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FORMER SOHO GLASSWORKS,
LODGE ROAD, WINSON GREEN,
BIRMINGHAM, WEST MIDLANDS

Historic Building Record and
Archaeological Evaluation,
February 2008

UNIVERSITY OF BIRMINGHAM

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By

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For

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SUMMARY

This report summarises the results of a programme of historic building recording and archaeological evaluation carried out by Birmingham Archaeology in advance of redevelopment of the site of the former Soho Glassworks at Lodge Road, Winson Green, Birmingham, West Midlands (NGR: NGR SP 051 883)

The Soho Glassworks was established in 1805 on land owned by Samuel Shakespear and was, during its lifetime, associated with some of the principal names of the Birmingham glass industry. Its glasshouse, erected adjacent to the Soho Branch Canal, was the second canalside glasshouse built on Birmingham Heath. Originally in the hands of Shakespear, Johnson and Berry the works was sold in 1850 to John Walsh Walsh, who was to become one of the most prominent glass manufactures of his day, and the factory continued for many years to produce a wide range of high quality glassware. A second glasshouse was erected to the east in c.1866.

The site of the glassworks was taken over in 1952 by the Ford Motor Company who undertook a radical reordering, a process that involved the demolition of a large part of the glassworks era buildings. The building stock of the factory premises as recorded has been shown to date principally to the later years of the occupation of the site, mainly to the period between the 1930s and the 1950s, though elements of a number of earlier, pre-1930s structures survive. No element of the 19th-century glassworks complex was identified as surviving above ground. Throughout, the architecture is essentially utilitarian in nature and is of no inherent merit, the single exception being the main 1950s office range fronting onto Lodge Road to the south. This structure, as built, was of some architectural pretension with extensive use being made of glass-block walling.

Below-ground survival of a series of tunnels associated with the remains of the earliest glass cone (c. 1805) and a later glass-house (c. 1860—1870) were located beneath the remains of the present factory buildings. At least three phases of tunnels were revealed. The earliest were associated with the original works of 1805. A second phase was associated with the addition of the glass house and a third phase related to alterations during the early part of the 20th century.

The excavation of series of five evaluation trenches revealed a series of structures related to the period of manufacturing beginning in the early-19th century. Trench 1 provided limited evidence of human intervention apart from the insertion of a modern ceramic and concrete drainage pipe. Trenches 2 to 5 revealed structural and residual evidence of the 19th century glassworks buildings including the main areas of manufacturing (glass cone) and the workshop areas around the periphery.

The truncated foundations of the circular glass cone, along with the remains of a building extension attached to its exterior were exposed in Trench 2. The identified remains are likely to represent two phases of construction from this early-19th century period. A series of brick floor surfaces constructed over the early-19th to 20th century periods, were exposed in Trenches 3 and 4. These represent the remains of workshop buildings likely to have housed the glass finishing processes. Further structural evidence, of 19th to 20th century origin, was identified within Trench 5.

A range of process residues and construction materials relating to the period of the glassworks were identified in Trenches 3 and 4. These can be grouped into the discarded remains of the glass products, broken lumps of raw glass, sieges and furnace bricks.

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1 INTRODUCTION

1.1 Background to the project

Birmingham Archaeology was commissioned by Morris Homes (West Midlands) Ltd. to undertake a programme of historic building recording and archaeological evaluation at the site of the former Soho Glassworks, Winson Green, Birmingham, West Midlands ahead of the redevelopment of the site for residential purposes.

Planning permission (Application No. C/04024/03/OUT) has been granted for the residential redevelopment of the former Soho glassworks site. As a condition of planning permission, and in accordance with Policy 8.36 of Birmingham City Council's Unitary Development Plan, government advice in Planning Policy Guidance Note 16 (DoE 1990) and the City Council's Archaeology Strategy (Supplementary Planning Guidance), a programme of archaeological evaluation and building recording was required to be undertaken ahead of any works.

Archaeological work was undertaken in accordance with a Written Scheme of Investigation (WSI), prepared by Birmingham Archaeology (Birmingham Archaeology 2007, Appendix B), and in response to a Project Brief issued by Birmingham City Council Development Directorate (BCC 2006, Appendix A). The Historic Building Record has been made in accordance with English Heritage's 'Understanding Historic Buildings; A Guide to Good Recording Practice' (English Heritage 2006a) and the Institute of Field Archaeologists 'Standard and Guidance for the Archaeological Investigation and Recording of Standing Buildings or Structures' (IFA 2001a). The archaeological evaluation was undertaken in accordance with 'Standards and Guidance for Archaeological Evaluation' (IFA 2001b).

1.2 Site Location and Geology

The proposed development site was located on the northern side of Lodge Road, to the east of the centre of the suburb of Winson Green, and 2.5 km northeast of the City Centre of Birmingham, West Midlands (centred on NGR SP 051 883; see Figure 1). The site was bounded to the south by Lodge Road, to the north by the mainline Wolverhampton to Birmingham railway, to the east by the infilled basin of the former Soho Branch canal and to the west by the rear gardens of (late-20th century) properties fronting onto Hobson Close. The present state of the site comprises upstanding, derelict factory buildings of the Ford Motor Company (who occupied the site from 1952) and associated yard areas.

The site boundary contains no Scheduled Ancient Monuments (SAMs) or Statutory Listed Buildings; it is, however, included on the Birmingham City SMR, unique reference number SMR20052.

The solid geology of the site consists of a Bromsgrove Sandstone (formerly known as Keuper Sandstone) ridge that runs below Birmingham from the southwest to the northwest, a

geological fault in this has resulted in a sharp ridge falling away from the centre of the city, towards the River Rea valley floor. Towards the south and east of this the underlying solid geology of Birmingham is Mercia mudstone (formally known as Keuper Marl). The drift geology consists of some sand and gravel boulder clays, with some alluvial deposits on the Rea Valley floor. (Hodder 2004, 11)

2 AIMS AND OBJECTIVES

2.1 General Aims

The principal aim of the programme of archaeological work, as stated in the WSI (Birmingham Archaeology 2007) was to determine the character, extent, date, state of preservation and potential significance of the upstanding buildings and buried archaeological remains.

