

Wheel Race C

Walls; **1305** eastern elevation. **1304** western elevation. (**Phase 4**)

5.5m (exposed) in length

0.9 m in width

1.3m (maximum) in depth)

Approximately 5.5m of this mill race was identified. It was the westernmost wheel race of the three trenches and again it continued in a northerly direction beneath the northern edge of the excavation area.

The walls were of different constructions suggesting alteration at a later period. The eastern wall of the race (**1305**) was constructed of machine–cut 9 x 4 x 3¼-3½ inch engineering bricks set in an English bond. However, the western wall of the race (**1304**) was constructed of hand-made red bricks (8½ x 4¼ x 2¾ inch) set in an English Garden Wall bond. This wall appeared to be the earlier of the two. The base contained a shallow stepped construction, presumably to contain a wheel.

NON-FERROUS METALLURGICAL PROCESSES

Introduction

The main activity undertaken within the Union Rolling Mills (later Winfield's) was non-ferrous metal working, primarily brass working in various forms, other metals were also used (copper, iron and tin), having been identified in the documentary sources (Wrightson & Webb Birmingham Directory 1843). The sources suggest a wide variety of items were produced at the manufactory including;

-rolled metals
-wire
-brass and copper tubes

-ornamented brass tubes
-art metal work for ecclesiastical and domestic use
-gas chandeliers and fittings of all kinds
-brass and iron bedsteads
-brass fenders
-dogs and fire brasses
-memorial brasses
-electric light fittings
-wrought iron work
-stained and painted glass work (Dent 1894)

The majority of this list is comprised of metal items with the exception of the stained and painted glass work. The items were produced using a variety of processes, undertaken by specific machines at different locations across the works. Rolling, drawing, annealing, pickling, cleaning, dipping and casting were some of a number of techniques employed to produce the finished article. The main heavy works (rolling, wire drawing etc) were undertaken in the buildings north of Gibson's Arm Canal and the more refined work (such assembly of finished items and small casting) were undertaken south of the canal.

The Rolling Mill and Mill Machinery (Phases 3, 4 & 5)

Historical Evidence

1897 The area originally occupied by the Union Rolling Mill was described in detail in the 1897 Sales catalogue; *'Square of buildings greater part of which his one storey (approx 96ft x 77ft-floor space 7680ft) comprising metal rolling mills, warehouse, wire drawing mills, engine house, wire cleaning shop with carpenters shop over part of the building and two large storage tanks over centre to supply boilers fed by canal water- pumping being done by mill engine'* (Scott v Winfield 1897).

Details of the structures contained within are also described. Two pairs of breaking down rolls, one pair of intermediate rolls, three pairs of finishing rolls and one pair of preparing rolls were mentioned in the 1897 inventory along with their component parts (Scott v Winfield 1897). Each pair of rolls was set within cast iron housings and driven by pairs of spur pinions. They were fixed on oak or cast iron beds with holding down pins and brick foundations. Comprehensive dimensions of these articles are given in the sales catalogue.

1897 The breaking down and getting down roll, and pinion housings were *'out of line and level'* according to Watt & Co's report and it was recommended that *'these ought to be put right at the earliest possible moment, so as to lessen the power that passes through the train of wheels'* (Watt & Co, 1897).

1911-1912 During this time there was a partial conversion of the plant to electric power. Despite Winfield & Co's early incursion into the electric trade, the rolling Mills continued to be lighted by gas, whilst the steam engine provided the power for the cutters, drawing benches, rolling mills and the wire mills. Now part of the plant was replaced with new rolls driven by electric motors. The works were now lighted by electricity and all power was supplied by Birmingham Corporation (Birmingham library Archives 1911-1912).

Archaeological Evidence

Several phases of construction can be identified within the main structure of the Rolling Mill building and the structures contained within. The primary build (Phase 3) was the construction of the mill building itself. Additional building and reconstruction was noted within the rolling mill. The rolling machine bases, wheel race(s), floor surfaces etc all received later treatment.

Almost the entire floor plan of the rolling mill was exposed in the excavations. This was the area of the original Union Rolling Mill which later became incorporated into the larger Winfield's complex. The northern elevation remained unexcavated beneath Cambridge Street, which must have been widened at some point in its history. The internal floor space measured an area 20m (65.6ft) in length (maximum) by 23.5m (77.08ft) in width. If the length of the boiler building (29ft) is included as part of the length of the Rolling Mill this brings the total length to 94.6ft.

The dimensions of the Rolling Mill, as recorded in 1897 (and not including the mill warehouse), were 96ft x 77ft, this is almost identical to the excavated dimensions (94.6ft x 77.08ft).

The dimensions of the Union Rolling Mill would therefore have been approximately 96ft (length) x 81ft (width- this includes the area marked on the 1897 plan as the mill warehouse).

The walls of the main Rolling Mill building (formerly the Union Rolling Mill) were four courses thick (0.5m) and constructed of handmade, 9 x 4 ½ x 3 inch, red bricks. These walls (**1163** & **1295**- south wall, **1218**/**1413**, **1221**/**1222** & **1409**- east wall and **1446**- west wall), appeared to have received very little alteration, except in the later period, (early 20th century- Phase 5) when the south-eastern corner was extensively altered. This occurred at the same time as the eastern muffles were destroyed for the insertion of the square concrete structure.

The mill warehouse

A large internal wall (**1233**/ **1249**) interpreted as the western wall of the mill warehouse, was also preserved. This was constructed of the same building materials, in a stretcher bond, the foundations had survived to a depth of 1m. The south-eastern corner of this wall (**1249**) contained a number of gaps the largest of which may be the location of an arch, as seen in the 19th century pictorial representation of the Rolling Mill.

The rolling mill bases

Located to the east and west of the mill race(s) were the rolling mill bases. The locations of these were not marked on any of the historical plans but details of the machinery were described in the 1897 sales catalogue (see above). A number of different types of rolling machine were described, however, all that remained were the large brick built foundations upon which these machines were mounted. Each of these foundations was built to a considerable depth- presumably to accommodate the spur pinions which attached to the main spur wheels located in the wheel race. Above these foundations would have been mounted a series of different types of rolls. These rolls worked in pairs and metal ingots were passed between them by teams of workers to gradually reduce the thickness, eventually becoming sheet metal.

There were two areas of rolling mill bases within the main mill building. The first was located to the east of the wheel-race(s). This area contained five rolling pits, three of which (A, B & C) were likely to have been related to the primary phase of Rolling Mill construction (Phase 3), based upon the materials used.

The second area of rolling machine bases was west of the wheel race(s) in the area marked on the 1897 sale of works plan as the Wire Drawing Mill. This area contained four pits, similar in construction to the structures known to be rolling machine bases. These probably represent later rolling machine bases. The foundations of these rolling machine bases overlay several earlier brick structures (**1300**, **1306**, **1308**, **1330** & **1338**) which are likely to be the truncated remains of these wire drawing bench foundations. The rolling machine bases located in this area (F, G, H & I) were of a later construction (concrete and/or stone and cement like that of machine pits D and E), perhaps being constructed around 1900 when parts of the works were taken into new ownership and the rolling mill plant was rebuilt.

The historical information suggests that there were seven sets of rolls in use in the later 19th century (Scott v Winfield 1897). An attempt was made to excavate each of these rolling machine pits, the width between some of the walls however meant that machine excavation was not possible.

The rolling pit dimensions and construction materials are individually described below. It is important to note that each of these lengths of brickwork may have supported several sets of rolls and that the machines may not have been used contemporarily with each other. The construction of each set of rolling machine bases is different. The spacing between rolling pits A and B and also C and D was the same (1.3m) suggesting this was the optimum working space need to pass the rolled metal between rolls.

<u>The rolling machine bases east of the wheel races.</u>

Rolling Pit A:
(**1251**) Dimensions: 8m Length, 0.55m-0.9m Width, 1.8m Depth (x22 courses)
(**Phase 3**) Description: machine-cut, 9½ x 4½ x 3½ inch red bricks set in an English bond. The rolling pit was a stone construction at western end and brick construction at eastern end. Two distinctive sections. Six pairs of holding down pins still *in situ*.

Rolling Pit B:
(**1250**) Dimensions: 11m Length, 0.55m-0.8m Width, 2m Depth (x 22 courses).
(**Phase 3**) Description: machine- cut, 9 x 4½ x 3 inch red bricks set in an English bond. Constructed entirely of brick. Had large square cement and brick base in the centre with arch running beneath. Fifteen pairs of holding down pins (or holding down pin positions).

Rolling Pit C
(**1344a**) Dimensions: 5.3m Length, 0.45m Width, (unexcavated depth)
(**Phase 4**) Description: machine- cut 8½- 9 x 4½ x 3 inch bricks. Constructed of brick had a cement surface. Fourteen pairs of holding down pins (or holding down pin positions).

Rolling Pit D
(**1344b**) Dimensions: 5m Length x 0.5m Width, (unexcavated depth)
(**Phase 4**) Description: Large stone and cement construction. Two semi- circular niches opposite on another at eastern end. Three pairs of holding down pins. Brick floor working area between bases 1344a and b.

Rolling Pit E
(**1342**) Dimensions: 5.6m Length, only partially excavated the rest remained beneath the northern excavation edge.
(**Phase 4**) Description: Large stone and cement construction. Four pairs of holding down pins (visible).

<u>The rolling machine bases west of the wheel races.</u>

Rolling Pit F
(**1299**) Dimensions: 5m Length x 0.75m Width, 0.3m Depth (not fully excavated)
(**Phase 4**) Description: Concrete/ crushed brick and cement construction. Four pairs of holding down pins.

Rolling Pit G
(**1300**) Dimensions: 6m Length x 1.2m Width x 1.7m Depth

(**Phase 4**) Description: Concrete/ crushed brick and cement construction. Four pairs of holding down pins.

Rolling Pit H
(**1301**) Dimensions: 5.3m Length x 0.9m Width x 0.9m Depth
(**Phase 4**) Description: Concrete/ crushed brick and cement construction. Four pairs of holding down pins.

Rolling Pit I
(**1302**) Dimensions: 9.5m Length x 0.65 Width x 0.3 Depth (not fully excavated)
(**Phase 4**) Description: Orientated north to south at western end of pits F-H. This may be an additional drive shaft. Concrete/ crushed brick and cement construction. Six+ pairs of holding down pins.

The drive shaft (**Phase 3**)

An additional linear trench (**1237**/ **1248**) ran from wheel race A in an easterly direction to the outer elevation of the rolling mill. This trench ran between rolling pits B and C and was constructed of hand-made 9 x 4½ x 2½ inch red bricks set in a stretcher bond. This trench was 17m length x 0.6m width x 0.85 depth (not fully excavated) and was interpreted as an additional drive shaft, which further powered the driving mechanism of the rolling machines.

The pickling vats

The foundations of the 'pickling vats' (**1232** & **1234**- floor, **1235**- western wall), were preserved. These were located towards the northern corner of the rolling mill against the western wall of the mill warehouse (**1233**). They covered an area of 6m x 1.5m. The bases of these pickling vats were constructed of a mixture of red bricks and crushed brick and mortar. Drainage was set into these floors to carry away the waste liquids.

Along with annealing, the process of pickling would have been undertaken intermittently during the rolling process to soften and improve elasticity. Particular rolled metals needed to be heated in annealing furnace, this made them made them scale. They then needed to be lowered into warm diluted sulphuric acid, then rinsed with cold water before being rolled again.

The Wire Drawing Mill and Machinery (Phase 4)

Historical Evidence

1897 The wire drawing mill was known to have a *'jigger shop on the first floor'* (Scott v Winfield 1897). The wire drawing benches contained within were driven by shafting as in 1897 the *'line of shafting that drives these mills'* was in a *'dilapidated state'* (Watt & Co, 1897).

From the sale of works plan it is clear that in 1897 there were two areas of wire drawing mill. The first area was located to the west of the main mill race(s) and within the original part of union mills. A secondary rectangular wire drawing mill occupied the space between the original Union Rolling Mills western elevation and the brass tube drawing mill.

Archaeological Evidence

The wire drawing mill described below is the mill which occupied the space between the original Union Rolling Mills western elevation and the brass tube drawing mill. It had a first floor which housed the *'jigger shop'.* The other wire drawing mill is briefly described above as part of the rolling mill, having been truncated by the insertion of rolling machine bases in the early 20th century.

The severely truncated, wire drawing mill was 6m (19.7 ft) in width by 17m (55.6ft- exposed) in length. No original floor surfaces remained, having been truncated by later developments. South of the wire mill were the chimney foundations. The pictorial

representations of the chimney show it was outside of the wire mill. The eastern wall of the wire drawing mill was made up of the western wall of the Union Rolling Mill (**1446**) and the western elevation was made up of the eastern wall of the brass tube drawing mill (**1435**). There was no southern elevation and the northern elevation lay outside of the excavation area.

Much of what remained within the wire drawing mill were features that would have beneath the floor levels such as drainage (**1458**/ **1461**) and culverts (**1462**/**1464**). However, within the northern end of the wire drawing mill were the foundations of several large machine pits (**1443**, **1444**, **1445**, **1453** & **1454**). Two of these machine pits were similar having been constructed of timber (**1443** & **1445**). The layout and construction of these machine pits was different to that of the rolling machine bases and it was unclear what type of machines were supported.

The Wire Drawing Machinery

Machine Pit **1443**	Dimensions: (3.5m Length x 0.45m Width x 0.4m Depth)
	Description: Aligned east- west and constructed upon the northern wall of pit **1444**. Timber frame construction and joined with mortice and tenon joints and iron tie bars. Four pairs of holding down pins.
Machine Pit **1444**	Dimensions: (5m Length x 1.05m Width x 1.35m Depth)
	Description: Aligned east- west. Machine- cut 9 x 4 x 3 inch bricks. Set in English bond. X2+ pairs of holding down pins (or holding down pin positions).
Machine Pit **1445**	Dimensions: (4.5m Length x 0.45m Width x 0.2m Depth- excavated)
	Description: Aligned east-west. Machine- cut 9 x 4 x 3 inch bricks. Set in English bond, with a timer frame construction, joined with mortice and tenon joints above. Five pairs of holding down pins.
Machine Pit **1453**	Dimensions: (6m Length x 0.5m Width x Depth unexcavated)
	Description: Aligned north-south at the western end of pits 1443-1445. Constructed of Machine- cut 9 x 4 x 3 inch bricks.
Machine Pit **1454**	Dimensions: (3m Length x 0.5m Width x Depth unexcavated)
	Description: Aligned north-south at the eastern end of pits 1443-1445. Constructed of Machine- cut 9 x 4 x 3 inch bricks.

The drive shaft (**Phase 4**)

An additional linear trench (1330/ 1442) ran from wheel race C in a westerly direction into the wire drawing mill. This trench ran between rolling pits F and G and was constructed of machinie-cut 9 x 4½ x 3 inch engineering bricks. This trench was 15m length x 0.6m width x 0.8 depth (not fully excavated) and was interpreted as an additional drive shaft, which further powered the driving mechanism of the rolling machines.

The Brass Tube Drawing Mill and Machinery (Phase 4)

Historical Evidence

1897 The brass tube drawing mill was described in detail in the sales catalogue of 1897. It was described as a *'One storey building approx 121ft x 74 ft- superficial area 8906ft forming brass tube drawing mill (separate chimney about 80ft in height 11ft x 11ft at base), contains three soldering hearths annealing furnaces and coke pit'* (Scott v Winfield 1897).

Archaeological Evidence

The brass tube drawing mill was located west of the wire drawing mill. It covered the entire expanse of space between Cambridge Street and Gibson's Arm Canal. Power to the works was supplied from the engine located in the main rolling mill. It contained its own chimney, annealing furnace and soldering hearths (these were however, located outside of excavation area).

Approximately 32m length (104.96ft) x 4m width (13.12ft) was exposed within the excavation area– the rest had been truncated during the construction of the new REP in 1971. The main wall (**1435**) was constructed of machine- cut 9 x 4½ x 2½ inch red bricks. Along the eastern elevation of its length were a series of strengthening buttresses.

The engineering brick floor surface (**1448**) of the mill contained three square and rectangular brick built pits (**A**, **B** & **C**) each with timber base plates around their edge and holding down rods on their western side. These may have been types of hearth or casting pits. Two of the pits (**B** & **C**) were filled with clean dark red sand, which may suggest a casting function for these pits (or perhaps soldering hearths which are not marked on the plan). Timber rails laid into the brick floor in front of these structures would have had a shock absorbing effect when items were moved across the floor between them.

Machine pit **A** (Square- 0.9m Length x 0.9m Width x 0.8m Depth –excavated)

Machine pit **B** (Square- 0.9m Length x 0.9m Width x 0.8m Depth)

Machine Pit **C** (Rectangular- 0.5m Length x 0.95m Width x 0.7m Depth)

A further machine base (**1497**) was identified south of these pits. This base was constructed of engineering bricks and was 1.77m in length x 1.04m in width. There were four pairs of holding down pins set within it.

There was access to the canal loading bay via a set of steps (**1496**) at the southern end of the brass tube drawing mill.

The Bedstead Works (Phases 4 & 5)

The bedstead works was located to the south of Gibson's Arm canal. The exact date of construction cannot be confirmed, although it certainly occurred between 1825 and 1855, when it makes its first appearance on Piggott Smith's Map. A series of major alterations had occurred within the Cambridge Street Works during the 1840/50s and it seems likely that this is when the Bedstead works was developed. The area of the wharf which the bedstead works came to occupy was the location of the coal merchants business. This business had moved by 1852 and the land was acquired for the bedstead factory.

The bedstead works was joined to the main Rolling mill by footbridges, the locations of which can be identified from the historic sources. These footbridges were presumably for the use of pedestrians. There must also have been a means by which the rolled brass was transferred from the mill to the bedstead works side. It is likely that the road network running around the outside of the Cambridge Street works was used for this purpose. Cranes, located in the loading areas adjacent to the canal may also have been used to transfer materials. The buildings were arranged generally east to west along the length of Gibson's Arm Canal and were separated into ranges of buildings within which were workshops.

A full description of every feature contained within the bedstead works is not possible, or necessary here. Further work is proposed to identify the types of machine likely to have been positioned within each individual room and the processes undertaken by them. The buildings have been assigned letters A-G during the post- excavation process, these separations are based upon the stratigraphic relationships and documentary evidence. The buildings shall each be briefly described in terms of their room separations, construction materials, dimensions and phase.

The phases covered by these buildings were phases 4 & 5 (1840's/50's to early 20th century). There were subtle alterations to the building layout during phase 4, therefore this phase has been divided into two;

Phase 4a Main build

Phase 4b Internal reconstructions (Subtle wall alterations, some of the original walls demolished and built over).

Phase 5 Further alteration in concrete (Pillar bases -for roofing over of external walkways, additional machine bases. Re-flooring in concrete)

Historical Evidence

1843 During the 1840s Winfield stated in advertisements and notices that he was the *'proprietor of the original patent for the metallic bedstead and patentee of other improved principals'* (Birmingham Gazette 1843).

1922-25*.* During 1922-25 Baskerville Basin was filled in to make way for the Hall of Memory and the adjacent gardens. The demolition of the bedstead works occurred around the same time. (Shill 2006).

Archaeological Evidence

The foundations of the bedstead works were well preserved. Archaeologically, the layout of the works could be clearly seen, as could different phases of construction and rebuilding. The area was defined by a series of workshops constructed around pathways. Inside these workshops there was evidence of machine bases, bench locations, crucible hearths and storage areas. Some of the activities undertaken within each area could be identified by the deposition of artefacts and the structures contained within. The preserved dimensions of the bedstead works were 42.5m (139.4ft) in length x 20.5 in width (67.2ft). This was approximately only a third of the original length of the whole works. The rest of the works were located outside of the excavation area, and the surviving foundations had been truncated by the construction of the surrounding buildings (REP -1971, Baskerville House -1938 and Centenary Square -1936).

The bedstead works was made up of a series of buildings containing individual workshops. These workshops housed machines, workbenches, hearths, storage areas etc, the locations of which were identified through machine base and hearth foundations, post-holes and artefactual evidence. Between the buildings there were a series of external walkways, some of which had been built over and converted to internal workshops at a later period.

The artefactual evidence identified contained small items which had been unknowingly swept into the machine base and bench foundation holes. These items give an idea of the processes being undertaken at these locations. Items included small pieces of stamped brass, off-cuts and glass fragments.

The majority of the works was constructed of standard machine-cut 9 x 4 ¼ x 3 inch engineering bricks set in an English bond, there were however a close range of variations of brick used. Holes set into the brick and concrete floor were the locations of machine and workbench bases. A full inventory of these locations is not possible here but they were located within every surviving floor surface. All the buildings were constructed during phase 4, there was significant rebuilding during the later period (Phase 5) identified by the presence of concrete floor surfaces. A group of pillar bases (**1027**, **1030**, **1034**, **1037**, **1040**, **1043**, **1057**, **1070** & **1072**), which probably supported a rebuilt roof were also from this phase

Building A 13.5m length x 8m width. Main wall **1065**, orientated east to west.
Room A1 2.4m length x 5.5m width. Concrete floor **1050** (Phase 5)
Room A2 6.4m length x 5.5m width. Concrete floor **1051** (Phase 5)
Room A3 3.7m length x 5.5m width. Brick floor **1056**. Contained crucible furnace D.

Room A4 13.5m length x 2m width. Concrete floor **1063** (Phase 5). Glass residues and off-cuts- evidence of stained glass working

Building B 17m length x 8m width. Main Wall **1125**/**1105**, orientated east to west.
Room B1 3.5m length x 6.8m width
Room B2 3.1m length x 7.4m width. Contained crucible furnaces B & C
Room B3 2m length x 7.4m width
Room B4 6.2m length x 7.4 width

Building C 14m length x 5m width. Main wall **1065**- rounded at E end, orientated east to west.
Room C1 2.5m length x 4.4m width. Brick floor **1007**- split into two rooms
Room C2 5.6m length x 4.4m width. Brick floor **1039**/**1041**
Room C3 4.4m length x 4.4m width. Brick floor **1044**. Contained crucible furnace A

Building D 3.6m length x 3.4m width. Main wall **1074**, orientated east to west.

Building E 26.5m length x 4m width. Main wall **1066**, orientated east to west.
Room E1 6.2m length x 4m width. Brick floor **1033**
Room E2 6m length x 4m width. Brick floor **1035**
Room E3 6.5m length x 4m width. Brick floor **1036**

Building F 8m length x 4m width. Main wall **1086**, orientated east to west.
Room F1 8m length x 4m.
Room F2 6.1m length x 4m width (This room was a western extension to Room F1- phase 4b)

Building G 9.5m length x 21m width . Main wall **1501**. Brick floor **1007**/**1130**, Concrete floor **1001**/**1009**/**1019**, orientated north to south (phase 5). Stamped brass and brass off-cuts.

Building H 14.1m length x 6.5m width (Filled in area between Buildings B & F) Concrete floor **1096** Machine bases **1090**-**1094** (phase 5)

Area I Orientated both east to west (17.5m length) and north to south (16m length) Width of corridor 1.7m.
Area I1 Brick floor **1038**/**1046**/**1048**
Area I2 Concrete floor **1049** (phase 5)
Area I3 Concrete floor **1062.** Machine bases **1059**, **1061** (phase 5)

The Crucible Furnaces

Located within several of the workshops were the foundations of crucible furnaces, the presence of which confirmed the surviving illustrated examples of crucible furnace working on the site. This evidence was supplemented by the presence of broken crucibles and crucible waste (slags). There crucible furnaces survived in different forms, but each would have functioned in the same way. They may however, have performed different functions. The furnaces were essentially fire pits within which there were grills. The fire was set upon these grills, beneath which were flues. These supplied air to the fire. Each furnace would probably had its own small chimney, constructed above the furnace. The furnaces were probably used for the casting of small items. Off-cuts of brass were placed within the fireclay crucibles to be heated until the brass was molten, the resulting mix was then poured in moulds. Amounts of clinker beneath the fire-pits suggest the fuel used was coal or coke.

Crucible Furnace A (**1042**)	Dimensions: 1.7m Width x 2.3m Length x 1.2 Depth (Fire-holes 0.25m x 0.25m) Description: machine cut 9 x 4 ¼ x 3 inch red brick construction. Two fire-holes lined with fire brick.

Crucible Furnace B (**1119**)	Dimensions: 1.2m Width x 2.2m Length x 0.48m Depth (Fire-hole 0.25m x 0.25m) Description: machine cut 9 x 4 x 3 inch red brick construction. One fire-hole lined with fire brick. Very truncated.
Crucible Furnace C (**1118**)	Dimensions: 1.9m Width x 2.7m Length x 1.1m Depth (Fire-holes 0.45m x 0.45m) Description: machine cut 9 x 4 ¼ x 3 inch red brick construction. Two fire-holes lined with fire brick. Similar in construction to crucible furnace A, surviving metal grill in one of fire-holes.
Crucible Furnace D (**1079**)	Dimensions: 3.2m Width x 2.25m Length x 0.8m Depth (Fire-holes 0.35m x 0.35m) Description: cut 9 x 4 x 3 inch red brick construction. Four fire-holes lined with fire brick, with surviving metal grills, paired by four additional holes. Truncated by later machine base.

The 'Muffle' Buildings (annealing) (Phase 4 & 5)

The locations of two separate muffle buildings were marked on the 1897 sales plan (Scott v Winfield 1897), they are described below as the eastern and western muffle building, these muffle buildings contained annealing furnaces.

More is known of the western muffle building as there is detailed documentary evidence, supplemented by well preserved archaeological evidence. The eastern muffle building was severely truncated by later developments (the plating/ tinning structure- early 20th century) and only part of the foundations survived.

Historical Evidence

1897 There is mention of three *'brick and iron annealing furnace(s)'* within the muffle house. The muffle house itself was a three storey building, with the *'three muffles on the ground floor'*, the first floor was the *'lacquer still room'*, and the second floor was *'formerly used as a plumbers shop and glass cutters shop'* (Scott v Winfield 1897).

A further three *'brick built annealing furnace (s)'* are mentioned. These are also described as the *'three rolling mill muffles'* These two sets of annealing furnaces are the two separate 'three muffles' mentioned on the sale plan.

1899-1902 William Dugard (Company Director at the time) persevered with a system of firing the muffles with gas from a gas producer. They had difficulty in obtaining suitable coal but by 1902 they had invested in an economiser and by 1903 saving in coal consumption were achieved.

1911-1912 During this time there was a partial conversion of the plant to electric power, which included the taking down and rebuilding of a group of muffles. (Birmingham library Archives 1911-1912)

Archaeological Evidence

The western muffle building

The two surviving 19th-century illustrations, identify the western muffle building as a three storey building with a pitched roof, arched windows and arched accesses on the ground floor. There is an additional extension built on to the eastern elevation at the ground floor level. This also had a sloping roof and open arched access.

The dimensions of the building were 9m x 6.5m. The base of its southern elevation was the northern wall of Gibson's Arm Canal (**1209**) and its western elevation was the eastern

elevation of the brass tube drawing mill (**1435**). The northern and eastern elevations were open sided, using pillars to support the elevation above (**1472**, **1482**, **1484**, **1487** & **1488**).

The engineering brick pillar bases were to support the arches. There are further pillar bases within the building (**1472**, **1479** & **1538**).The construction method of using pillars would have provided easy access and open ventilation to the annealing furnaces.

Along the southern site of the building was an access corridor with an engineering brick floor (**1476**).

This surface ran between the bases of two distinct structures contained within the building. The processes undertaken within these structures must have involved fire as the bricks were heat affected and there were small square hearth features connected to flues contained within. They are likely to be the annealing hearths mentioned in the sources.

The easternmost of these structures (**1478**/ **1478**) was made up of a thick wall (1.85m) around a brick lined pit (**1513**) filled with layers of heat effected sand (**1508**, **1515**-**1518**). On the northern side of the structure were two fire brick lined, square hearth features (**1491**). It was 4.5m in length by 2.5m in width.

The westernmost of these structures was 4.5m in length by 2.7m in width and was constructed of yellow firebricks (**1475**) which were heat affected due to prolonged contact with heat. On the eastern side of the structure was a fire brick lined, square hearth feature (**1473**) and on the northern side was a square feature (**1474**) which led into a flue (**1471**). A gate attached to this would have regulated the air flow into the furnace. There had been rebuilding of this structure and pits on the southern side and in the centre of the structure had been filled in and covered with bricks.

The eastern muffle building

The area within which the eastern muffle building would have been located was occupied by the plating/ tinning structure which was constructed in the early 20th century. All that remained of the muffle structure was a fire brick square feature (**1158**), which was probably part of the firing system and a part of a wall orientated east to west (**1159**).

The Furnace/ casting pit/ annealing hearth structure (Phase 3 & 5)

A large rectangular feature, later overlain by a two phase rectangular structure was located adjacent to the northern side of Gibson's arm canal (**1209**). These features were not present on any of the mapping evidence before 1922. A building occupying the area appears on the Ordnance Survey map between 1905 and 1922 and is visible on the watercolour of 1929 and the photograph from 1936. On these it is an open sided, corrugated- iron, and barrel roof building. It is very likely that this was the location of the rebuilt muffles mentioned in the archives from 1911-12 and the archaeological evidence confirms this fact.

Archaeologically there are three phases;

The furnace structure (**1369**, **1380**, & **1381**) (**Phase 3**)

8.5m length x 2.8m width x 2.1 depth (maximum)

This structure was likely to be contemporary with the Union Rolling Mill phase of building, although it is not present in any of the mapping from the period, including the detailed 1897 plan. It was a large rectangular structure made up of three chambers and was constructed of brick with iron re-enforcements. The structure was made up machine-cut, 9 x 4 ¼ x 3 inch red bricks, the interior of the chambers were lined with yellow fire bricks. The central chamber (**1380**) was rectangular and was the largest of the three. Two square chambers (**1369** & **1381**) located either side of this were connected to the central one via an arch through their side wall. There were vent holes along the top edge of these chambers also

connected to the central chamber. The bricks were severely heat affected, and there was vitrification and slag accumulation on the interior of each chamber. It is possible that this structure was a large brass smelting furnace.

The casting pit structure (**1240**) (**Phase 5**)

6.3m length x 4.5m width

The second structure to be introduced was a feature (**1240**) made up of six stepped brick pits connected to fire pits (**1182** & **1227**) and flues (**1182**, **1183**, **1184** & **1194**). The structure was constructed upon a slab of concrete/ brick aggregate, which had capped the structure beneath (**1369**, **1380**, & **1381***).* The bricks used were machine-cut 8¾ x 4¼ x 2¾ inch red bricks. The pits on the eastern side of the feature were 1.3m x 1.2m and 0.46m and the pits on the western side were 0.9 x 1.2m x 0.46m These pits were filled with deposits of clean burnt sand. This suggests that these may have been casting beds. On the northern side of the structure were two fire brick lined, square hearth features (**1182 & 1227**), similar in form the crucible hearths identified within the bedstead works.

The annealing hearth structure (**1186**-**89**) (**Phase 5**-the 'rebuilt muffles' 1911-12)

6.3m length x 4.5m width

The final phase of the structure involved the reorganisation and bricking over of the pits and its restructuring into four equal linear sections. Each of these linear sections was 0.7m in width and covered the whole length of the structure (6.3m). The two fire brick lined, square hearth features (**1182 & 1227**) remained in use as did the flue. Archaeologically, its layout was very similar in nature to the known annealing hearth base located just to the west, within the muffle house. Taking this evidence into account it is likely that, in its final phase at least, this structure was the 'rebuilt muffles' (annealing hearth) mentioned in 1911-12.

The Strip Casting Shop (Phase 4)

A single wall relating to the strip casting shop was exposed in the excavation area. This wall (**1142**) had a distinctive change of angle which mirrored the wall identified in the 1897 plan. The interior of the workshop remained unexcavated (being beneath the excavation edge). The wall itself was constructed of machine-cut, 9 x 4 x 3 inch red bricks set in an English bond. Overall, approximately 6m x 1.5m of the structure was exposed.

The Wire Cleaning & Dipping Shop (Phase 3 & 4)

1897 Described in the 1897 sales catalogue as the *'wire cleaning shop with carpenters shop over part of the building'* (Scott v Winfield 1897).