Specifically, the programme of work was designed to record and understand the following:

- The structural details of the former glass cone and associated structures belonging to the glassworks.
- Evidence for alterations and additions to the structures over time and their relationship to the processes and products of the industry.
- Similarities and differences between the structural remains and those of other surviving and excavated glassworks in the West Midlands area.
- The implications for the likely survival and significance of below-ground archaeological remains at other glasswork sites in Birmingham.

2.2 Specific Aims

It was anticipated that glass waste and residues would be recovered. The sampling of industrial residues complied with the guidelines set out in the 'Science for Historic Industries' (English Heritage 2006b).

Specifically the aims were to recover and sample;

- Sieved samples of working surfaces to recover glass fragments.
- Glass samples from in and around the cone for identification of type and raw material.
- Sample deposits of material for identification (clay for crucibles, glass raw materials).
- Sample fuel for identification.
- Sample residues of the glass making process such as un-worked glass lumps and crucible waste.

At the evaluation stage sampling sought to identify the potential for analysis within further stages of archaeological work. Glass residues were sent to Dr. David Dungworth (English Heritage) for specialist analysis.

3 METHODOLOGY

3.1 Documentary Research

No significant new documentary research has been undertaken as a part of the current programme of work, though reference has been made to a desk-based archaeological assessment related to the site, previously undertaken by Birmingham Archaeology (Ramsey, 2004). Reference has been made to readily available cartographic sources, and to a series of original planning design drawings held by the Birmingham City Archives, to illuminate more recent evolution of the standing building stock. Supplementary documentary research has been undertaken by industrial specialist Peter Bone (PWB Archaeology) and incorporated into this text.

3.2 Historic Building Recording

A full written, drawn and photographic record of the standing buildings was made in advance of demolition, as follows:

3.2.1 The Written Record

The written record of the factory complex on a building-by-building basis was made using *pro forma* building recording sheets.

3.2.2 The Drawn Record

A measured survey was made of the current layout of the building, including the below ground passages and cellars to the eastern side of the site. Survey extended to floor plans of all principal buildings at each floor level and the recording of selected elevations where they could be demonstrated to relate to the earlier phases of the glassworks development. Survey was undertaken by a combination of reflectorless EDM and hand measurement, drawings being produced at an appropriate scale (plans at 1:100 plans, elevations at 1:50). A survey of comparative levels sought to relate the levels recorded in the standing buildings and cellars to the remains exposed within the evaluation trenches.

3.2.3 The Photographic Record

The photographic survey comprised monochrome print accompanied by high-resolution digital photography. Where possible, photographs included a graduated photographic scale. Details of photographs were recorded on *pro forma* index sheets, and included location, subject and orientation.

3.3 Archaeological Evaluation

3.3.1 Fieldwork

The Phase 1 evaluation was undertaken before any demolitions were due to take place. It consisted of *c.* 80m length of excavated trenches by 1.8m width in currently open accessible areas of the site. Trenches were located in order to attempt to locate 19th-century survival of the glassworks as defined on the historical map evidence outlined in the desk-based assessment (Ramsey 2004). Trial-trenches were surveyed-in using an EDM total station and planned using traditional drawing methods.

Some of the dimensions of the trenches were adjusted from those of the proposed dimensions due to unforeseen factors such as live underground services, the total trench coverage remained within the scope of the project.

The evaluation involved the following trenches; these were located for the investigation of specific areas:

Trench 1 12.5m x 4m– designed to examine workshops at the south of the site as defined on the plans of 1935.
Trench 2 15m x 4m– designed to examine the survival of the former glass cone.
Trench 3 20m x 1.8m– designed to examine workshops on the west of the site.
Trench 4 10m x 1.8m– designed to examine the extent of workshops to the north of the site.
Trench 5 10m x 1.8m– designed to examine the possible survival of buildings depicted on the Piggot-Smith maps of 1852 in the northwest of the site.

The excavation of the trenches was preceded by the removal of hard-standing using a mechanical breaker. Further to this, all modern overburden was removed using a JCB type mechanical excavator with a toothless ditching bucket below the hard-standing material, under direct archaeological supervision, down to the top of the uppermost archaeological horizon or the subsoil. Subsequent cleaning and excavation was done by hand. A representative sample of archaeological features and deposits were manually sample excavated sufficiently to define their character and to obtain suitable dating evidence. The structural walls were defined and slots were excavated to confirm their foundation depth. Archaeological deposits were not completely excavated unless this was unavoidable. The depth of archaeological deposits across the site was assessed, although it was not possible to excavate the full length of every trench down to the natural.

All stratigraphic sequences were recorded, even where no archaeology was present. Features were planned at a scale of 1:20 and 1:50, and sections were drawn of all cut features and significant vertical stratigraphy at a scale of 1:20 and 1:50. A comprehensive written record was maintained using a continuous numbered context system on *pro forma* context and feature cards. Written records and scale plans were supplemented by photographs using monochrome, colour slide photography for archive supplemented by high quality digital photography.

Recovered finds were cleaned, marked and remedial conservation work was undertaken as necessary. Treatment of all finds conformed to guidance contained within 'A strategy for the care and investigation of finds' published by English Heritage (English Heritage 1995).

The full site archive will include all artefactual and/or ecofactual remains recovered from the site. The site archive will be prepared according to guidelines set down in Appendix 3 of the 'Management of Archaeology Projects' (English Heritage, 1991), the 'Guidelines for the Preparation of Excavation Archives for Long-term Storage' (Walker 1990) and' Standards in the Museum Care of Archaeological collections' (Museum and Art Galleries Commission, 1992). Finds and the paper archive will be deposited with Department of Human History, Birmingham Museums and Art Gallery subject to permission from the landowner. They will be deposited in the standard boxes used by the City Museum and accompanied by archive lists.