Immediately west of the engine house were the remains of an area, identified on the 1897 plan as the Wire Cleaning & Dipping Shop. The area was approximately 5.8m in width by 8m in length and was made up of two main walls (**1446** and **1295**), within which was a distinctive internal flooring composed of square engineering floor tiles and brick. Surrounding this flooring were the remains of a drainage and guttering system (**1294** and **1296**), connected to a culvert (**1462**/ **1464**)

The southern (**1295**) and western (**1446**) walls of the structure made up the southern corner of the original Union Rolling Mill. These walls were constructed of hand-made, 9 x 4½ x 2¾ inch red brick. There was no evidence of the northern elevation present on the 1897 mapping and it appears that this end of the structure had been altered, a later concrete flooring (**1297**) was present in this area. The doorway within the western elevation present of the 1897 plan was identified by the use of floor tiles.

A culvert (**1462**/ **1464**), connected to the drainage channels and attached to the western elevation of the room, ran beneath the wire drawing mill and muffles before joining the north western corner of the canal.

The processes undertaken within the room (wire cleaning and dipping) would have required the use of cleaning and dipping solutions (such as acids and lacquers) followed by water for rinsing. The construction of the flooring, with flat floor tiles surrounded by drainage channels, would have made it easier to clean down. The culvert would have carried away the waste products created during these processes.

OTHER INDUSTRIAL PROCESSES

Plating/ Tinning (Phase 5)

Within the south-eastern corner of the rolling mill was a large square structure which was constructed at a lower level than the original floor surface. The structure itself was made up of a group of concrete walls (**1150** & **1152**) metal I-bars and concrete floors (**1151** & **1153**). The concrete used was pre-war in origin. It was pinkish grey/ white with aggregate inclusions. The walls survived to a depth of 1.3m below floor level in some places. In the south eastern corner of the structure was a square tank with sloping floor and inlet/outlet pipes in two of its corners. In the north- eastern corner of the structure was a hearth/ fire hole (**1155**) structure which connected directly to a flue, this would have ultimately fed into the main flue and chimney. Adjacent to this were two concrete chutes (**1156** & **1157**) which may have been coal chutes from the floor of the adjacent building (**1149**).

Around the same time as the construction of this structure part of the Rolling Mill was rebuilt and concreted over. This concrete surface (**1149**) extended from the eastern wall of the mill warehouse to the northern elevation of the structure (**1152**).

This structure may have been used as an acid bath an electroplating structure or as a Zinc bath for tinning. Historic sources show that during the First World War, Birmingham Aluminium Castings introduced die castings with zinc rich alloys. It does not appear on the 1897 sales plan and is located in the position marked as *'three muffles'*, it therefore must have been constructed after this date.

Painted and Stained Glass production (Phases 4 & 5)

Documentary and artefactual evidence

Part of the business that Winfield's was known to have been involved in was stained glass. In 1887 they supplied a window to the Priory Church, Malvern (Birmingham Daily Post 1887) and in 1891 they supplied stained glass windows to the refurbished Grand Hotel, Colmore Row, Birmingham (Birmingham Daily Post 1891). They also won a series of awards throughout the years of production.

One of the locations of glass working was known to have been the second floor of the building above the muffles (Watt & Co, 1897). Artefacts, including glass off-cuts and waste, were identified on the bedstead works side.

One area in which glass artefacts were identified was the bedstead works. Within the post holes located in floor (**1063**) there were accumulations of glass debris (melted glass) suggesting glass preparation was undertaken within this room. A large assemblage of glass cut, and prepared for use in stained glass windows was found upon the floor in the adjacent room (**1058**). The locations of these artefacts suggest that this area of the bedstead works was used for stained glass production at some point.

WELFAFE AND STORAGE

The Coke Pit and Rubbish Store (Phase 4)

A small building located on the eastern side of the site and adjacent to the northern side of Gibson's Arm Canal was interpreted as the coke pit and rubbish store. The sale plan of 1897 identifies this structure as *'Coke stores, refuse pit and WC's forming a three storey building'* (Scott v Winfield 1897).

The southern wall of the structure was the northern wall of Gibson's Arm Canal (**1206**). The structure itself was split into two by a central wall (**1141**). The southern half of the structure was the *'coke pit'*. Access was obtained through a large gap in the eastern side. A brick floor (**1140**) was located within, and although truncated, must have originally attached to the main yard surface (**1146**) located next to the canal. Beneath the rubble backfill and against the back wall (**1143**/ **1210**) at the eastern end of this room, were the *in situ* remains of a large quantity of coke, confirming its documented use. This coke pit was situated for the easy unloading of the raw material from the barges. The northern half of the structure was the rubbish store, again part of the internal floor surface (**1206**) remained. Ceramic drain pipes and drainage confirm the likelihood that this building doubled as the WC's.

BUILDINGS SOUTH OF BASKERVILLE PASSAGE AND THE WINFIELD WORKS

Broad Street Metal Works and Screw Manufactory (Phase 4)

To the south of the site, beneath what was Centenary Square, were the truncated remains of industrial buildings located on the site of the Broad Street Metal Works and Screw Manufactory.

These buildings were situated south of Baskerville Passage and surrounded Baskervile Basin Canal. The historic mapping confirms that this area began to be populated with industrial buildings between 1824/5 and 1855, around the same time as the construction of the Union Rolling Mills. The area would have been as densely covered by buildings as the rest of site, but preservation in this area was poor. Much of the truncation encountered within this area of site was due to the lowered level of the later Centenary Square, and its extensive landscaping (particularly the large concrete fountain foundation pad, planters and service trench elements.

Several brick structures were identified both to the north and south of Baskerville Basin, the majority of which remained without interpretation due to their fragmentary nature. These were likely to have been various floors, walls, drains and other industrial features (**1541**-**46**, **1550**-**52**, **1554**-**58** and **1563**-**55**).

The most substantial and in tact structure was that of a machine base and fly wheel pit and associated L-shaped wall. The machine base (**1567**) was made up of a main rectangular pit, 5.4m in length x 1m in width x 1m+ in depth. This was constructed of machine-cut, 9 x 4¼ x 3 inch red bricks set in an English bond. On both its northern and southern sides were machine bases with built in holding down pins, its structure was different from the other machine bases identified on site. The L-shaped wall (**1566**/ **1568**) which surrounded the base on its northern and eastern sides was 7m x 4m, and was likely to have been an external elevation.

During the construction of centenary square Baskerville Basin was filled in. Bridging walls were constructed over the both the eastern (**1542**) and western (**1539** & **1553**) ends, presumably to add support to the surfacing above.

THE END. INDUSTRIAL DEMISE IN THE 20TH CENTURY (Phase 6)

1922-25 During 1922-25 Baskerville Basin was filled in to make way for the Hall of Memory and its adjacent gardens (Shill 2006). A photograph of 7 June 1926 shows the newly constructed Hall of Memory and gardens in place of the canal basin. In the background can be seen the surviving Winfield's buildings including the Rolling mill and chimney. A watercolour for 1929 also shows this scene.

1936 Gibson's basin was retained to serve Winfield's rolling mill, until in 1936 it was backfilled when Winfield's relocated, in part due to Birmingham Corporations plans for a new civic centre. During this time the rolling mills were pulled down and the land cleared. This included the scrapping of the engine (and presumably all other profitable machinery) (Birmingham Gazette 1936). These plans for a civic centre never fully came to fruition (Shill 2006). Also in this year the engine was scrapped

The documentary sources confirm that demolition and backfilling of the site began around 1922 and continued piecemeal as production ceased in different areas. The Ordnance Survey map of 1922 shows the area built up with industrial buildings and by the Ordnance Survey map of 1936, these buildings had been replaced by an open land and the Hall of memory. It is unclear exactly when the area formerly occupied by the Cambridge Street works became a car park. Part of the car park construction involved the creation of drainage. Large trenches were cut through the site, pipes were laid and manholes constructed. This drainage had a minimal impact on the interpretation of the surviving archaeology.

Appendix 4 Documentary Research *by Ray Shill*

Brass

Brass is an alloy of copper and zinc, with a higher percentage of copper to zinc. That percentage was variable, but was usually in ratio of 80/20 or 70/30. Small quantities of tin or lead might be added to create a metal for specific uses. The combination of metals added strength and the result was an alloy that could be polished to make an attractive product.

Brass was first made through mixing copper with calamine (zinc carbonate ore) in a furnace. This was an imprecise method perhaps, but one that guaranteed a high priced article. It was an unhealthy existence for the brass makers who laboured at the task in confined quarters mixing the copper with the ore until a suitable mix of the alloy was achieved. Once ingots of brass were made they went onto the founder, the roller or the wire drawer.

Rolled sheet brass went to the stamped brass foundry trade, whilst the founder recast the brass for a variety of uses. Brass wire was in great demand for pin making. Brass had many applications in the wealthy household for cabinet furniture, chandeliers, curtain fittings, door furniture, fire irons and stair rods. In the engineering trade various steam engine components were made from brass. Brass was also extensively used in the lamp trade.

The Brass Trade in Birmingham

The working of metals had begun with iron in Birmingham, but these skills were translated into the fashioning of other metal. The town became a community with skills in general metal working and became known for four important trades, jewellery making, button making, gun making and the brass trade (Court 1938, p70).

Whilst iron had sources of raw material near to Birmingham, the supply of the materials that made brass came from a distance and brass ingots were imported into Birmingham. During the 18th century most brass in the form of ingots came into Birmingham from works in the Bristol area, or Cheadle, in Staffordshire (Aitken in Timmins 1866 p240).

The first brass works recorded in Birmingham belonged to Turner. These works in Coleshill Street were established about 1740, but this was an isolated case.

Canal communication reduced the cost of raw material transport, but the brass makers of Bristol and Cheadle chose to advance of the price of ingot brass in 1780. It was a decision that influenced the Birmingham brassworkers to form a new company to make brass in Birmingham. Those that set up the works became shareholders and were entitled to a share of the brass made. The site for the works was chosen to be beside the canal at Broad Street and these brass works were established during 1781. Later other works were set up beside the Birmingham Canal at Smethwick and Spon Lane. All received supplies of copper that principally came along the Severn and the canal network.

During the 19th century larger manufactories were established by firms that included Messenger & Son (Broad Street), T Smith & Sons (Bartholomew Street) and Robert Walter Winfield (Cambridge Street).

A revolution in the brass making trade happened during the 1830s with the increased availability of metallic zinc (spelter) and it became an easier task to mix the zinc with copper by a process that was often referred to as strip casting. Furnaces fuelled by coke heated up crucibles that melted copper tiles or ingots. The zinc was introduced and mixture stirred with an iron rod or poker. The process generated a white light and bits of zinc flew off as white flakes (This process was illustrated in an engraving made by A Morrow and probably depicts strip casting at Winfields Works in Cambridge Street (Morrow in Becker).

The relative ease of mixing the two metals coupled improved canal and road transport and a comprehensive system of carrier organisations, metal merchants and local metal warehouses meant brass working flourished in Birmingham. As a consequence, merchants were willing to hold stocks of brass, the same criteria applied to requirements for iron and steel.

Diversity was an important facet of this Birmingham industry. There were those that specialised in brass casting supplying the trade with rough (unfinished) or finished casting. In addition to the foundry there was the trade of stamping that grew with demand. Stamped brass (rough and finished) encompassed a range of products such as mouldings for furniture ornaments, girandoles, picture and looking glass frames, coffin furniture, door handles, door knobs and cornice pole ends. There was an increased use over the years to stamped rather than cast items. A third type of manufacture which used a lathe, produced a method of spinning the metal into certain shapes.

A form of classification developed in the trade into which different groups of brass production were divided: -

(1) Cabinet, Bell and General Brass Foundry
This discipline made brass work for the cabinet makers and carpenters and included items such as castor, hinges, bolts, table fastenings, handles, knockers, railings for desks, balustrades for staircases, picture frames, hat rods, screens, poles and fire guards

(2) Cock making, Plumbers Brass Foundry and Engineers Brass Foundry
Manufactured items included cocks for plumbing, beer engines and engineering purposes (eg. Stationary engines, portable engines, road and railway steam locomotives).

(3) Rolled Brass, Wire and Sheathing
Rolled brass was a material on which the stamped brass founder depended, without it, soldered brass tube, patent cased tube or cased stair rods could not be made. Rolling was first conducted in watermills, but in the Birmingham district there was strong competition for water powered mills on the rivers Cole, Rea and Tame. With the inception of steam power (crank or sun and planet motion) adapted to the rolling of metals (ferrous or non ferrous), the district considerably increased. For non ferrous metals such as brass and nickel a business in contract rolling mills grew up where metals were rolled to order.

(4) Tube making
Tubes included welded tubes, cased tubes (brass on iron) and seamless brass tubes for locomotive boilers.

(5) Lamp Making
Lamps were made for household, carriage, mining and railway use in considerable variety.

(6) Gas Fittings

(7) Naval Brass Foundry
Brass was a popular choice for the casing of various instruments and fittings found on board ships and other vessels.

(8) Military Ornaments
This group includes metals and whistles.

(9) Metallic Bedsteads
R.W Winfield specialised in general brass foundry, chandeliers, gas fittings, rolling, tube making and wire drawing. They also were pioneers in the metallic bedstead where the skills of working with iron and brass was brought together to make the bedsteads. Metallic bedsteads were a popular choice for military barracks, hospitals

and workhouses and there was also an important foreign market. Domestic demand was however slower to develop.

(10) Nails, pins etc
Brass was in increasing demand throughout the second half of the 19th century. The new trades of art metal, bicycle making, church brass work and stained glass and electric light fittings added to the diversity of manufacturing trades.

Towards the end of the 19th century a new process, extrusion, came into use. Recycling brass also became big business where cuttings, discarded metal from the press, dust and swarf were collected and re-melted.

The brass trade in the 20th century changed, but the usage of copper and brass continued to increase. The number of rolling mills in the district benefited from an increased demand for metal strip. The ammunition industry fuelled by the demands of two world wars created a large demand for shell cases. A rising population encouraged a demand for domestic items and whilst gas lighting was decreasing there was an increase in demand for electrical products.

Those employed in the British Brass and Copper industries had a high concentrated in the West Midlands (Staffordshire, Warwickshire and Worcestershire). Maurice Cook quoted a figure of 37,700 workers for Birmingham alone in the year 1921 (Cook 1936).

After 1920 demand for brass decreased. Fashioned changed and new metals such as aluminium, phosphor bronze and stainless steel entered the market. Plastics also began to replace brass as an all purpose material in the domestic and foreign markets. Metal rolling mills remained an important supplier of rolled brass, tubes and wire. The mergers that created IMI took over an important share of the local trade, but others remained independent. Yet towards the end the 20th century serious foreign competition and lack of local and central government support had terminally injured many aspects of the trade. A few firms still engage in the supply of rolled non-ferrous metals using technology such as continuous casting. Recycling of scrap metal is a key element to this trade.

Thomas Gibson and the Baskerville Estate

The Baskerville estate was so named due to the occupation of John Baskerville who lived in a house and grounds located at a place known as Easy Hill. The building faced east, had its own grounds and a carriage drive joined Easy Row. At the north east corner was a "Bowling Green" and a perimeter road (Cambridge Street) skirted this Green to join up with a road called the "Crescent".

Thomas Gibson was born at Corley near Coventry and came to Birmingham where he worked for George Russell, merchant. Later he entered into partnership with William Shore, ironmonger, built a house, warehouse and a malthouse in Suffolk Street and became an iron and steel merchant (Gibson Obituary 1840, Trade directories 1800 & 1801). By 1803 this partnership had extended to include a Mr Tomlins (ironfounder of Bartholomew Street). Gibson, Shore & Tomlins were recorded as iron and steel merchants at Suffolk Street and Digbeth (Chapman's Directory 1803).

Gibson & Shore acquired the "Bowling Green" and the Baskerville property at Easy Hill and during 1810 was advertising property to let, that included the former Bowling Green (Aris's Gazette 1810). It was a project of Thomas Gibson to open up the Baskerville Estate for industrial development and conceived the idea of making canal basins on the estate. The concept involved the construction of a private branch from the Newhall Branch Canal into the estate and the making of a lock to raise boats to the higher level.