4 HISTORICAL AND ARCHAEOLOGICAL BACKGROUND

4.1 General Historical Background

The archaeological and historical background of the Soho Glassworks site has been the subject of a previous Archaeological Desk-Based Assessment (Ramsey, 2004); the following historical account is based for the most part upon this earlier assessment and is repeated here for reasons of completeness.

Glass has been produced in England since the Roman period, although field evidence for pre-medieval manufacture is scarce. Material from the wood-using industry which existed from the 13th century to the early years of the 17th century is, however, wide-spread, and in most forest areas there were furnaces, though not on the scale of the Weald of Surrey and Sussex where the industry was concentrated. The English industry is unique in having undergone a sudden and total change to the use of mineral fuel, in the decade before 1620. This brought about a shift in location, and the industry was to remain closely connected with suitable coal-fields until recent years (Crossley 1993, 3).

From the mid-17th century, England became a major centre of European glass making and in the next hundred years it underwent a revolution in process techniques with changes to the fuel used and the scale and design of glassworks. Reduced taxes, growing demand and new forming techniques in the nineteenth century brought further improvements, which continued into the early 20th century. The flint glass industry was always, craft based, high skill and labour intensive which led to decline in the post war period (Bone pers comm.).

The abundance of local fuel and resources needed to produce glass such as high quality fireclay for glass-making pots and crucibles, found chiefly around Stourbridge, combined with the vastly improved infrastructure created by the construction of the canals, led to a boom in the industry within the Birmingham and Black Country region during the 19th century. The production of glass toys and trinkets was an important constituent of the overall trade in these goods for which Birmingham especially became renowned, and the Soho Glass Works itself was at one time a major supplier of glass to the button industry.

High-quality vessel-glass production became concentrated in the West Midlands, with Stourbridge a centre with an international reputation for the production of quality crystal glass. The West Midlands as a whole saw the development of numerous small works, with specialisation in vessel and scientific products (Crossley 1993, 17).

The most striking feature of glass manufactories in Britain during this period was the conical brick structure known as the glasshouse cone. Not only did the cone act as a giant chimney for the furnace, creating a sufficiently strong updraft to enable an adequate temperature to be maintained, but it was actually inside the cone that the glassmakers worked, in the area between the circular furnace in the centre and the surrounding cone wall. The upper part of the furnace consisted of a low shallow domed chamber containing the clay pots in which the glass was melted, arranged in a circle. In the furnace wall above each pot there was an opening through which the glassmakers inserted their irons to gather the molten glass. Below the pots in the centre was the fire on an iron grate, to which air was conduced via an elaborate tunnel system running underneath the floor of the cone. At the base of the furnace was a stokehole through which a man known as the teaser fed the coals on to the fire (Dodsworth 1982, 13).

Effective annealing is an essential post production process. In the early works this would have been within or adjacent to the cone, where annealing was carried out as a batch process. Later it is likely to have been a lehr, which ware was hauled through on guided or tracked wheeled stillages. The floor of the annealing area and lehr would have been of tile or glazed brick and would show evidence of heat over a prolonged period (Bone pers comm.).

Many glassworks made their own pots, particularly in the first half of the 19th century. Later they tended to be bought in but still had to be 'conditioned' to reduce the moisture content before they could be used. The pot store would be close to the batching area (Bone pers comm.)

During the early 19th century, in England experiments and innovations in glass technology were hampered by regulations of the Excise Act. However, this was repealed in 1845, and by the time of the 1851 Great Exhibition a striking range of colours were being shown by several of the Birmingham and Stourbridge factories (Dodsworth 1982, 21).

The manufactories themselves changed considerably during the later-19th century. Glass cones ceased to be built after about 1830 although existing cones continued in operation. The new type of glasshouse was a much more anonymous structure, in the form of a large shed housing one or two furnaces connected to a giant central chimney that rose through a cast iron roof. The later-19th century factory was generally larger than its Georgian predecessor as all the different operations in glass making now tended to be concentrated on one site. The grander works had, besides several glass houses, their own potmaking and mouldmaking departments, cutting, engraving and etching shops, packing warehouse, storerooms and large areas for preparing and mixing the raw materials (Dodsworth 1982, 25).

The glass producing industry continued to evolve and change with new technologies. However, the rationale for the protection of nineteenth-century glass works structures has in the past been questioned, due to apparently plentiful written records, in a period when published journals and text-books commonly contained descriptions and diagrams of current practice (Crossley 1996, 9). In cities such as Birmingham, London and Manchester, most glass-works buildings have been demolished (Crossley 1993, 30). This view has been challenged by recent work which has shown how, in a period of rapid development in methods, structures were modified due to new innovations and experience, in ways which were not recorded by contemporary sources, but which are identifiable by submitting archaeological surveys to analysis by specialists in the technology of modern glass production (Crossley 1996, 9).

4.2 The Soho Glassworks

The first glassworks in Birmingham grew out of one of the town's major industries, the toy trade, with the first glasshouse being constructed by Mayer Oppenheim in 1757 on Snow Hill (Demidowicz and Hodder 1997, 101). The industry greatly expanded following the arrival of the canals, and by the mid-1800s the city had built a reputation for producing high quality goods. The Soho Glassworks was established in 1805 on land owned by Shakespear, and during its lifetime was associated with some of the principal names of the Birmingham glass industry. The glass house was located adjacent to the Soho Branch canal, which linked Soho Wharf and Matthew Boultons Soho Manufactury to the Birmingham Old Canal, and was the second canalside glass house built on Birmingham Heath; the first being the Park Glass House owned by Issac Hawker. The initial owner of the Soho Glass Works was a member of the Shakespear family who with Johnson and Berry were cut and plain glass and glass toy manufacturers.

The Shakespear and Johnson families were both involved in the glass industry of Birmingham at the beginning of the 19th century, as were other families that would be influential in the development of the glass trade for the next two centuries. Hudson and Shakespear are mentioned in the Birmingham Directory of 1791 as glass manufacturers based in Snow Hill and William Shakespear is recorded in the Birmingham Rate Books in 1794 and 1800 as owning a glasshouse on Lancaster Street and Snow Hill. The Soho Glassworks, built by William Shakespear, were a successor to the Lancaster Street Works. Shakespear and Johnson are mentioned in Holdens Triennial Directory (1805-7) as cut and plain glass and glass toy makers, New Town Row. William Shakespear was also recorded as a glass button and toy maker on Great Charles Street. Owen Johnson was recorded as a glass and glass toy manufacturer and dealer in cornelians at Islington (Fiveways). Bills relating to Matthew Boultons housekeeper from 1805 put Shakespear, Johnson and Berry (plain and cut glass manufacturers) at New Town Glass House. This may be the first reference to this new triumvirate/partnership. This early-19th century date of construction corresponds with the building of the canal since the Hockley Branch off the Soho Loop was opened in 1812 (Boughey 1994). Many glassworks were built at canalside locations since it facilitated the import of coal and raw materials and the distribution of a fragile product.

Bisset's Magnificent Guide, or Grand Corporate Directory for the town of Birmingham in 1808, mentioned only the most eminent public companies and records Owen Johnson in Islington. Chapman's Annual Directory of the same year describes Shakespear, Johnson and Berry as cut and plain glass, and glass toy makers at Birmingham Heath, the site of the Soho Glassworks. Seakspear (sic.) and Osler are also described as general manufacturers of chandelier furniture and toys in glass in Gt. Charles Street. A John Shakespear is recorded as a glass seller on Church Street and Thomas Osler as a glass cutter in St. Paul's Square. Other Johnsons and Berrys are also mentioned associated with the glass industry.

Household correspondence from the Matthew Boulton Papers dated to 1810 records Shakespear, Johnson and Berry as still being associated with New Town Glass House, and it seems likely that the partners were at this point working at both sites. Wrightson's Birmingham Directory of 1812 describes Shakespear, Johnson and Berry as plain and cut glass manufacturers at Soho Glass House, and Shakespear and Osler as chandelier furniture and toy manufacturers at New Town Row. The same directory (Wrightson's) of 1815 also describes Shakespear, Johnson and Berry as plain and cut glass manufacturers at Soho Glass House, with Jane Shakespear now occupying New Town Row.

On January 26th, 1816 the Aris Gazette ran an article on the Soho Glassworks:

'In succeeding to these premises WILLIAM SHAKESPEAR begs leave to return his most grateful thanks to all his friends and the public for the many favours conferred on him during his late partnership with Messrs. Owen Johnson and John Berry and while he respectfully solicits a continuance of those favours, he assures them it will be the constant study of himself and his present partner Mr THOMAS FLETCHER to merit the same.'

There are also housekeeper's bills from the Matthew Boulton Papers dated from 1816 related to Shakespear and Fletcher, plain and cut glass manufacturers, Soho Glass House, Birmingham. In the Commercial Directory of Birmingham 1816-17, the Soho Glass Works was under the control of Shakespear and his new partner, Fletcher. Johnson and Berry had at this time joined with Rice Harris at the Islington Glass Works. This remained for over ten years until Pigot and Co.'s National Commercial Directory of Staffordshire (1828-9) listed Shakespear and Son as glass manufacturers (flint) at Birmingham Heath (Soho Glass Works).

Wrightson's Directory of Birmingham (1833) describes Shakespear and Son as flint glass manufacturers. Pigots National and Commercial Directory of Warwickshire (Part 2) of 1835 states that, in this year, Hannah Shakespear and Son were present at Soho. The Directory of Birmingham, Coventry, Dudley, Wolverhampton and their immediate environs (Robson 1839) lists Samuel Shakespear at Soho Glass House but by 1849, the glassworks were held by the trustees of the estate of Samuel Shakespear, and remained in trust until 1850 (from Slater's Directory of Warwickshire). In this year (1850) the factory was purchased by John Walsh Walsh (Reynolds 1999).

In Slater's Directory of Birmingham 1852-3 the glassworks were first listed as the Soho and Vesta Flint and Coloured Glass Works, Birmingham Heath. John Walsh Walsh was also described in this directory as a manufacturer of soda water and mustard, and an importer of cigars. Thus began the career of one of the most prominent glass manufacturers of his day, one whose products are still held in regard today and are highly collectable. The history of John Walsh Walsh and the Soho Glassworks has been written about in detail (Reynolds 1999) and will be summarised here.

A letterhead/advert dated to around 1855 (Figure 3) describes John Walsh Walsh as the successor to Mr Samuel Shakespear, and a manufacturer of every description of flint, opal, enamel and coloured glass lamp and lustre work, chemical apparatus, lenses, shades, vases etc etc. John Walsh Walsh himself died in 1884 and the executors of the estate had the power to provide income by either continuing to operate, or to dispose of the business and decided to sell (ibid.). Ellen Eliza, a daughter of John Walsh Walsh from his first marriage, had married Birmingham businessman Thomas Ferdinand Walker, and she persuaded him to buy the glass business from the executors. Ellen Eliza was, therefore, successful in securing the long-term family ownership of the business (Reynolds 1999, 9).

Thomas Ferdinand Walker was, then, in effective control of the business, and appointed Lewis John Murray to manage it. Murray introduced many new designs which were also registered and patented to avoid copies (Reynolds 1999, 11). The introduction of new ranges increased production requirement far beyond the capacity of the existing factory, and in 1886 it was necessary to build a second furnace. The Pottery Gazette of 1888 reported that:

'Mr Walsh can still boast of being the only manufacturer in the fancy goods trade in the Midlands who has two furnaces at work.' (Reynolds 1999,12).

At this date a new furnace would probably have been accommodated in a louvered ventilated roofed building and may have been gas rather than coal fired. However, this would be dependent on a town gas supply or the manufacture of town gas on site.

The factory continued for many years to produce a wide range of high quality, highly desirable glassware, whilst continuing to introduce new ranges and patterns, and developing modifications of existing ranges in order to prevent imitation (Reynolds 1999, 15).