Local contractors would have been hired to make the link. There was a certain amount of skilled canal cutters in the area and such people were engaged in making other local

networks. Gibsons private branch was cut during 1811, and wharves, spoil and earth were advertised for sale in June 1811 (Aris's Gazette, 1811). Contemporary maps show the basins were made in the shape of a Letter F. The canal nearest Cambridge Street became known as Gibson's Basin. That nearer Easy Hill (later Broad Street) was known as the Baskerville Basin. The work of completing the basins probably continued on through 1812.

The lock was a single rise of approximately 9 ft. There were two bottom mitre gates and a single top gate. The channel from the Newhall Branch passed under Cambridge Street at a bridge and the lock was placed closed to the south side of this bridge. There was an engine house with a steam pump that raised water to the upper level. Later much of the private branch towards Cambridge Street was built over to cover the canal and make this section a tunnel. Gibson arranged for a new mill, Gibson mill, to be made near the lock.

Tomlins had ceased to be a partner by 1808 and Shore left the partnership in 1814 leaving Thomas Gibson and his family to develop the Baskerville estate and run the slitting mill in Bradford Street (Aris's Gazette, 1814). Baskerville House was rebuilt as Baskerville House Mill and was first occupied by Benjamin Cook and Thomas Attwood. The former "house" was bisected by a road or way that became known as Attwood's Passage, with the main mill property placed on the south side of this passage and the Baskerville Arm of the canal running alongside the southern perimeter of the mill. The house buildings north of Attwoods Passage seem to have been absorbed into the later Winfield's Works.

Thomas Gibson built up a coal trade by canal and came to own ten narrowboats. He withdrew from the merchant, rolling and slitting trade leaving the business to his sons during 1823. Thomas concentrated his efforts on further development of his property. A trade depression that followed the end of the wars with France handicapped further industrial development of the Baskerville estate. Matters improved from 1820 when Robert Winfield set up the Cambridge Street Works. Other properties were then taken with leases arranged for land in Cambridge Street (Crescent Foundry, and Union Rolling Mills and on Broad Street (Thomas Bolton copper works and Nettlefolds Screw Factory). Two courts of back-to back houses were constructed in Baskerville Passage that covered a square of land between the passage and Baskerville Basin.

Those that leased land from Gibson also entered into agreements for the use of the lock and a complex set of rules were established for charging or not to charge boats ascending the lock. Revenue for lock tolls went originally to Gibson. There was a coal, lime and brick wharf whose entrance faced the junction of Easy Row and Easy Hill. Boats arriving here were close to the centre of old Birmingham. Gradually leases were granted for all the property around the basins. Thomas Gibson died in 1840 and the estate was then administered by his executors.

Responsibility for working the lock finally passed to Winfield's Rolling Mills, who periodically arranged for the canal to be cleansed. Traffic along the arm ceased with the closure of Winfield's Rolling Mills. Gibson's Lock was removed with the laying of the foundations for the present Baskerville House.

Gibson's Arm and the Baskerville Arm provided a canal link to the main Birmingham Canal Navigations, which had access to coal mines, limestone quarries and brickworks along its length. The common mode of transport was the narrow boat, which was usually made of wood, but could also be of iron construction. Narrow boats may posses or lack a cabin and in the later case were described as open boats or day boats. Their maximum dimensions were 70ft long by 7ft wide when it was necessary to pass through locks. Some were longer (and wider) when short journeys on lockless sections occurred.

Gibson's Lock, a privately owned lock, appears to have been of the same dimensions as those on the main line, but with a greater rise than most. Craft navigating the BCN and mooring on the Gibson's or Baskerville Arms had the luxury of unloading and loading at wharves close to the town centre. There were coal wharves, timber wharves and lime wharves. Coal was also

conveyed to the various steam engines that served the Union Rolling Mills and the mills on Broad Street.

Genesis of the Cambridge Street Works

Robert Walter Winfield began making small items of brassware such as stair rods in Cambridge Street during 1820. This small operation grew into a much larger business where Winfields made brass light fittings and metallic bedsteads. This expansion has been stated to have happened in the year 1829 (Winfields, *Prospectus for formation*), when the original part of the Cambridge Street Works came into being.

This section of the works was constructed alongside Cambridge Street to the junction with Easy Row. The property was bounded by part of the private canal basins constructed for Thomas Gibson (1811-1812). Gibson had constructed a factory beside the lock that raised boats up into the basins. His factory became Gibsons Mill.

During 1824 a piece of vacant land was leased from Thomas Gibson (lease, 1st October 1824) that lay between Cambridge Street and the Gibsons Arm Canal. The lessees Daniel Ledsam, Joseph Ledsam, William Potts, Matthew Dixon and R.W.Winfield and they used this property to set up the Union Rolling Mills. A caretaker's house was built on the land, which became 43 Cambridge Street.

Matthew Dixon was a manufacturer of silver and plated wares Daniel Ledsam made nails, screws, shoe heels and tips. William Potts was involved in the manufacture of brass moulding, stair rod and astragals. All had need of rolled metals and the association of the Union Mill would have provided Ledsam, Potts and Winfield with rolled brass and copper.

These premises occupied only part of the land. To the west another section of land was leased by Thomas Crowther, timber merchant, box and cask maker (Wrightsons Directory 1833). A section was taken by Allen Everitt for a wire and tube mill (Wrightsons Directory 1839). Their property became known as the Kingston Mill.

Engine power for the works seems to have been derived from the mill race powered by the Union Mill engine. This engine was described in 1847 sales notices (Birmingham Gazette 25th January 1847 – 8th March 1847) as being of 95 horse power beam engine. These notices also mentioned that power was provided to adjacent properties. This sale may have been occasioned through partners leaving the partnership. There were 11 names in the partnership in 1845 (London Gazette 7th March 1845), but James Potts had died and Ambrose Warner and William Steel decided to leave.

A plan for the improvement to the Union Mills included a pair of 30 HP horizontal engines with rollers and wire drawing were requested from Boulton and Watt [8] (MS 3147/7/32 mill and apparatus Cambridge Street Works) in January 1850, but which may not have been supplied. Improvements to the original engine, or a replacement, led to a 160 HP beam engine working the mill.

The arrangement of the engine and mill was orientated about a south - north axis. The cylinder of the beam engine was closest to the canal arm with the beam acting on a crank, driving wheel and fly wheel. Linked to these through spurs was a series of wheels in the race that drove the rolling mills, wire mills and other machinery.

Tube and wire manufacture, at 42 Cambridge Street, was kept as independent business by the Birmingham Patent Welded Iron Tube Company. Bower left the partnership and for a time (until 1850) William Hodges of Great Bookham was a partner (London Gazette 1850). The name changed to the Birmingham Patent and Brass Tube Company and this company set up a new mill beside the Cape Arm on the borders of Birmingham and Smethwick. Partners in this venture included George Selby, George Thomas Selby, Henry Johns and Sampson

Hanbury. George Selby and Henry Johns were also partners in a firm engaged in enamelling iron with glass at 288 Bradford Street.

Richard Prosser, engineer was the next occupant of the tube mill. Prosser experimented with new forms of tube making including a patented idea of anti-weld tubes that had certain concepts that formed part of the development of the local Weldless Tube Industry. The Cambridge Street Works had a steam powered hydraulic press invented by Mr Prosser. When Prosser died, the tube mill plant was put up for sale (Birmingham Journal 1854).

Robert Walter Winfield acquired the lease of the Union Mills in September 1853, and the lease of 43 Cambridge Street from George Crowther in October 1857 (Birmingham Library Archives). Winfield combined the rolling, wire and tube drawing plant into one operation. These premises were separated from the other Cambridge Street properties by Gibsons Mill and the Crescent Foundry.

Further along the canal arm, and opposite the rolling mills, the land was developed by Winfield as a bedstead works. The excavations have demonstrated that the wharf wall was made of engineering brick and this make of brick would be consistent with building extensions made in the 1840s or 1850's. These buildings were in place by the time Pigott Smith Map (1855) was produced (Pigott Smith).

Winfields came to occupy about half of Gibson estate. They also built up a busy coal merchants business in Browning Street and had a shop in Great Hampton Street. Robert Walter Winfield traded with his son John Fawkener Winfield as R.W. Winfield and Son. Publicity through exhibitions such as that at Crystal Palace and the Paris Exhibition improved custom and Winfields became one of the best known brass founders, chandelier makers and bedstead makers in the country.

A Brief history of Winfields

Robert Walter Winfield has been described as prince of the Birmingham Brass Trade. R.W Winfield first appears in trade directories listed as a brassfounder and brass tube maker of Cambridge Street and 84 New Street (Wrightson's Directory 1821). He was then, one of 114 separate brass founders listed in the trade in Birmingham. Winfield's factory grew to cover all the land on the north east corner of the Gibson estate and extended from Gibson's Lock to Attwood's Passage. The address became known as 1 Cambridge Street

Robert Winfield employed some the best workmen and he supported this trade through patents. Here he practiced the trade of brassfounder and metal bedstead maker. Winfield had patents for metallic bedsteads and was steadfast in enforcing those rights. Robert regularly stated in advertisements and notices that he was the proprietor of the original patent for the metallic bedstead and patentee of other improved principals (Birmingham Gazette 1843). In particular there was the patent for the continuous hollow pillar that was so essential to the success of the Birmingham metallic bedstead trade. Winfield was a keen advocate of the use of wrought iron, in place of cast iron and this metal was used in construction of the "travelling" bedsteads supplied to the Army and Navy.

Winfield may have had the first patent for bedsteads, but he was not the first to make them. That claim was made by Benjamin Cook, Winfields' former employer, who moved to a factory in Digbeth. For years afterwards, this Digbeth factory continued to state they were the first.

Winfield advertised that he was the patentee of the metallic, military, travelling and house bedstead for home use or for export and used the services of John Simms, at 141 Fleet Street, London, as agent. He supplied also, brass, copper, iron and tin and cased tubing and made cornice pole ends, rings and brackets, plain and ornamental gas fittings, railings and stair rods (Wrightson & Webb Birmingham Directory 1843). All were made in the premises at Cambridge Street. Winfield also set up a separate coal and coke business from Baskerville

Place. Narrowboats would bring coal from the collieries to the Baskerville Place wharf for sale or use at Winfield's Works or the associated Union Rolling Mills where Winfield was a partner. The profits from the trade enabled him to build a house in Ladywood Road. This was named Hawthorn House and became the family home for the rest of his life.

The coal merchants business was moved to Tindal Street. This seems to have happened by 1852 (Slater's directory of Birmingham 1852), when the wharf occupied for the coal trade was acquired for a new bedstead factory.

Robert had taken his son, John, into the business during the late 1840s. During 1848 John Fawkner Winfield, contacted Gilbert Hamilton from James Watt & Co as to a rolling mill [6] (Boulton & Watt Letter Book 1848). Watt & Co completely rebuilt the rolling mill at the Union Mill during 1851 and 1852 (Boulton & Watt Letter Book 1848) and Winfield had to source their rolling elsewhere. Watt provided new boilers and it was possibly during this work that the engine was replaced with a larger, but evidently second hand beam engine.

During this period the Union Rolling Mills at 42 Cambridge Street had a period of changed ownership. They had been offered for sale in 1847 and contemporary rate book entries do not list an occupier. The Watt correspondence indicates the mill was then in a poor condition. It is known that the situation was resolved through the purchase of the Union Mills by Winfield, and this may correspond with the date of the sale, but the lease for the mill was not settled until 1854. The subsequent acquisition of the adjacent tube mill provided more business opportunities for Winfield. Various types of tubes were made including various forms of ornamental and twisted tubes.

The greater Cambridge Street Works came into being with the acquisition of the rolling mills, tube mills and wire mills (42 & 43 Cambridge Street). Parts of the former Baskerville House Mill also appears to have been absorbed leaving Winfields with a continuous line of buildings along Attwoods and Baskerville Passage. The main offices were at 1 Cambridge Street, as was an extensive showroom.

John died in January 1861. Robert Winfield was devastated through his son's death. He was also no longer young. Robert took Charles Weston and James Atkins in to partnership in 1864 (Birmingham Daily Post 1864). They had been managers at Cambridge Street.

Robert's health failed. He became an invalid and died in December 1869. Management then devolved on the former partners Atkins and Weston. Winfields' two daughters also gained a say. This was done through their husbands, Charles Busbridge Snepp and Philip Browne. Both were clergymen, Snepp was the Clerk for Perry Barr, whilst Browne was at Edgbaston.

During the 1870's Winfields faced increased competition from other manufacturers, particularly in the metallic bedstead trade. Charles Walker Torr gained his knowledge of the trade through working in the foundry. Torr rose through the ranks to become manager of the works and eventually a partner. His name started appear on patents from 1874. James Atkins left the partnership in February 1879 leaving the firm in the hands of Philip Browne, Charles Snepp, Henry C Taylor and Charles Torr (London Gazette 1879). With Atkins departure was lost the last link with the times of Robert Winfield.

Later history of the Cambridge Street works (Winfields)

Charles Torr paid particular attention to the possibilities of electric lighting and through him, Winfield's became one of the pioneering firms that made electric light fittings. During 1882 Torr entered into an agreement with Crompton & Co, electrical engineers of Chelmsford. This arrangement became known as the Crompton-Winfield Association. They contracted to supply electric power and lighting to the Birmingham Town Hall for the Music Festival (28th August-1st September 1882) (Birmingham Daily Post 28th August 1882). It was the first use of public

electric lighting in the town. Electrical power was supplied by a dynamo driven by shafting linked to the beam steam engine at the Cambridge Street Rolling Mill.

This concept encouraged further use of electric lighting powered by dynamo. Other events at the Birmingham Town Hall benefited from the electric light and in October 1883 the Crompton-Winfield Association provided lighting for the Leeds Music Festival.

In 1886 Winfield's sought to break their ties with Crompton and even went to court to reclaim costs, but it was proved that no legal agreement had existed and Winfield were left with the loss.

Another experimental business was the supply of stained glass. This was conducted in a part of the premises at 1 Cambridge Street. In 1887 they supplied a window to the Priory Church, Malvern (Birmingham Daily Post 1887). Later in 1891 they supplied stained glass windows to he refurbished Grand Hotel in Colmore Row (Birmingham Daily Post 1891).

Winfields Ltd was registered in February 1887. The first year trading yielded a profit, but 1888 was to prove to be a bad year financially and otherwise. In September 1888 a serious fire broke out in the bedstead works that principally affected included the main four storey block. Charles Torr praised the action of the Fire Brigade, without whose assistance more serious damage might have been done. Amongst the salvage material sold off after the fire was a load of scrap iron cased tubing. The loss of patterns and stock was an inconvenience, but the most serious outcome was the interruption to a major earner, the metallic bedstead trade.

Falling profits led to a change of management and eventually a reduction of the share price of the company. Charles Torr was displaced as managing director in April 1889. The new board of directors included S.H Thompson, J Lee, W Wilson and P Gabriel. William Reuben Lane (an accountant and secretary to Winfields) became acting manager of the company.

A further financial blow came in January 1890 when an action was brought by the trustees of the Scott Estate of Great Barr to reclaim moneys due from a loan of £27,000 made by Sir Arthur Scott in 1883 to finance the electric supply venture. The action was brought against Julia Snepp, Charles Torr, Winfields Ltd and their solicitors Milward and Co. An important result of this action was the transfer of security from Winfield and Co to Winfields Ltd (Birmingham Daily Post 1890).

Meanwhile little investment was made in the plant and the rolling mills deteriorated. James Watt & Co was commissioned to make various repairs in 1897 (James Watt and Co, 1897). The continued ill-fortune of the company led to the appointment of a receiver in May 1897. W R Lane remained as manager.

Nine 9 departments at Cambridge Street were affected by the sale: (1) Tube Metal & Wire, (2) Chandeliers and Gas Fittings, (3) Electric Light Fittings, (4) Metallic Bedsteads, (5) Art Metal Work, (6) General Brass Foundry, (7) Wrought Ironwork, (8) Stained and painted Glass Tiles & (9) Church Work. They also operated coal boats from the Tindal Street Wharf. The systematic break up of the estate now followed and these different parts of the Cambridge Street Works were sold off separately during 1898. Lane supervised the transfers of these businesses.