Following Lewis Murray's death in 1912, Philip Jeffrey Walker, John Walsh Walsh's grandson, took over the management of the firm (Reynolds 1999). A major addition to the product range during the period 1913-1915 was the development of the Koh-i-Noor cut pattern. This soon became extremely popular and was the flagship of Walsh production for many years (ibid, 17). Colour had never previously been a major feature of Walsh glass but the growing market awareness of the importance of colour during this period prompted experiments in various shades, including blue, that became a standard feature in bowls and vases (ibid, 18).

The years following the 1914-1918 war were difficult for Walsh, but attention was now directed towards rebuilding the company's original skills base. Walsh employees were respected in the trade as some of the most experienced and versatile glass workers in the country (ibid., 19), these skills included cutting, acid etching and other glass working techniques. Many reports from several generations of the families employed at the Lodge Road Glassworks also gave a favourable view of the factory's working conditions (Reynolds 1999, 19).

In 1922, conversion to a private limited company was arranged with a registered capital of £10,000. One of the first actions on becoming a limited company was the registration of the trademark 'WALSH' which was later modified to include 'ENGLAND'. Following this William Riley (whose wife was the great-granddaughter of John Walsh Walsh) was appointed managing directory in 1927 and continued in this position until the demise of the factory in 1951. In 1929 a specific trademark 'VESTA' was registered for the Twelve Labours of Hercules series of lighting panels designed by the sculptor Walter Gilbert, though the manufacture of these appears to have been limited to the period 1929 to 1932 (Reynolds 1999, 22).

The period between 1930 and 1945 was one of the most exciting in the history of John Walsh Walsh, and as the country recovered from the 1930's recession, Riley courageously embarked on a major reconstruction and investment programme (Reynolds 1999, 24). The furnace facility was rearranged with the installation of new equipment controlled by the most recent developments in measuring techniques. The annealing department was reorganised with the object of increasing output as well as improving quality (ibid, 24). Riley recognised that an effective way to expand was to acquire businesses which were manufacturing complementary, but not identical, products. His foresight in purchasing Hands, who primarily manufactured commercial and industrial lighting, and Robinsons, manufacturers of contract orders for hotels and shipping lines, would impress many business tycoons of the late-20th century (ibid, 24)

In 1933 there was a move away from the almost total dependence on the complex, decorative cut patterns of the past twenty years, to the inclusion of simpler forms of flute cut patterns, and the designs of Clyne Farquharson, who had been a designer for the company since he was a young man, became prominent (Reynolds 1999, 27). However, the outbreak of the Second World War brought an end to the rising fortunes of the company. As employees were called up to serve, simpler patterns were introduced to combat the shortage of labour. These were primarily for export, targeted at the American and Australian markets with only a limited availability in the home market. An increasing amount of capacity was directed towards the wartime effort by transferring resources to products required in the medical and scientific fields (ibid., 28) as well as lighting arrays for the RAF.

Of all the glassworks in Birmingham, only two, those of John Walsh and F & C Olser, survived beyond the second world war and by 1951 part of the Soho Glassworks had been turned into The British Heat Resisting Glass Co. Ltd. at 112a Lodge Road (Kelly's Directory of Birmingham 1951). The inability to restore the company's former worldwide reputation gradually eroded the will and determination of the management team. The cut glass department continued to be more and more uneconomic, and a decision was taken in 1949 to close this down. Without a core product line the future of the business was in serious jeopardy, and the final closure of the factory was announced in the autumn of 1951 (Reynolds 1999, 38). The site of 112a Lodge Road continued to be owned by The British Heat Resisting Glass Co. Ltd, and the site of the Soho Glassworks was taken over by The Ford Motor Company (Kelly's Directory of Birmingham, 1952).

4.3 Map Regression

The first cartographic evidence relating to the site of the Soho Glassworks is Snape's 1801 Enclosure map of Birmingham which depicts Shakespear's plot of land adjacent to the Soho Branch Canal and Lodge Road. Kempson's map of 1810 (Figure 4) illustrates the circular glass cone and two rectangular associated buildings, one parallel to the road and one parallel to the canal. Neither the glassworks nor the canal are depicted on the map of 1832, though the glass cone is depicted on Guests map of 1855, annotated as *'Shakespears Glasshouse'* though the documentary evidence records reveal that the works were, by this time, owned by John Walsh Walsh.

The Board of Health Survey maps (1850-55) and John Piggot Smith's map of 1855 (Figure 5) depict the works in much fuller detail. The outline of the glass cone is visible in the southeast corner of the site, surrounded by adjoining buildings. To the northwest of the cone was a yard with a possible well, flanked by blocks of buildings on the north and east sides. To the east of the cone there was an open area adjacent to the canal, and to the northeast another range of buildings enclosing a smaller courtyard. To the west of the works a house with a semi-circular path and formal gardens is depicted. Bloods map of 1857 only depicts the outline of the works, and is annotated Soho and Vesta Glassworks.

The Ordnance Survey 1st Edition (dated to 1889, Figure 6) illustrates important changes within the glassworks. While the majority of the building outlines remain the same, the open area adjacent to the canal depicted on the 1855 maps was by now occupied by a second glasshouse known, from documentary sources to have been built *c.*1886. The site is annotated Soho and Vesta Glass Works, and the house adjacent to the works identified as Vesta House.

The layout of the site at this time bears comparison with the Richardson factory in Wordsley, established in 1825 (Dodsworth 1982, 24). The Richardson factory was another canal-side glassworks that possessed two glasshouses, one with a traditional cone, the other of the new chimney type incorporated into the same building block (ibid.). The plan of the factory is similar to the Soho Glassworks with the glasshouses surrounded by adjoining buildings, and with a courtyard flanked by rectangular buildings divided into stores, acid and cutting shops and offices. It was clearly the intention of the grander 19th-century factories to be as self-sufficient as possible (ibid.).

The Ordnance Survey maps of 1905 (Figure 7) and 1918 depict only minor changes to the works, mainly concerning the peripheral buildings. By 1905 the railway had been cut through the area immediately to the north of the site, and by 1918 part of the canal had closed, ending at the Soho Wharf Basin within the study area. The factory itself, however, was still probably supplied by the canal. Building plans drawn up by Dallas and Lloyd Architects, Newhall Street, Birmingham in 1930 and 1934 clearly illustrate the specifics of the reconstruction and investment programme embarked upon by William Riley. Also, more interestingly, it is possible from the annotation of the existing buildings to pinpoint which parts of the factory complex were being used for specific purposes.