The brass foundry business was taken J & A Tonks, Sperryns took over a major part of the Bedstead Works. Paint makers Llewellyn Ryland acquired the former Varnish making works (Cromwell Works) and Winfield Rolling Mills Ltd was formed to purchase the Rolling, Wire and Tube Mills in January 1898. The first chairman was Francis Mitchell (Steel Pen Maker) and he was assisted by directors George and William Dugard (partners in the firm of Dugard Brothers) (Birmingham Library Archives). Bedstead making was lost to their competitors and Winfields general role as a leader in the various brass trades fell to Smethwick–based competitors Evered.

C.J. Bamford was appointed manager of the Rolling Mills and he steadfastly worked to improve the rolling, tube and wire trades. The bulk of their custom was in the Birmingham area, with lesser amounts of orders going to "country" sales. Leeds sales were entered as a separate item. Leeds had several important private railway and road locomotive builders and sales of tubes would have included this market. Brass wire was used in the screw trades and Winfield's customers for wire were in this line.

The Rolling Mills became a successful business supplying tube, sheets and wire and with time made various improvements to the plant. They also capitalised on letting of spare shopping. W Markes and Co agreed a tenancy of a former lacquer room at the rolling mills during 1898 where they had access to engine power to drive their lathes. Other spare shopping was leased to Butler & Co and W & J George.

From 1899-1902 William Dugard persevered with a system of firing the muffles with gas from a gas producer. They had difficulty obtaining suitable coal but by 1902 had decided to invest in an economiser and from 1903 savings in coal consumption were achieved.

Between 1911 and 1912 the Rolling Mills embarked on a partial conversion of the plant to electric power, which included the taking down and rebuilding of a group of muffles. Despite Winfield & Co's early incursion into the electricity trade, the rolling mills continued to be lighted by gas, whilst the steam engine provided the power for the cutters, drawing benches, rolling mills and the wire mills. Now part of the rolling mill plant was replaced with new rolls driven by electric motors. The works were now lighted by electricity and all power was supplied by Birmingham Corporation (Birmingham Library Archives 1911 to 1912).

Winfield's Rolling Mills prospered as a supplier of material to a busy working city such as Birmingham became. During the First World War they were taken over by the Ministry of Munitions and were Government owned for the duration of the conflict. In 1917 they assigned over the old boiler house, on the Bedstead side to the Birmingham Aluminium Castings Company who taken some of the former Winfield's buildings. The other two boilers were retained to supply the Watt beam engine.

After the war Winfield's Rolling Mills invested in new wire drawing plant and some new electrically driven plant for the Rolling Mill. The Bamford family also gained a stronger control of the business. C.J Bamford became managing director and his sons C.C Bamford and F.J Bamford gained seats on the board.

Many of the other former Winfield's buildings were pulled down in the 1920's. Some were levelled to make way for the Peace Gardens and Hall of Memory. The rest as a scheme was proposed for a Civic Centre. Winfield's Rolling Mills had contemplated a move to another site during the 1920's but the Civic Scheme made it an urgent reality in the 1930's. A site at Icknield Port became available when Vivian's closed down their Birmingham Rolling Mills. Winfield's moved in and rebuilt the premises to their needs. A totally electrically driven mill was created. In February 1936 the local papers printed story that the old Watt beam engine was to be scrapped.

The canal that served the rolling mills lasted to this time. It, the lock and the rolling mills were swept away for the new Civic Centre. Only Baskerville House was completed before the onset of the Second World War halted any further work. From 1945 Birmingham Corporation forged new schemes and plans and the Civic Centre was revitalised with a Philharmonic Hall built on part of the vacant site. This proposal was dropped and the wasteland that had been Winfield's Tube Mills was later occupied by the New Repertory Theatre, the rolling mills and part of the old bedstead works became a car park.

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Birmingham Library Archives MS 322/8, assignment of leasehold mill in Baskerville Place Daniel Ledsam and others to Robert Walter Winfield 27th September 1853. MS 322/10 premises in Cambridge Street, George Crowther to Robert Walter Winfield 31st October 1857

Piggots Smith Map bears the date of 1855 but copies were updated during the next ten or twelve years with building alterations and new buildings being added to the plan. In the case of Winfields, the Bedstead Works seem to be contemporary with the original plan and balloon views of the works complex published from 1856 show the Bedstead Works

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Birmingham Library Archives MS1422 60/1/7/1, Directors Minutes various entries 16th May 1911 though to 21st May 1912

Appendix 5 Artefactual Assessments

The Pottery by Emma Collins

Summary of factual data. The pottery assemblage consisted of 62 sherds weighing 1054 grams and was recovered from a minimum of six contexts. The assemblage dates to the late post medieval period to the modern period.

Methodology. The pottery was examined macroscopically and was counted, weighed and the fabric/type and form identified.

Discussion. Details of pottery are described in the table below;

SF	Cntxt	Type	Form	Qty	Wgt	Rim	Base	Spot date
10b	1027	Blackware		1	5g			17th-18thC
22b	1058	Creamware	Bowl	1	12g	1		M18th - E19thC
26b	u/s	Industrial slipware	Bowl	2	24g			19thC
36c	1109	Modern glazed ware		1	1g			19th-E20thC
38	1109	Blue transfer print	Bowl	1	6g	1		19th-E20thC
38	1109	Blackware		3	26g			17th-18thC
40c	1101	Coarseware	Jar	1	56g		1	17th-18thC
40c	1101	Creamware	Scalloped edge plate	1	3g	1		M18th - E19thC
45	?	Modern glazed ware	Tea cup	3	19g	1		19th-E20thC
54	?	Brown Salt glaze		37	848g			19th-E20thC
54	?	Creamware	Plate	7			1	M18th - E19thC
74	?	Modern glazed ware		2	52g	1	1	19th-20thC
88	1384	Industrial slipware		1	2g			19thC
-	1456	Blackware		1	<1g			17th-18thC

Table 5.1: Catalogue of the assemblage

There was also a small amount of none vessel ceramics in the form of two fragments of toilet (SF60) and one fragment of sink (SF48).

Statement of potential. The assemblage does not contain any particular significant sherds and does not warrant any further investigation.

Storage and conservation. The assemblage does not need any conservation or X-ray.

Illustration. No illustrations are needed.

Further Work. No further work is needed.

The Brick by Emma Collins and Chris Hewitson

Summary of factual data. Brick; 37 fragments (predominantly single whole brick samples); weight 112,070g; recovered from minimum 22 contexts; comprised of material from the early modern period (dated *c.* 1820-1920).

Methodology. The majority of the assemblage was collected on-site as a representative sample of each brick-built structure on-site. Some samples were collected from rubble deposits and specifically selected due to the presence of brick stamps. The assemblage was studies macroscopically with the occasional use of a 6x magnification hand lens. Each brick/fragment was measure, weighted, photographed and the fabric as examined. No reference collection was available so a fabric series was created.

Discussion. There were three types of brick in the assemblage, firebrick, redbrick and engineering brick. A fabric series was created and was as follows;

Fabric 1. Redbrick. Light orangish pink slightly soft fabric with occasional large rock fragments.

Fabric 2. Redbrick. Light brownish orange fairly hard fabric with occasional fragments of red iron stone and occasional small sub-rounded lumps of red grog.

Fabric 3. Redbrick. Mid brownish red hard fabric with very occasional sub-rounded light yellowish brown grog and occasional grit.

Fabric 4. Engineering brick. Mixed dark grey and greyish red hard fabric with dark brown rock fragments.

Fabric 5. Engineering brick. Dark brownish red core turning dark purplish grey exterior. Inclusions as Fabric 3 but with frequent lumps of light coloured grog.

Fabric 6. Engineering brick. Mid brownish red very hard fabric with dark purplish blue surfaces. Has occasional 1-2mm limestone fragments, very occasional sub-rounded dark grey grog and very occasional angular voids inclusions.

Fabric 7. Engineering brick. Dark reddish brown fabric with dark greyish brown surfaces. Inclusions include varying sized lumps of grog and very occasional 2-4mm rock fragments.

Fabric 8. Firebrick. Light brownish pink hard fabric with a rough feel and varying sized irregular voids and small sub-angular rock inclusions.

Fabric 9. Firebrick. Light yellow fabric with frequent varying sized irregular voids and frequent dull white angular rock fragments.

Fabric 10. Firebricks. Light brownish yellow hard fabric with frequent 2mm black ironstone inclusions.

The bricks samples came from a series of structures including areas of the bedstead works, the canal wall, the boiler bases, the engine house, the wheel races and the flue structures.

Statement of potential. The assemblage represents a wide variety of bricks reflecting the multi-phases of the site and also bricks for specific purposes, for example, the firebrick lining of the boiler bases. The brick has the potential to inform us about techniques adopted in the construction of Birmingham factory construction technology in the early/ mid-19th century. At present there is little published and no excavated reports on this subject. Further research is required to place the use of brick for certain structures in context. In particular the firebricks have brick-stamps that relate to their factory of manufacture and patterns of localised brick-sourcing and trading can be examined. The variation of brick size/ type/ fabric should be examined with respect to the established site chronology. This may elucidate variations in brick use by phase. Comparisons with recently excavated examples of brickworks in the local area (e.g. Blakesley Hall, Cook 2008; Saltley, Duncan forthcoming) may add to our current knowledge of 19th century brick manufacture. In addition the brick should be placed within the chronology of brick building in the West Midlands generally.

1.1.1. A catalogue of the assemblage is shown in Table 5.2 below.

Brick no.	SF no?	Cntxt	Dimentions	Type	Initial description	Structure/ Context Description	Wgt(g)	Fabric
13		1064	4 1/2" x 3 1/4" x 9 1/4"	Eng.		Workshop wall bedsteads works	4450	1
7		1068	4 1/4" x 3 1/4" x 9"	Eng.	Burnt on orange?	Canal wall	4850	4
8		1068	4" x 3 1/2" x 8 1/2"	Eng.		Canal wall	4500	6
14		1079	4 1/2" x 2 1/2" x 9"	Fire	Sooted on stamped side. Stamp: 'BEST STOURBRIDGE'	Floor Brass Furnaces – bedstead works	2850	5
10		1163	4 1/4" x 2 3/4" x 9"	Red	one bed sooted, other covered in mortar	Lancaster boilers	3475	2
2		1165	4 1/4" x 3" x 9"	Red	one edge is very burnt	Lancaster Boilers	4050	3
3		1165	4 1/4" x 2 1/2" x 9"	Fire	Baked red sand over most of the surface	Lancaster Boilers	3550	10
18		1183	8 3/4" x 4" x 2"	Fire	Stamped: 'KING BROTHERS STOURBRIDGE'	Chimney Culvert/ Flue	2400	9
5		1186	4 1/4" x 2 1/2" x 8 3/4"	Fire	One edge partial burnt/eroded	Annealing Hearth Base	3015	10
4		1189?	4 1/8" x 2 7/8" x 9"	Red	One edge much more orange	Early phase of boiler base	3700	3
9		1206	4" x 2 3/4" x 3 1/2"	Eng.		Boiler Feed Pump	3600	4
6		1209	4" x 2 1/2" x 8 3/4"	Eng.	Very black, looks handmade	Canal Wall	2850	5
15		1209	9 1/2" x 4 1/2" x 3"	Eng.	Stained	Canal Wall	4550	4
11		1252	4 1/4" x 2 1/2" x 8 3/4"	Red		Large Wheel Pit	3200	2
1		1283	4 1/4" x 2 3/4" x 9"	Red	one edge burnt, other covered with mortar	Steam Engine Base	3275	2
12		1345	4" x 3" x 9"	Red?	All surfaces except one burnt. One that is not is mortar covered.	Wheel Pit	4200	7
19		1362	9" X 4 1/2" x 3 1/8"	Eng.		Early Boilers	5000	7
17		1380	8 3/4" x 4 1/4" x 3"	Red	Sooted on one end and vitrified on the other	Earlier Muffles/ Furnace	4025	3

Brick no.	SF no?	Cntxt	Dimentions	Type	Initial description	Structure/ Context Description	Wgt(g)	Fabric
16		1381	9" x 4 1/2" x 2 1/2"	Fire	Vitrified/encrusted down one edge	Earlier Muffles/ Furnace	3275	8
23		1384	8 3/4" x 4 1/4" x 2 3/4"	Red	Yellow residue on a lot of it	Flue/ Early Boiler Base	2925	1
21		1386	9 1/4" x 4 1/4" x 3 1/4"	Eng.		Early Boiler Base	4850	5
20		1388	9" x 4 1/4" x 2 3/4"	Red	very fragmentary	Flue/ Early Boiler Base	3175	2
22		1390	9" x 4 1/4" x 3-2 1/4"	Eng./red?	Plinth brick	Early Culvert	3450	5
24		1539		Red		Canal wall (Area 2)	4000	2
25		1540		Red		Canal wall (Area 2)	4300	2
	64	U/S	? x 6" x 2 1/4"	Eng.	Stamped with 'TIMMIS & Co LTD'		4850	5
	64	U/S	? X 4 1/2" x 2 1/2"	Eng.			1700	5
	27	U/S	9 1/2" x 4 1/2" x 3"	Red	Brick stamped with '1839'		3775	2
	51	U/S		Fire	7 fragments with lots of slag adhered		2330	10
	68	U/S	? x ? x 3"	Red	Brick fragment, 'L' shaped		1175	3
	76	U/S		Eng.	Bull nosed		4725	5

Table 5.2: Catalogue of the brick assemblage

Storage and conservation. The assemblage is stable and no conservation is required on the assemblage. The bricks have been digitally photographed as part of site archive. It is recommended that as the bricks have been fully recorded the majority can be discarded. However, the stamped bricks (Bricks No. 14, 18; SF no 27, 64) may be retained as part of the site archive after discussion with the Birmingham Arts and Galleries Museum Service.

Illustration. Illustrations of the key stamped brick items (Bricks No. 14, 18; SF no 27, 64) may be necessary as part of the full report. Otherwise no further illustration is necessary for the assemblage.

Further Work. No further recording of the brick is necessary. The fragments SF51 has been added to the metallurgical assessment. Further research should be undertaken in particular with regard the origin of the stamped bricks and requirements for firebricks within the construction of the brass works. A full report should be undertaken detailing the construction of the brass works, the variation in brick typology in comparison with the established construction sequence and the potential origin of the brick.

Other Finds by Erica Macey-Bracken

Summary of factual data A small quantity of finds was recovered from the site including clay pipe, glass and worked bone. The items were removed from site and are retained as part of the site archive.

Methodology The finds were washed and marked and then quantified by count and weight for each context. The finds were then examined macroscopically for the purposes of this report.