Design drawings dated to 1930[1] (Figures 9 and 10) illustrate details of a proposed new stores building (Building K, see §.5.15) to the northeast of the glass cone. It also depicts coal bunkers situated directly adjoining the northeast wall of the cone near to where the canal access was, as well as a cone cleaning room and a sand washing room. Earlier buildings incorporated into the design of the new works include a crate shop, stock room, shade store, blue lining room,

[1] Birmingham City Archives, Building Drawing Register Ref. No. 52546.

cleaning room, acid polishing shop, acid store, Earnshaws cutting shop and a boatman's room next to the canal.

Design proposal drawings from March 1934[2] show a *'new works'* building (and associated transformer house) immediately to the north of Vesta House, west of the current development site, in an area previously occupied by gardens. The building comprised two parallel ranges of steel frame construction with double, inverted Howe configuration trusses and a part-glazed, corrugated iron roof. More significantly, however, are design drawings from April 1934[3] (Figures 11 and 12) for *'extensions to the glassworks'* to the east of the large glass cone. This plan describes the original cone as the *'large glass house'* and the newer (1886) building to the east as the *'small glass house'*.

The Ordnance Survey map of 1954 (Figure 8) illustrates the plot of 112 Lodge Road as two separate entities, the Glass Works and the Motor Research Works. The Glass Works would have been owned by The British Heat Resisting Glass Co. Ltd and occupied Vesta House and the new building erected in 1934. However, a new factory had been constructed on the site of the main glassworks, which was owned by the Ford Motor Company from 1952; it is these buildings that, for the most part, survive on the site today.

[2] Birmingham City Archives, Building Drawing Register Ref. No. 60035/60735.
[3] Birmingham City Archives, Building Drawing Register Ref. No. 60307.

5 BUILDING DESCRIPTIONS

5.1 General Arrangements

The development site extends to a total area of 0.8ha and includes a series of derelict factory buildings dating, for the most part, to the mid-20th century. The eastern part of the site comprises the former basin of the Soho Branch Canal (1801, infilled) and associated Soho Wharf. The northeastern boundary wall constitutes the boundary wall to the mainline Wolverhampton to Birmingham railway line, established as the Birmingham Wolverhampton and Dudley Railway by an act of parliament of 1846. The surviving factory buildings are arranged generally to east and west of a long, north to south aligned range which runs perpendicular to Lodge Road to the south. The buildings to the east of this range are laid out principally to respect the former wharf, while to the west, two contemporary ranges are aligned parallel to Lodge Road, abutting the north to south range to the east; the southern of these ranges, the main office range of the complex, is set back somewhat from the road behind a small yard area which it is bounded to the south by a brick constructed wall (Plates 1 and 2). Principal access to the complex is via a gateway to the western end of the southern boundary wall (Gate 1, Figure 2); two further gates to the eastern end of the wall give onto a loading platform area (Gate 2) and onto a ramp descending to the former wharf area (Gate 3). A total of 19 structures were recorded as part of the current programme of work. These structures were assigned the letters A - S during the recording process, and the system has been adhered to within the flowing descriptions; locations of buildings are illustrated in the site layout plan (Figure 2).

5.2 Building A

Building A comprises a small, two-storey, flat-roofed block of five bays, aligned approximately north to south and located to the western side of the main factory entrance gate at the southwestern corner of the development site (Plates 2-3). The northern two bays of the block project forward slightly to the east while, at the southern end of the block is a small, single-storey projection with a curving wall to the southwest corner (Plate 2). The building is brick built, in red-brick laid to English garden wall bond with seven stretcher courses between header courses. The single-storey street elevation (Plate 4) includes a single window and pedestrian doorway, with a further window occupying the curving section of wall to the east. Window and door jambs are enhanced by alternate projecting brick courses, and the windows have projecting concrete cills and head detail (the latter being continuous; Plate 2). The elevation is capped by a single soldier course of headers and projecting concrete coping. The east elevation of the main two-storey block has a continuous range of sliding, garage doors to ground floor level with regular fenestration of steel framed windows to first floor (Plate 3). The projecting bays to the north end of the elevation include a further double-width opening and a single, pedestrian door giving onto a straight-flight stair rising to first floor level. The north elevation of the building is of roughly finished brick, partly rendered and includes a blocked doorway at its western corner; the elevation shows no obvious traces of a former northern continuation, though reference to the Ordnance Survey edition of 1954 (Figure 8) indicates that the building was formerly continuous with the range backing onto Vesta House to the north and east.

Internally, the ground floor is divided into three spaces corresponding to the single storey street projection, the central section served by the sliding garage doors, and the northern two

bays. Flooring is in concrete throughout. The first floor, of concrete construction and supported on transverse RSJs, is accessed via the straight flight stair rising against the north wall of the building. The first floor originally formed a single open space, though it has been sub-divided by a series of inserted studwork partitions. It is lit by regular steel framed windows in the east wall and by a ridged and hipped rooflight above the northern two bays. A single door opens in the south wall onto the roof of the single-storey projection.

The roof of the structure slopes slightly from west to east and is supported on three RSJs from which rest on projecting piers of brick to the west; it is clad in corrugated asbestos sheeting carried on three tiers of RSA section purlins.

5.3 Building B

Building B forms the principal office range of the factory complex and comprises a two-storey, flat roofed structure (partly basemented), aligned approximately east to west, parallel to Lodge Road from which is separated by a small yard area (Building B1; Plate 7). At its eastern end, the office range returns southwards (Building B2; Plate 1), extending as far as Lodge Road, where it forms a singular, uniform elevation with the southern gable end of Building D. Both sections are of steel-framed construction, clad externally in brick and share a common vocabulary of features and detailing indicating that they are contemporary.