Discussion Details of the finds are described in the table below;

Finds Number	Context	Description	Material	Measurements
9c	1025	1 x pipe stem	Clay Pipe	19mm
36	1109	3 x pipe stems	Clay Pipe	38mm, 39mm, 22mm
-	1005	1 x pipe stem	Clay Pipe	25mm
3	1018	7 x fragments modern window glass, ridged on one side so that it is not see-through 1 x scrap of modern clear window glass	Glass	Various sizes
20	1051	Assorted fragments of glass, including: 5 x complete or near-complete clear glass lenses 5 x blue and 1 x green glass offcuts, possibly from stained glass 1 x frosted window glass 1 x clear window glass 3 x red vessel glass 4 x amber vessel glass 8 x clear vessel glass 2 x light green bottle glass 1 x dark green bottle glass 24 x fragments of melted glass residue 2 x clear glass fuse fragments	Glass	Various sizes
22	1058	1 x neck and part of body from a clear green Daddies sauce bottle. The name DADDIES is embossed on one side and remains of the red, yellow and white printed label are visible on another side. 1 x fragment of vaguely-trefoil-shaped moulded clear glass, broken off at base	Glass	Bottle: 137mm x 37mm Shaped glass: 26mm x 25mm

Finds Number	Context	Description	Material	Measurements
34	1137	1 x glass with lead window calme frame	Glass / lead	90mm (approx)
36	1109	1 x fragment of melted glass residue	Glass	51mm x 20mm x 25mm
39	1105	1 x complete clear glass drink bottle, embossed with the name Mitchells & Butlers Ltd. Early 20th century.	Glass	200mm high
55		2 x fragments from a glass fuse	Glass	47mm, 21mm
75		1 x piece of thick opaque window glass 1 x neck of a clear glass bottle	Glass	Window glass: 109mm x 97mm x 5mm Bottle: 45mm
-	1406	1 x fragment of clear green bottle glass, embossed with the letters DI	Glass	30mm x 31mm x 3mm
-	U/S	1 x complete dark green glass bottle, embossed at the shoulder with the name ANSELLS BREWERY LTD. The rubber stopper is present, and is also embossed with ANSELL'S BREWERY LTD BIRMINGHAM and the AAA trademark. Mid 20th century.	Glass	278mm high
36d	1109	2 x pieces of bone-working waste – cutouts from button making	Bone	23mm x 15mm x 3mm; 21mm x 11mm x 3mm
9b	1025	1 x fragment of sawn bone – working waste	Bone	34mm x 23mm x 6mm
-	1001	1 x cutout from button-making, as Find Number 36d above	Bone	25mm x 22mm x 4mm
-	1406	1 x unworked bone fragment	Bone	70mm x 27mm x 12mm
20a	1051	1 x doorknob 2 x vessel base fragments 1 x possible vessel rim 1 x circular fitting with threaded centre	Bakelite / plastic	Various sizes
21	1058	1 x shallow cup – possibly to protect carpet from furniture castors	Bakelite / plastic	55mm diameter, 19mm deep
23	-	1 x fragment of newspaper, showing part of a title of an article on unemployment figures on one side and part of an advertisement on the other Several unreadable pieces of newpaper	Paper	64mm x 52mm (approx) Various sizes
-	1406	Several unreadable pieces of newspaper	Paper	Various sizes
34b	1137	3 x fragments of shoe sole. Stitching holes visible on all pieces	Leather	Various sizes

Table 5.3: Assemblage of other finds

Statement of potential. The assemblage is very small and largely non-diagnostic. The early modern date of the site has meant that finds have not provided significant dating evidence. The clay tobacco pipe and vessel glass is of limited archaeological significance. However, the group of glass fragments from contexts 1051 and 1058 may relate to the stained glass window production on the site. The worked bone fragments are common finds on Birmingham site and represent part of an increasing body of evidence for the shell button industry (see Patrick and Rátkai 2009; Edgeworth *et al* forthcoming; Watkins 2010).

Storage and conservation. The assemblage is stable and does not require conservation or X-ray.

Illustration. Illustration by photography of the stained glass may be suitable for the final report in order to show the range of colours being used in the Winfield's stained glass production.

Further Work. The stained glass should be photographed for the archive and a short report should be included on them as part of the final report. The working waste should be photographed as part of the site archive and a short report included as part of the final report.

Large Finds by Sam Hepburn and Chris Hewitson

Summary of factual data. The large finds were recovered and recorded on-site. They included a series of structural elements of various machinery parts recovered from the site of ferrous, wooden or composite material. The location of where they were recovered from has been recorded and marked on plan.

Methodology. The nature of much of this assemblage meant that it could not be recovered from site and was recorded and discarded on site. Reasons for this included weight, size and petro-chemical material contamination. The assemblage was recorded on site. Each object was assigned an individual finds number, a detailed description was undertaken and a scaled photographic record was taken of each item. Due to their size the items were not weighed. The material has been examined at assessment stage, where further work is required to understand the nature or function of the item this has been recommended.

Discussion. Details of all large finds are described in the table below;

Finds Number	Description	Material	Measurements (approximate)
1	Part of a metal sign painted red with white lettering, the letters 'TRY' are visible.	Fe/ Tin	0.20m x 0.20m
3	5 miscellaneous strips of Fe and brass	Fe/ Cu Alloy	Various lengths
9	Heavily corroded section of bent Fe pipe	Fe	0.17m x 0.10m x 0.10m
10	Small Fe plate with 4 bolt attachments	Fe	0.05m x 0.05m x 0.01m
11	Possible Fe machine component	Fe	0.25m x 0.13m x 0.05m
13	Square Fe vent with small circular holes.	Fe	0.25m x 0.25m x 0.025m
22	Machine component consisting of 2 fe metal pipes connected together by a small cast iron beam	Fe	1.10m x 0.50m x 0.03m
23	Large hinged machine arm, comprised of a cast iron beam and a pole with a hooked end	Fe	3m x 0.20m x 0.06m
24	Machine components consisting of 2 metal pipes connected together by a small cast iron beam, bent out of shape	Fe	1.10m x 0.50m x 0.03m
27	0.15m diameter pulley wheel with a track for the rope, it is attached to a metal bracket with its bolts still attached	Fe	1.25m x 0.15m x 0.15m
31	Large Fe plate with decorative rectangular designs along the length, at each of the rounded ends is a 0.05m x 0.05m square hole.	Fe	1.45m x 0.20m x 0.08m
34	Large circular stone weight with a metal fixing used to hang it	Fe/ Stone	0.44m dia. x 0.15m
28	1 wooden stake, and 2 large metal bolts, possibly used to secure large machinery	Fe/ Wood	0.05m x 0.05m x 0.25m 0.05m x 0.05m x 0.30m 0.10m x 0.10m x 0.50m
26	Wooden beam with a small (0.10m x 0.025m) rectangular	Wood	0.09m x 0.09m x 1m

Finds Number	Description	Material	Measurements (approximate)
	hole cut through it		
29	Wooden beam/plank	Wood	1.50m x 0.40m x 0.20m
30	Large wooden beam rotten in places, with part of a wooden plank bolted to it on one side	Wood	2.54m x 0.25m x 0.25m
32	2 wooden chocks, the ends of each chock taper to a point	Wood	0.45m x 0.10m x 0.06m 0.30m x 0.075m x 0.06m
21	Wooden shelf with rounded corners, with two Fe triangular fixing brackets	Wood/ species unrecorded	1.30m x 0.25m x 0.30m
7	Large block of corroded material	??	0.18m x 0.15m
25	Rectangular concrete slab, with a small lip on one edge, broken in two	Concrete	0.65m x 0.35 x 0.07m
2	Small pair of leather boots	Leather	0.15m x 0.05m
20	Large pair of leather work shoes	Leather	0.18m x 0.07m x 0.06m
33	Leather shoe	Leather	0.26m x 0.11m x 0.09m

Table 5.4: Assemblage of Large Finds

Statement of potential. Many of the items do not warrant further investigation. Some of the structural elements may shed light on the function of machines within the works. These include the cast-iron machine arm (#23), the circular weight (#34), the small cast-iron pulley wheel assemblage (#27), the cast-iron decorative plate (#31), the wooden chocks (#32), large beam (#30), and the two possible machine components (#22 and 24).

Storage and conservation. Many of the large ferrous items were initially set aside on site, with a view to retaining them. Unfortunately during the process of moving from Area 1 to Area 2 the finds were lost. Although regrettable the record prior to loss should be sufficient to reconstruct their function.

The wooden items were usually either too large or heavily contaminated with petro-chemical residues. The three sets of leather shoes (all dating to the demolition phase) were also contaminated with petro-chemicals. Contamination prevented the retention of the material on health and safety grounds. Therefore the decision was taken on site to record the items. A photographic record was made of all the items prior to discard on-site as part of the demolition process.

Illustration. Several of the large pieces should be photographically illustrated as part of the final report, they are not recommended for full illustration except if they prove to be significant functional items. These include the cast-iron machine arm (#23), the circular weight (#34), the small cast-iron pulley wheel assemblage (#27), the cast-iron decorative plate (#31), the wooden chocks (#32), large beam (#30), and the two possible machine components (#22 and 24).

Further Work. Further research should be conducted to understand the function of the machine arm (#23), the purpose of the circular weight (#34), the small cast-iron wheel (#27) and the possible machine components (#22 and 24). The items mentioned above should be shown to specialists as part of the consultation on the machine functionality of the works.

The scrap metal and crucible fragments by Sam Hepburn and Chris Hewitson

The assemblage consists of a range of ferrous and non-ferrous scrap metal fragments collected from stratified and unstratified contexts from the site of Cambridge Street, Birmingham (BA1955). The assemblage consists of 209 fragments of material from 69 separate contexts, with a combined weight of 29.61kg. The material came from a series of early modern deposits dated to the period 1820-1920 AD.

The assemblage was collected from deposits throughout the site. The collection policy was not to take a 100% sample but to take a representative example of material for further analysis. Un-sampled material was discarded on site or remained uncollected. The material was examined visually, weighed, quantified and catalogued. Descriptions were based on the authors experience and cross-reference to the material contained within the JW Evans archive (located at English Heritage stores in Atcham). Material typologies were based on visual analysis only at this stage of assessment. Where further XRF analysis was deemed necessary it has been recommended.

The assemblage contains a mixture of items from waste products (slag and crucibles) to unfinished objects. All of the metal finds recovered and assessed here fall in to 3 types, tools, formed items either cast or pressed but not finished and metal waste/off-cuts. The formed metal items are produced by using one of several processes, the sheet metal items have been pressed using drop stamps or fly presses to cut out the blanks and to shape them, the brass studs and many of the fe items have been cast, and the wire present has been drawn from the brass/cu alloy strip found on the site, 1404 has several examples of this strip with signs of it being drawn in to wire.

Details of all contexts are described in the table below;

SF No	Context	Description	Count	Weight	Comment
1	1016	Small circular pressed brass blank with hole punched in the centre	1	2g	Further analysis required
2	1006	11 circular pressed brass blanks of various sizes, small brass sheet metal off-cuts, and several small concreted clumps of metal off-cuts	11	123g	Send lump of concretion for met. analysis Sample #1
3	1018	Small rectangular brass cast block? and a small piece of slag	2	22g	Further analysis required
4	1018	Circular pressed brass blank, large sheet metal off-cut (brass), 2 small lumps of concreted off-cuts and a small lump of slag	3	47g	send lump of slag and concretion for met. analysis Sample #2
5a	1017	Small brass? nail/tack, small cast machine part, 4 brass pressed items, 7 small sheet metal off-cuts (brass?)	13	61g	cast and pressed items for met. analysis Sample #3
5b	1017	3 pieces of tile with slag/metallic concretions	3	61g	met. analysis Sample #4
7	1018	Small rectangular brass sheet metal off-cut	1	1g	
8	1018	5 brass sheet metal off-cuts, and 2 small brass pressed and shaped items	7	8g	
9	1025	6 small brass? nails/tacks, a circular pressed brass blank and folded sheet metal off-cut (brass?)	6	14g	
10	1027	2 small brass? nails/tacks	2	310g	
12b	1035	lead/brass? decorative cast handle	1	11g	x-ref to archive catalogues required
12c	1035	3 corroded brass sheet metal off-cuts, and a decorative cast circular brass stud	4	72g	
14	1044	Large iron sheet metal off-cut very corroded	1	68g	Further analysis

SF No	Context	Description	Count	Weight	Comment
					required
16	1039	A very corroded iron nail, and a circular brass pressed item	2	32g	
17	1051	6 small pieces of slag	6	134g	met. analysis Sample #5
18	1051	2 small pieces of hard and light slag	2	44g	met. analysis Sample #6
19	1051	Small brass sheet metal off-cut	1	1g	
20b	1051	4 pieces of light and rough slag	4	388g	met. analysis Sample #7
22	1058	5 circular brass pressed buttons, and a broken corroded iron key	6	31g	
24	-	Circular brass pressed blank	1	4g	
25	-	Bag full of large brass thin sheet metal off-cuts		569g	send a piece for further analysis Sample #8
26	u/s	2 large pieces of hard, rough, globular looking slag	2	801g	Met. analysis Sample #9
28	1056	Small circular brass pressed blank and washer	2	1g	
29	-	16 pieces of slag, cast iron rod, heat affected circular pressed blank, waste metal?	16		send several pieces of slag for met. analysis Sample #10
30	1079	Broken circular pressed cu alloy/brass? Button	1	1g	
35	1113	2 pieces of crucible	2	496g	Further analysis required
36a	1109	Small piece of slag	1	55g	Further analysis required
36b	1109	Small length of copper pipe and a piece of brass sheet metal off-cut (waste from button making)	2	12g	
36g	1109	3 crucible fragments	3	1142g	Further analysis required
40	1101	Small bag of pale fragmentary slag		35g	Further analysis required
46	-	Circular brass pressed container with concretions	2	290g	Further analysis required
49	-	4 brass strip off-cuts and 3 pieces of drawn wire	7	100g	send a piece of wire for met analysis Sample #11
52	-	7 pieces of cu alloy drawn wire off-cuts	7		
56	-	6 pieces of drawn wire of different gauges, a piece of concreted material, and a piece of brass sheet metal off-cut	8	466g	
58	-	3 pieces of concreted material, 2 pieces of drawn wire, and a brass sheet metal off-cut	6	6000g	send a piece of concreted material for met analysis Sample #12
63	-	4 brass strips, off-cuts	4	69g	
67	-	2 pieces of brass drawn wire and 2 pieces of brass sheet metal off-cuts	4	77g	
71	-	3 pieces of brass drawn wire, a coil of copper electrical wire and 4 brass strip off-cuts	8	114g	
72	-	Small piece of slag	1	2g	Further analysis required
73	-	3 cast iron strips (from a machine?), and a cast iron poker/pry bar	4	1702g	
78	-	A brass? nail/tack, a shaped piece of drawn wire with flattened ends (a small handle), and 2 brass strip off-cut	4	20g	
79	-	Flat brass pressed plaque/clamp? machine part with 2 pieces of wire attached	1	69g	
80	1151	Large pieces of slag	1	385g	Further analysis required

SF No	Context	Description	Count	Weight	Comment
81	-	2 small wooden paddles, the ends held together with a coil of cu alloy drawn wire	1	52g	
82	-	Small circular brass pressed blank	1	1g	
83	1063	Small piece of brass sheet metal off-cut and fragments of corroded iron spring		65g	
86a	1042	7 fragments of triangular shaped files, 3 lengths of iron pipes with holes in it and covered in concretions, a small length of lead pipe, several clumps of heavily corroded hollow iron wire (lots of small fragments of this) fragments of a metal container with concretions		4000g	send a length of pipe and fragment of container for met analysis Sample #13
86d	1042	Small length of thin brass pipe	1	17g	
86e	1042	Small circular crucible base	1	1000g	Further analysis required
89	1396	2 small pieces of slag	2	15g	Further analysis required
90	1388	2 small pieces of pale coloured slag	2	32g	Further analysis required
91	1411	Small pieces of slag	1	23g	Further analysis required
-	u/s	Cast iron pincers (one half)	1		
-	u/s Area C	Small circular crucible base	1	1396g	Further analysis required
-	1245	9 brass? cast machine parts (ribbed rods, pipe fittings, rivets, knob etc)	9	180g	
-	1245	4 small pieces of slag	4		Further analysis required
-	1255	4 pieces of crucible	4	3400g	Further analysis required
-	1255	4 lengths of iron pipe (2 have concretions), 2 pieces of slag, 2 pieces of triangular shaped file, a lump of corroded iron hollow wire, fragments of a metal container with metallic concretions		2850g	send container fragment, slag and piece of pipe with concretions for met analysis Sample #14
-	1279	Medium sized bag filled with small pieces of slag			send a piece for met analysis Sample #15
-	1327	2 brass sheet metal off-cuts and a small brass? nail/tack	3	17g	
-	1329	Small circular pressed cu alloy button	1	1g	
-	1333	2 circular pressed brass buttons, 6 pressed brass machine parts, 2 pieces of thick gauge brass drawn wire and a brass sheet metal off-cut	11	64g	
-	1347	A length of thick gauge drawn brass wire, twisted to form a loop	1	288g	
-	1406	A piece of hard, dense slag/concretion	1	106g	Further met required
-	1406	4 cu alloy pressed vessels/machine parts, circular brass pressed button blanks and washers (various sizes), 2 small brass lengths off pipe, 2 pressed brass machine parts, 2 cast brass items, large pile of drawn brass wire lengths/off-cuts, large pile of brass strip off-cuts, a small pile of brass sheet metal off-cuts, 2 strips of brass that have started to be drawn into wire		1410g	Send a piece of sheet metal off-cut and 1 of the part drawn strips for met. analysis Sample #16
-	1547	Part of a crucible base	1	856g	Further analysis required

Table 5.5: Details of the scrap metal and crucible assemblage

The assemblage was collected in order to establish the processes undertaken within specific areas of the site. The potential of the assemblage for understanding the composition of the different material used within the site, and thus the different processes undertaken is detailed in the archaeometallurgical assessment (McDonnell see below). The scrap wire and rolled brass also has the potential for understanding the nature of the final produced material from the factory. The assemblage also has the potential to understand the distribution and typology of small machines operating within specific areas of the site and from this the distribution of the work within different areas of the site.