5.4 Building B1

The principal elevation faces to the south (Plate 4); it is of nine bays (here numbered 1 to 9 from east to west), clad externally in brick laid to English garden wall bond with seven stretcher courses between header courses, and is liberally fenestrated at both ground and first floor levels. The principal entrance door is located at the centre of the elevation (Bay 5), projecting forwards from the wall plane, furnished with a flat hood and flanked by tapering jambs and glazing (Plate 5). To east and west, the ground floor is lit by bands of windows with projecting, continuous concrete head and cill details, which serve to accentuate the horizontality of the range. At first floor, this emphasis is repeated by the glazing which here forms a near continuous band, again with continuous head and cill details, separated only by piers on the line of the internal bay divisions (faced externally in curved glass brick; Plate 6), and at the centre of the elevation, where a decorative tripartite window of glass brick construction occupies the space above the ground floor doorway (Plate 5). The eaves of the range are furnished with a decorative frieze comprising recessed panels of vertically set stretchers between slightly projecting, double-stretchers on end, and are capped by a flat, projecting concrete coping. The coping is broken at the centre of the elevation where the wall face extends above the eaves line by six brick courses, directly above the decorative glass brick window and principal door below.

The northern elevation is again of brick, laid to English garden wall bond with seven stretcher courses between headers, with a two bay projection (Bays 8 and 9) to the far western end. The focal point of the elevation is a double-height, curved window of glass brick construction within Bay 5 (Plate 7) that lights the internal principal stair; the curved window is flanked by symmetrical, tall rectangular windows to east and west which light the half landings of the stair. Otherwise the fenestration of the range is of regular, steel framed windows (3 panes by 3 to first floor and 3 panes wide by 4 tall to ground floor level), with continuous projecting concrete cill and head details as in the south façade. The eaves are again augmented by a decorative frieze, though the detail varies slightly here with the inset panels comprising horizontally laid stretchers as opposed to stretchers on end, all capped by a projecting

concrete coping. The first floor of the projecting end bay includes a full width window, returning as a single panel to east and west onto the side elevations.

The range is accessed from the south via the centrally set door, previously described, opening onto a three-bay wide lobby area (Plate 8) which extends to the full depth of the range; open save for two circular columns on the line of the bay divisions supporting the upper floor level, these are formed of steel RSTs encased in plaster (Plate 8). The lobby is dominated by the principal stair which rises as a single central flight, lit by the full height, glass-brick window of the north elevation (Plate 9); at half-landing level the stair splits into two flights which return along the northern wall before rising against the side walls of the lobby to east and west. To east and west of the central lobby, the ground floor is separated into a series of separate office rooms. At first floor level, a central axial corridor runs the length of the range, closing over the open stairwell. The southern wall of this corridor is again constructed entirely in glass brick (Plate 10), though several panels have been subsequently obscured by plasterboard. The original effect, with light from the stairwell and from the liberally fenestrated southern façade filtering through the glass brick corridor partition, must have created an especially light and airy space. The remainder of the first floor is divided to form a series of office spaces to north and south of the central corridor, the higher status rooms being located to the western end of the range within Bays 8 and 9. Two blocked doors within the eastern wall of the range (Plate 12) formerly provided through access to Building B2 and Building D.

Building B is partly basemented, the lower level being accessed via stairs located within Bay 6 (N) of Building B1 and at the northern end of Building B2. Access to these cellars was restricted due to the presence of standing water and factory detritus, accumulated after its abandonment. It is predicted though, that these cellars once formed part of the underground flues and firing tunnels of the large glass-cone furnace and are likely to have once connected to the tunnel complex below building H. Alterations were noted on the stair access as the walls had been clad in ceramic glazed tiles. Observations were noted from two low openings within the northern elevation of building B, this confirmed that the cellaring continued in a northwesterly direction and were set back at least 3 metres beneath building B1.

5.5 Building B2

Building B2 forms the southern return of the main office range (B1) with which it is contemporary. It is of steel-frame construction, clad externally in brick laid to English garden wall bond with seven courses of stretchers between header courses. The range extends to 8 bays (here numbered 1 to 8 from south to north), corresponding to Bays 1 to 8 of Building D to the east. The west elevation of Building B2 is of four bays, closing the front yard area between Building B1 and the southern boundary wall. It shares many of the stylistic qualities of Building B1, with horizontal bands of glazing to ground and first floor levels, decorative eaves frieze and projecting cill, head and coping details. The piers defining the internal bay divisions are here in brick with alternate projecting courses and are not enhanced with curved glass brick as in Building B1. The upper level of fenestration is shorter than that of Building B1, the cill level being set higher and the head being continuous with the adjacent range. The southern elevation, facing onto Lodge Road is fairly plain, with a single window to first floor level (Plate 13); panels of brick with alternate projecting courses are located to each side of the upper window, the decorative device being extended around the corner of the structure to the south-west onto the southern window pier of the west elevation. The decorative device is again used at ground floor as a broad band above street level, continuous across the full elevation of Building B2 and the gable end of Building D to the east.

The interior of Building B2 is accessed at ground floor level via two doorways in the north wall, opening off the middle yard, and from Building B1 the west. The ground floor comprises a single open space, divided off from Building D to the east by a wall, partly of ½ glazed, glass brick construction (Plate 22). Flooring is in concrete throughout. The first floor structure is also of concrete, supported on regularly spaced, transverse RSJs on the line of the bay divisions and carried to east and west by RSCs encased within projecting piers of brick. The first floor of is accessed via a quarter-turn stair located in the southernmost bay of Building D (Plate 23), and was formerly accessed from the axial corridor and front office range of Building B1 to the west, though these latter doors have been subsequently blocked. The first floor again essentially forms a single space, with the exception of a partitioned office within Bays 7/8 to the north and an inserted office formed of stud partitioning within Bay 1/2 to the southwest corner of the range. The eastern side of the range is open to Building D with which it shares common bay divisions. The range was originally lit by extensive fenestration within the west and north walls (most of the western windows have been blocked internally) and by a series of three, ridged and hipped skylights within Bays 3/4, 6 and 8. Blocked doorways in the west wall of Bays 6 and 7 formerly opened onto the north office range and axial corridor of Building B1 respectively.