Due to the scrap nature of the assemblage no further conservation is recommended. The material is presently stable, a specific discard policy is recommended for the scrap on completion of full analysis.

Catalogue illustration of specific pieces has been undertaken. In addition detailed illustration by photography should be undertaken for finds types. In the region of 6-10 photographs should be reproduced for the final report.

Specific pieces have been recommended for further archaeometallurgical analysis (see table above). These include off-cuts, products, items, tools, residues and crucibles. In addition to this specific groups have been highlighted for further quantification, and detailed description. The remainder of the items are less diagnostic metallurgical items. These are mostly single items and are not part of a larger assemblage. Some items may include off-cuts, products, items and tools. The present quantification is sufficiently appropriate for these.

A full report on all the pieces of scrap metal should be completed once the archaeometallurgical results have been fully analysed and in conjunction with the archaeometallurgist. This should aim to highlight areas of production, specific processes occurring within the works and their geographical location. In particular the work should aim to understand whether specific types of cu alloy were associated with specific areas of production/ processes and link these to the historical understanding of the works.

- The processes by which the residues would have occurred eg slags, industrial waste.
- Ideas of production methods – brass offcuts, wire, rolled brass etc
- Identification of the brass used- could it have been produced in Birmingham?
- Does any of the slag suggest smelting being done on site?
- Do any of the residues/ sand/ slag suggest casting being done on site?
- Are any of the artefacts identifiable? Are they a known item being produced at the works?

The aim is to produce a synthetic report that will examine modes of production within the works and inform the structural archaeological and historical analysis.

Archaeo-metallurgical assessment of the scrap metal and crucible fragments by Gerry McDonnell

Summary of the Material

The residues sent for assessment from 1955 Cambridge Street, Birmingham are a sub-sample of the total quantity of material recovered and can be categorised into two main types. Firstly, the assemblage comprises metal artefacts and metal waste and secondly the slags and residues (Appendix 1). The metal artefacts include copper alloy and iron (alloy) artefacts. The copper alloy artefacts include both cast artefacts and wrought

artefacts e.g. strip and wire. Within the copper alloy waste are sheet off-cuts, rod, bar and wire. The ironwork is either structural (a spike, [1044] SFN 14) or possibly part of manufacturing equipment (a tube with holes, (a tuyere?), Sample 13 [1042] SFN 86a). The slags and residues are sub-divided into three main groups. There are crucible fragments, including bases and wall fragments (e.g. [1109] SFN 36g). The second group are broadly classified as slag, some have copper alloy corrosion products on the surface of the slags, indicative of use in hot working the wrought copper alloy (e.g. Sample 1 [1317]). The final sub-group comprise a varied range of slags some white (e.g. [1101] SFN 40b) other more similar to hammer scale (e.g. Sample 9 Bag 1 [1406]).

The potential of the material

The metal

The 2008 publication of a Research Framework for Archaeo-metallurgy (Bayley *et al*. 2008, 69) highlights the lack of comparative data from the archaeological and historical record for the post-medieval period. It noted that the rapid changes in technology places a reliance on the historical record, but this clearly requires confirmation by the archaeological record. The document focussed on production, e.g. of brass rather than the secondary metalworking processes. However these can be considered as equal importance to understand how specific alloys were exploited. The Winfield Works was the leader in the field of brass working and hence would have been at the forefront of alloy development and use. Brass could be utilised in both cast and wrought products, and additions of other alloying elements e.g. lead, tin antimony could be added to enhance specific properties creating ternary and quaternary alloys that would be broadly classified as brass. Some copper alloys are more suited to casting and others as wrought metalwork (hot and cold working). It is assumed that both these types of artefacts are representative of the Phases 3-5 production. The presence of both cast and wrought metalwork provides an exceptional opportunity to investigate alloy variation with function. Thus it will offer the opportunity to assess whether specific alloy compositions or range of compositions were used for the cast products and the wrought products. Within the two groups (wrought and cast) specific alloys may have been used for specific purposes. For example one piece in particular shows the transformation from strip to wire (Sample 16 [1406]), and the study can investigate whether the composition of other wire fragments are similar and whether sheet compositions differ from the wire alloy. Although alloy compositions can be selected for their production properties, i.e. cast or wrought, a further consideration is that of colour. The alloying process changes the colour as well as the physical and mechanical properties. Thus alloy compositions may be changed to achieve particular colour or patination colours. Hence the analysis may show changes in composition between specific artefacts type but that difference may have been dictated by colour rather than casting or mechanical properties.

The Crucibles

All copper alloy must be melted in a crucible poured into a mould and then either cleaned up as a cast product or hot and/or cold worked to produce a wrought product. Hence the crucible is the starting point of all the process unless the alloy was imported as bar. If possible the volume of the crucibles will be estimated. Some of the crucibles show adhering corrosion products of copper alloy, other are apparently clean. All used crucible fragments will generate a signal of the metals used in the alloy. However zinc, the second alloying element of brass posses particular problems because the volatilisation temperature of zinc is 907^{o}C, and the melting point of a 30% Zn brass at c 950^{o}c all crucible bodies will be heavily saturated with zinc. It is therefore unlikely that an exact answer can be obtained to determine the composition of alloys cast in a crucible. However detection of additional alloying elements e.g. Sn, Pb and Sb would indicate if a range of alloys were produced or were they consistently producing one alloy

range in terms of minor alloying elements. This would indicate consistency of alloy production, i.e. are they operating to a formula or are they throwing anything into the crucible. Crucibles vary is shape, size and volume and the analysis would assess whether specific crucible types are present on the site and whether they show distinct alloy compositions. The minor elements (Sn, Pb and Sb) will offer an opportunity to assess any linkage between the crucible data and the metal data.

The Slags

There are 21 samples identified as smithing slag and two provisionally identified as hearth bottoms. Six of the 21 (29%) show evidence of copper alloy corrosion products, i.e. the hearth had been used for hot working copper alloy. Analysis will show whether the copper alloy equates to the wrought metal data. Hot working copper alloy in itself is not normally associated with the formation of smithing slag, hence the question arises as to whether the slag is typical in microstructure and composition to other archaeological smithing slags, e.g. iron oxide and iron silicate minerals in a glassy matrix. If so, it is probable that the hearths were used for the hot working of copper alloy but were also used for iron smithing probably to manufacture and repair tools and fittings required in the works.

The morphology and characteristics of the slags indicate the use of coal or coke as the fuel.

In addition to the smithing slags that are three examples of a white/cream coloured slag which have not been recognized as a slag type previously. The colour may derive from either zinc and/or lead. This requires examination for health and safety consideration for the disposal of material and future curation. In addition examples of stone and/or clay hearth lining have been recognised.

Summary of the Significance of the Assemblage

The Cambridge Street assemblage offers an excellent opportunity to investigate the use and manipulation of zinc based copper alloys of the 19th/20th centuries. It is essential to undertake archaeo-metallurgical analysis to understand and interpret the site and be specific about the alloys used, rather than a generic 'brass works'. It is a unique opportunity to investigate the quality of manufacture from one of the foremost brass works in Britain. The work would accord with the research agenda identified by Bayley *et al* (2008, 69) to provide archaeological/scientific data to complement historical data. This document notes that "…19th and 20th century remains should be given priority…". The assemblage is very significant in having both cast and wrought products, which offers the opportunity to investigate alloy selection for specific purposes. The presence of very specific processes e.g. wire drawing offers an excellent opportunity to investigate alloy composition and method of manufacture of very specific artefacts that require specific properties, i.e. the ability to be drawn to wire. The presence of a significant crucible assemblage will provide insight into linkages between residues in crucibles, the cast metal and the historical record. The evidence of hot working in the form of slags are an important indicator of manufacturing processes and require characterisation. The Cambridge Street assemblage will provide a benchmark for future excavations of similar sites dating to this period.

Recommendation for Further work

Analysis would be undertaken according to the English Heritage Centre for archaeology Archaeometallurgy Guidelines (Bayley *et al* 2001) and Science for Historic Industries (Dungworth and Paynter 2006).

The Copper Alloy Metal

There are approximately 64 copper alloy artefacts of which 13 are cast and the remainder various forms or wrought metalwork including, bar, sheet, strip and wire. XRF (X-ray Fluorescence) analysis would be undertaken using a Bruker S1 Turbosdr hand-held device operating at 40kV. This would answer question of artefact composition in broad terms. However it must be stressed that XRF is a surface sensitive technique (10microns penetration) and thus reflects the corroded surface unless permission is given to clean an area to bright metal, which is recommended. Equally during corrosion de-zincification occurs and tin enrichment occurs. If an accurate record of composition is required it would be recommended that the artefacts are XRF'd followed by selected metallographic of a small number of artefacts (e.g. 5-10) including SEM analysis. The presence of a sample that shows the manufacture from strip to wire should be fully analysed to investigate the method of manufacture, e.g. whether the wire was drawn hot or cold.

The Iron Objects

There are two iron objects one possibly structural and one part of equipment. Archaeometallurgical analysis of the two artefacts would not provide sufficient data, in terms of numbers, to justify the analysis. However if there were a large number of iron artefacts a research driven project could be justified.

The Crucibles

There are 11 crucible fragments, selected by the excavators as representative of a far larger assemblage recovered during the excavation, all of which are large. Analysis would be undertaken using a Bruker S1 Turbosdr hand-held device operating at 40kV. Due to the volatilisation of zinc at 907^{o}C, and the melting point of a 30% Zn brass at c 950^{o}C all crucible bodies will be heavily saturated with zinc which will dominate the XRF spectra. It is therefore unlikely that any answer can be obtained to determine the exact composition of alloys cast in a crucible. However detection of other alloying elements e.g. Sn, Pb and Sb would indicate if a range of alloys were produced or were they consistently producing one alloy range in terms of minor alloying elements. This would indicate consistency of alloy production, i.e. are they operating to a formula or are they throwing anything into the crucible. These results would provide comparative data with the metal analyses, in particular the cast products.

The Slags

All smithing slag samples, including the hearth bottoms, (c35 samples/fragments) should be analysed by XRF to assess presence of copper alloy elements. This would indicate whether all the slags derive from hot working of copper alloy or some are specific to copper alloy working others to iron working. If two groups can be distinguished sub-samples should be sectioned and analysed using optical and electron microscopy to confirm the analyses. The white slags (3) should be analysed by XRF, if the presence of high Zn or Pb levels are detected a full archaeometallurgical investigation should be carried out including optical and scanning electron microscopy. Other slags (circa 15) require XRF to record the presence of copper alloy elements to assess whether the slags relate to non-ferrous metalworking.

sample num	bag	strat no	Finds Number	Description	total num of artefacts	cu alloy	fe metal	crucible	smith slag	white slag	lining	other	comment 1	comment 2
		1006	2	compacte	5	y			y				xrf assess non-ferrous signature	
	3	1009	3	1 frag of b	2	y							xrf assess non-ferrous signature	
4		1016	1	Cu alloy w	1	y							xrf assess non-ferrous signature	
14		1017	5a	2 cu alloy	2	y							xrf assess non-ferrous signature	
		1035	12b	cast Cu all	1	y							xrf assess non-ferrous signature	
7		1245		2 sheet fra	13	y							xrf assess non-ferrous signature	
9		1406		metal frga	33	y							xrf assess	context 1406 or 1408
4		1406		1 strip dra	3	y							xrf assess non-ferrous signature	
3			25	Cu alloy st	1	y							xrf assess non-ferrous signature	
1			46	1 sheet, 1	2	y							xrf assess	un-strat?
5			58	1 rod, 2 fr	1	y							xrf assess non-ferrous signature	
		1042	86a	Fe tube, with holes on one s			y						x-radiograph?, metallographic se	
15		1044	14	Fe bar/spike			y							
8		1042	86e	crucible base				y					xrf assess non-ferrous signature	
		1109	36g	3 crucible frags				y					xrf assess non-ferrous signature	
2		1113	35	2 crucible frags				y					xrf assess non-ferrous signature	
9		1255		3 large crucible frags				y					xrf assess non-ferrous signature	
2		1547		crucible base				y					xrf assess non-ferrous signature	
		99999	999999	crucible base				y					xrf assess	area C
9	2	1406		smithing slag, HL					y		y		xrf assess non-ferrous signature	
9	1	1018	4	slag frags,					y				xrf assess non-ferrous signature	
13	1	1051	17	1 frag of slag or vitrified stone					y				xrf assess non-ferrous signature	
		1051	18	1 frag smithing slag/cinder					y				xrf assess non-ferrous signature	
		1051	205	1 frag smithing slag/cinder					y				xrf assess non-ferrous signature	
8		1109	36a	1 slag frag					y				xrf assess non-ferrous signature	
		1151	80	hearth bottoms, coal fueled?					y				xrf assess non-ferrous signature	
		1255		smithing slag? With wooden shaft					y				xrf assess non-ferrous signature	
		1255		smithing slag, some v. flowed					y				xrf assess non-ferrous signature	
1		1279		smithing slag					y				xrf assess non-ferrous signature	
		1317		smithing slag, extensive Cu alloy stainir					y				xrf assess	note wrong struc num
		1323		hearth bottoms, green Cu allo corrosio					y				xrf assess non-ferrous signature	
6		1324		smithing slag, extensive Cu alloy stainir					y				xrf assess non-ferrous signature	
		1325	1119	smithing slag, high silica, cindery					y				xrf assess non-ferrous signature	
		1329	1073	smithing slag, extensive Cu alloy stainir					y				xrf assess non-ferrous signature	
10		1396	89	smithing slag, 4 frags					y				xrf assess non-ferrous signature	
		1406		hammer scale, some large fragments -					y				xrf assess non-ferrous signature	
3		1411	91	clinker/slag, Cu alloy staining					y				xrf assess non-ferrous signature	
			26	1 smith slag frag					y				xrf assess non-ferrous signature	
16			29	2 slag with Cu alloy staining, 1 slag frag					y				xrf assess non-ferrous signature	
9			72	smithing slag, spheroidal scale					y				xrf assess non-ferrous signature	
		1101	40b	white clinker, could be high Zn						y			xrf assess non-ferrous signature	
		1334		a form of fuel ash slag, not metallurgical?, whi						y			needs XRF	
12		1388	90	white clinker, could be high Zn						y			xrf assess non-ferrous signature	
6		1017	5b	stone lining(?) with attached Cu alloy slag etc							y		xrf assess non-ferrous signature	
7		1406		slag or hearth stone structure							y		xrf assess non-ferrous signature	
5		1406		flot sample								y	xrf assess non-ferrous signature	
		1369		slagged lining									xrf assess non-ferrous signature	

Table 5.6: List of Archaeo-metallurgical Samples

Glass and Glass Residues by David Dungworth

A small assemblage of glass and related materials was submitted for examination. The excavation at Cambridge Street covered the site of a historically-known brass-rolling mill. Associated works also carried out the manufacture of bedsteads including the production of coloured glass decoration for the bedsteads.

All items have been visually examined and selected samples have been analysed using EDXRF. Used in this way, EDXRF is non-destructive but yields only qualitative results which indicate the chemical composition of the surface. As such, these analyses will simultaneously indicate both the original composition of the analysed material as well as surface corrosion or contamination. Unfortunately, used in this way, the technique cannot distinguish between compositions due to original manufacture or later alteration.

Context	SF	Description	Count	Weight (g)
1058	21	Flat glass	22	109
1063	84	Glass fragments	4	5
1063	85	Glass fragments	10	74
1137	NA	Glass 'lens'	1	71
1137	34a	Glass in lead calme	1	63
1245	NA	Glass bottle rim	1	2

Table 5.7: Description of Glass residues

Context 1058

The glass from this context comprises 22 fragments of colourless and coloured flat glass (the colours include blue and green). The glass mostly comprises small circles (or fragments of circles) or pieces of glass from which circles have been cut (Figure 1). The size of the circles is comparable with those from context 1137, although all of the glass from context 1058 is flat. All of the glass from this context is a soda-lime-silica glass. The colourless glass contains low levels of iron and arsenic; the green contains chromium, iron and copper, the blue contains manganese, iron, cobalt, nickel copper and arsenic.

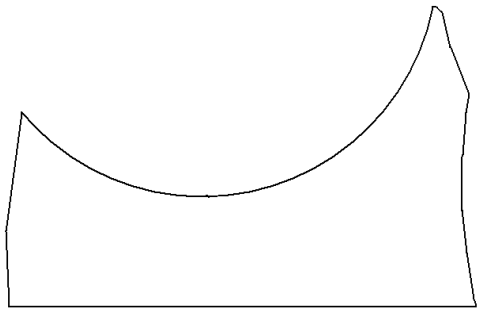

Figure 5.1. Sketch drawing of the green glass sheet from context 1058 (scale 1/1).

Context 1063

This context yielded small quantities of colourless and red glass (small find 84 comprising only colourless glass and small find 85 comprising both colourless and red glass. The five small fragments of colourless glass recorded as small find 84 include one piece of flat glass, one very small piece of vessel glass with a moulded surface comprising small roundels (1mm

diameter), a possible moil fragment and two small shards of glass. The colourless glass is a soda-lime-silica glass with a wide range of other elements detected (Fe, Mn, As, Sb, Pb). The moil fragment is significant as it implies that glass blowing took place. The colourless glass recorded as small find 85 comprises small chunks of glass with fracture surfaces. The pieces are thicker than most finished window or vessel glass but is comparable in thickness to the plano-convex glass artefacts from context 1137. These fragments may represent large chunks of working waste or fragments of large objects. This colourless glass has the same composition as that recorded as small find 84. The red glass recorded as small find 84 comprises small chunks of glass which like the colourless glass are too small/fragmentary to be certain whether they represent broken artefacts or working waste. The red glass is a soda-lime-silica glass but with zinc, cadmium and selenium (the last two elements responsible for the red colour).

Context 1137

This context contained two artefacts which may be fragments from the glass decoration components of the bedsteads.

The first consists of a plano-convex colourless glass artefact which was initially identified as a possible lens. The overall diameter 63mm, the height is 19mm and the plane surface has a small lip. The convex surface has striations but these do not appear to be the remains of any grinding or polishing action. There are no indications from the surface texture that the glass has ever been polished. The presence of the striations and lip on the plane surface suggest that the glass was formed by press moulding. The glass appears to be a soda-lime-silica glass. It contains small amounts of iron (but much greater than would be expected for an optical glass) as well as some manganese and arsenic which were probably added to the glass to counteract the colouring effects of the iron.

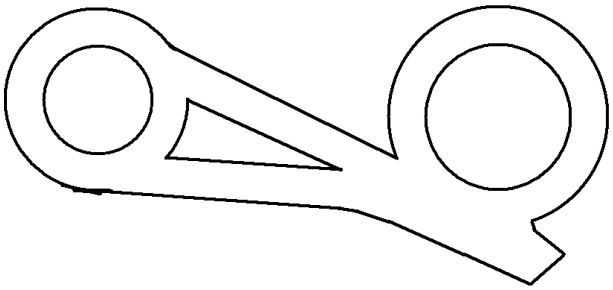

Figure 5.2. Sketch drawing of the lead-glass decoration small find 34a from context 1137 (scale 1/1).

The second artefact from context 1137 comprises one piece of flat glass and two plano-convex glass components (small find 34a, Figure 1) held together by I- or H-sectioned lead (calme). The use of lead calme for holding fragments of different coloured glass is well known for the production of decorative glass for windows (stained windows). The Cambridge Street example is unusual in several different ways. The glass components are generally rather small and the lead calme rather thick. In addition the two circular glass components are plano-convex rather than flat. The plano-convex shape of these glass components has a similar shape to the larger plano-convex glass artefacts from the same site (see above). The glass in this artefact (Figure 1) appears to have the same composition as the larger plano-convex artefact. Lead was detected It is likely that the arrangement of plano-convex and flat glass into decorative schemes and held together with lead calme was part of the production

of bedsteads. The rather thick lead calme would be sensible in this context as beds would be subject to more movement and stress than windows.

Context 1245

The only glass artefact from this context is a small fragment of very pale green glass from the rim of a narrow vessel. The external diameter is approximately 40mm and the internal diameter approximately 25mm. This glass fragment probably comes from the rim of a large bottle. The glass is a soda-lime-silica glass.

Discussion

The small assemblage of glass from Cambridge Street suggests the working of both colourless and coloured glass. Much of the glass comprises finished glass artefacts, however, the presence of a moil fragment indicates that some blowing of glass occurred. Glass blowing suggests that there must have been a furnace for melting glass on site. The glass lumps are difficult to interpret: they may represent fragments from relatively large finished artefacts or broken fragments of working waste. These lumps are too small and fragmentary to allow a positive identification of the process(es) which led to their creation. The size, shape and colours of most of the remaining glass fragments are consistent with the historically documented production of glass decoration for incorporation into bedsteads.

The coloured glass (blue, green and red) was coloured using carefully selected metal oxides. In all three cases at least one metal oxide was used to achieve a particular colour quality. The blue glass was coloured with cobalt, however, the presence of manganese, iron, nickel and copper. The green glass was coloured with chromium, although this was modified by the presence of copper. The red glass used both cadmium and selenium to achieve the red colour. The use of chromium as a colourant in a glass suggests a late 19th-century date at the earliest. The use of cadmium and selenium for the manufacture of a red glass suggests a very late 19th-century (or 20th-century) date at the earliest. Glass manufacturing technology in Britain in the late 19th century was generally uniform throughout the country and there is nothing about this glass assemblage which could demonstrate its manufacture in Birmingham.

Appendix 6: The Archive

ARCHIVE COMPONENT	DETAILS	QUANTITY			INDEX NO.	FILE	BOX
		A4	A3	other			
Project planning	WSI, Brief, Risk Assessment etc.	63	1		1/1	1	1
Documentary research	Various	87	4		1/2	2	1
Site survey records	Levels	1			1/3	6	2
	Station Data	2				6	2
Notebooks/ diaries	Area Plan		1		1/4	5	2
	Notes	6					
Trench records					1/5		
Group Sheets	Index and Sheets	62			1/5/3	7	2
Context records					1/6/1	6	2
Feature records	Intergrated and kept in numerical order	585			1/5/2	8-9	3-4
Building recording records					1/7		
Matrices					1/8		
Small finds records		4			1/9	6	2
Bulk finds records	Brick and Discard Register	2			1/12	6	2
Sample records		2			1/13	6	2
Skeleton records					1/14		
Finds and sample box lists					1/16		
Photographic records		43			1/17	11	6
Photographs	12 Films of Colour Slide				1/18		7
	Black and White Contacts			12		12	6
	Black and White Negatives			12		12	6
Digital Photographs	3 CD's				1/18		7
Field drawings	List	4			1/20	10	5
		4	60			10	5
	Annotated print outs	1	2			10	5
Interim reports					1/21		
Correspondance	emails and letters	13			1/26	3	1

Table 5.8: Site Archive

ARCHIVE COMPONENT	DETAILS	QUANTITY			INDEX NO.	FILE	BOX
		A4	A3	other			
Assessment reports and					2/1		
updated project designs							
Analytical trench records					2/5		
Analytical context records					2/6		
Analytical building records					2/7		

ARCHIVE COMPONENT	DETAILS	QUANTITY			INDEX NO.	FILE	BOX
Phasing/ matrices					2/8		
Analytical finds records					2/9		
Conservation records					2/10		
X-radiographs					2/11		
Analytical bulk finds records	Notes and Annotated Sample Lists	6			2/12	4	1
Analytical sample records					2/13		
Analytical human bone records					2/14		
Analytical animal bone records					2/15		
Integrated analytical records					2/16		
Photographic catalogues	Finds Shots-Thumbnails	4			2/17	4	1
Drawing catalogues					2/19		
Analytical drawings		1	17		2/20	4	1
Specialist reports					2/22		
Archive reports					2/23		
Published reports					2/24		
Ancilliary publications					2/25		
Correspondance					2/26		
Project management					2/27		
Digital Archive	Number/ location of CDs and disks		**NUMBER**		n/a	**BOX**	

Table 5.9: Research Archive

MATERIAL	CONTEXTS	COUNT	WEIGHT (G)
Brass/ Cu Alloy	34	173	5,639
Lead	3	3	65
Fe/ Fe composite	25	39	31,658
Slag	19		16,490
Lead/ Glass Composite	1	1	63
Glass	16	32	3,739
Ceramic Building Material			
Pottery	14	28	1,162
Clay Tobacco Pipe	5	8	27
Bakelite	3	3	36
Wood	3	3	150
Leather	5	5	592
Bone	4	6	61
Worked Bone	2	3	<1

Table 5.10: Material Archive

Appendix 7: The Brief

BIRMINGHAM CITY COUNCIL
DEVELOPMENT DIRECTORATE
Proposed New Library of Birmingham, Cambridge Street (centre SP 0631 8687; SMR 20828 and 20829)
Design Brief for *Archaeological Excavation* in advance of commencement of development

1. Summary

*Proposed development of the Library of Birmingham includes the site of buildings belonging to John Baskerville's house, former canal wharves, the Union Rolling Mill and brass and iron works and is therefore likely to affect below-ground archaeological remains. Following desk-based assessment, evaluation and observation of geotechnic test pits that demonstrated good survival of below-ground archaeological remains, this brief is for **archaeological excavation in advance of commencement of development followed by analysis and publication of the results**.*

2. Site location and description

The site is bounded by Cambridge Street on the north, the Repertory Theatre on the west, Baskerville House on the east, and part of on the south. It is currently occupied by a surfaced car park and by grassed and paved surfaces within Centenary Square.

3. Planning background

The proposed development consists of built development, including basements, across the entire site. Because the site is known to include archaeological remains which would be affected by the proposed redevelopment, **archaeological excavation is required in advance of commencement of development, followed by analysis and publication of the results.** This is in accordance with Policy 8.36 of the City Council's Unitary Development Plan, the City Council's Archaeology Strategy which has been adopted as Supplementary Planning Guidance, and government advice in Planning Policy Guidance Note 16, "Archaeology and Planning".

4. Existing archaeological information

An archaeological desk-based assessment carried out in October 2006 included historic maps and documents and suggested that there are well-preserved archaeological remains on the site, including buildings belonging to John Baskerville's house, a former canal wharf, and the Union Rolling Mill which became part of Winfield's Cambridge Street Works. The Cambridge Street Works included metal rolling, gas fitting, brass founding, carpentry, and wire manufacture.

An archaeological evaluation carried out in 2008 consisted of four trenches in the existing car park. Archaeological features and deposits were found in all of the trenches, and consisted of the former canal and associated towpaths and infrastructure, and industrial structures including walls, a chimney, machine bases and floor surfaces. All of the archaeological remains dated from the 19th to the early 20th century. The excavated structures could not be closely dated but three phases were identified, from stratigraphic relationships and brick type and form. The archaeological structures and deposits correlate well with the historic maps and plans, and supplement this information with details about internal features and structures.

Geotechnical test pits were excavated in January and February 2009 in both the existing car park and the adjoining part of Centenary Square, and archaeological features exposed in them were recorded. Within the existing car park the test pits confirmed the results of the evaluation trenches and demonstrated extensive survival of structural remains, including the canal arm, at the depths located in the evaluation. In the part of the site currently occupied by Centenary Square, which was not included in the evaluation, the test pits revealed a number of features including a parallel canal arm to at under the car park.

In summary, the evaluation and test pits demonstrated the exceptional survival of archaeological remains within the site and demonstrated how they can enhance our knowledge and understanding of internal structures shown on historic maps and plans.

5. Requirements for work

The desk-based assessment, archaeological field evaluation and observation of geotechnic test pits indicate the presence of well-preserved archaeological remains which would be affected by the proposed development. Archaeological excavation is therefore required in advance of commencement of development to ensure that these remains are investigated and recorded, followed by analysis and publication of the results.

The aims of the excavation are as follows:

(i)To fully investigate the archaeological features and deposits on the site.
(ii)To recover and analyse industrial residues of all kinds;
(iii)To identify and date phases of development of the site and the functions of different parts of it
(iv)To relate the excavated structures to the documentary record
(vi)To relate the historic development of the site to that found by excavation on nearby sites and to other sites or similar type elsewhere.

6.Stages of work

(i)Excavation:

Extent: Archaeological excavation of the whole of the site is required.

Method: All surface deposits are to be mechanically removed, using a toothless bucket, under archaeological supervision. Subsequent excavation is to be entirely manual and to be in accordance with a strategy agreed with the Planning Archaeologist. The strategy will include:

-identification and manual excavation of structures and deposits. The proposed proportion of excavation of each type of structure and deposit must be specified in the written scheme of investigation and agreed with the Planning Archaeologist in advance of commencement. Where deposits are extensive and/or deep, mechanical removal following partial manual excavation, under archaeological supervision, to expose underlying deposits and features, may be required subject to specific agreement of the Planning Archaeologist

-sampling of deposits likely to contain industrial residues. An appropriately qualified specialist must advise on-site on sampling locations and methods
-finds are to be cleaned, marked and bagged and any remedial conservation work undertaken.

(ii)Post-excavation Assessment:

An assessment of the potential of the results of the excavation for further analysis, in accordance with the recommendations in English Heritage's *Management of Archaeological Projects*(MAP 2*)* and *MoRPHE*. The post excavation assessment should be completed within six months of completion of work on site.

(iii)Post-excavation Analysis:

Following assessment, full analysis of the results of the project, including: dating and interpretation of excavated features; pottery and other finds analysis; analysis of industrial residues by an appropriate specialist or specialists; discussion of the results in their local, regional and national context, including relating the excavated features to documentary evidence for the site and nearby sites.

(iv)Preparation of a report for publication in an archaeological journal:

A written report accompanied by appropriate illustrations is to be submitted for publication in the *Transactions of the Birmingham and Warwickshire Archaeological Society* or other appropriate archaeological publication.

7. Standards and Staffing

The archaeological excavation is to be carried out in accordance with the Code of Conduct, Standards and Guidelines of the Institute for Archaeologists, and in accordance with English Heritage's Guidelines *Science for Historic Industries*, and all staff are to be suitably qualified and experienced for their roles in the project. It is recommended that the project be under the direct supervision of a Member or Associate Member of the Institute for Archaeologists.

8.Written Scheme of Investigation

A written scheme of investigation for the excavation which details methods (including provision for analysis of industrial residues) and staffing (including appropriately skilled specialists for post-excavation analysis) must be submitted to the Planning Archaeologist for approval in advance of commencement of work.

9. Monitoring

The excavation must be carried out to the satisfaction of Birmingham City Council, and will be monitored by the Planning Archaeologist. At least five working days' notice of commencement of the excavation must be given to the Planning Archaeologist, so that monitoring meetings can be arranged. The monitoring stages will be as follows:

(i)Consideration of excavation strategy;
(ii)Site visits during excavation, at least weekly;
(iii)Consideration of post-excavation assessment report;
(iv)Monitoring post-excavation analysis;
(iv)Consideration of draft report for publication

10. Archive deposition

Subject to the agreement of the site owner, it is recommended that the written, drawn and photographic records of the excavation, together with any finds, are deposited in Birmingham Museums and Art Gallery, within a reasonable time of completion. The deposit will be accepted in accordance with the guidelines issued by the Society of Museum Archaeologists, *Transfer of Archaeological Archives to Museums*. Finds must be deposited in the standard boxes used by the City Museum and accompanied by box lists.

11. Summary Publication

In addition to the full report described in Part 6 above:

(i)The contractor must submit a brief summary report to the Planning Archaeologist within two weeks of completion of work on site, so that initial information can be included in the Sites and Monuments Record. The summary should consist of no more than two pages of text and should be accompanied by photographs.
(ii)The contractor must submit a short summary report for inclusion in *West Midlands Archaeology* and summary reports to appropriate period journals.
(iii)On completion of the project the contractor must complete the obligatory fields of the OASIS form and submit an electronic version of the report to OASIS (http://ads.ahds.ac.uk/oasis)

BIRMINGHAM CITY COUNCIL
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