The roof structure of Building B2 is flat, of concrete construction supported on transverse RSJs aligned on the line of the bay divisions and carried by RSCs to east and west.

Buildings B1 and B2 are contemporary and are first illustrated on the Ordnance Survey edition of 1954 (Figure 8). They form part of the radical alterations to the factory complex (incl. Buildings A, C and M) undertaken in the early 1950s when the site was taken over by the Ford Motor Company.

5.6 Building C

Building C comprises a two-storey, pitch-roofed range aligned approximately east to west, parallel to Building B1, with which it is presumably contemporary, and forms the northern range of the middle yard (Figure 2; Plate 14). The building is of five full bays (here numbered 1 to 5 from east to west) with half bays to the eastern and western ends, of steel-frame construction, clad externally in brick. Brickwork is laid, in the long elevations, to English garden wall bond with 7 stretcher courses between header courses in the south elevation and 3 in the north elevation. The west elevation is distinct from the long elevations, employing a more purple/red brick, laid to Flemish stretcher bond, similar to the walling of Building E and suggesting that the wall may be secondary and/or that the range has been truncated. The range abuts Building D at its eastern end.

The south elevation of the range, overlooking the middle yard (Plate 14) has regular fenestration of steel framed, multi-pane windows to first floor level with continuous cill and heads of projecting concrete. A taller, vertically set window within Bay 5, with a decorative panel below, lights a stairwell internally (Plate 16). The easternmost window has been converted to a double-width doorway (Plate 15) serving as a loading bay for the upper level. At ground floor level the pattern of fenestration is less regular, and has been disturbed by the adaptation of certain windows to form doorways (see below). A single-flue, brick stack rises above the eaves at Bay 2/3 (Plate 14/15).

Internally, at ground floor level (Plate 17), the range is divided into two principal spaces by an inserted wall of breeze-block construction at Bay 4/5. The 1½ bay western space is accessed via a single, pedestrian doorway in the south elevation; the larger, 4 bay space to the east being furnished with both a primary pedestrian door and a wider double-width doorway,

adapted from a former window (Plate 14). The concrete first floor structure is carried by a series of deep, transverse RSJs at bay divisions and at mid-bay, supported on RSCs encased in brickwork to north and south. First floor level is accessed via two dog-leg stairs, one located in the half bay to the east of Bay 1 (ie. adjacent to Building D) and a second within the south-eastern part of Bay 5; the latter stair is lit by the tall window with decorative panel within the south elevation. Further access between floor levels is provided by a lift located in the half bay to the north of the eastern stairwell (Plate 19), which also serves the upper level of Building D to the east. A blocked doorway at the head of the eastern stair formerly provided through access to Building D to the east.

The roof is formed of steel trusses of standard Pratt design, one per bay plus intermediate trusses, totalling ten trusses with zig-zag longitudinal bracing to north and south (Plate 18). Principal trusses are carried by paired 'C' section steel posts encased within projecting piers of brickwork while intermediate trusses are carried on the deep concrete window lintels. The roof is supported on three tiers of RSA section purlins and ridge-piece and includes a continuous band of glazing to the upper part of the northern slope.

Building C is first illustrated on the Ordnance Survey edition of 1954 (Figure 8) and forms part of the radical alterations to the factory complex (incl. Buildings A, B1, B2 and M) undertaken in the early 1950s when the site was taken over by the Ford Motor Company.

5.7 Building D

Building D forms a 65m long, rectangular two-storey range with pitched roof, aligned approximately north-south, perpendicular to Lodge Road onto which it fronts in a gabled elevation to the south. The range is of 22 bays (here number 1-22 from south to north), of steel-frame construction, infilled with brick; exterior elevations of the range are not clearly visible, being obscured for the most part by adjoining structures. A short length of the west elevation is visible in the eastern side of the middle yard, though this section of wall comprises a secondary, 1950s refacing, contemporary with Buildings B and C. The southern, gabled elevation onto Lodge Road is continuous with the south elevation of Building B2 (Plate 1), featureless save for a double doorway that opens onto the landing of an internal quarter-turn stair rising from ground to first floor level (see below). The gable elevation is enhanced with a band of alternate projecting bricks at street level, extending onto the jambs of the doorway, and by a decorative frieze that continues from Building B2 to the west.

The ground floor of the range is dissected by a transverse passage at Bays 11 and 12 (Plate 20), providing through access from the middle yard to Building H to the east. To the south of the passage, at ground floor level, the range comprises a single open space (Bays 1-10; Plate 21), divided off from Building B2, which runs parallel to the range, by a wall, partly of ½ glazed, glass brick construction (Plate 22); doors within Bays 2, 5 and 8 provide access between the ranges. A quarter-turn stair rises in Bay 1 at the southern end of the building (Plate 23) providing access to the first floors of both Building D and Building B2; a double door opens off the landing of the stair to exterior street level (which is here at a raised level as it approaches the former bridge over the Soho Branch Canal; see Plates 1 and 21). A single door in the east wall of Bay 4, gives onto a straight flight stair, which rises to the level of an exterior loading platform (Plate 61), occupying the space between Building R and Lodge Road. The range is at ground and first floor level in concrete, the upper floor being supported on a series of transverse RSJs and two axial steel beams, aligned on the centre and to the eastern side of the range. The axial beams are supported by irregularly spaced RSCs. The area to the north of the transverse passage (Bays 12-22) is divided into two spaces by a wall of breeze-block construction at Bay 18; details of construction were noted to be similar to those recorded

within Bays 1-10. The northern section of Building D at ground floor level was not fully accessed due to Health and Safety considerations. Doors within the west wall at Bays 15 and 18 give onto Buildings C and P respectively (Plate 30).

The first floor of Building D shows the structure of the range more clearly at this level (Plate 25) where, though it comprises a single open space, it can be seen to comprise at least three different phases of construction, clearly denoted by variant roof structures. The southern section of the range is of 8 bays (Bays 1-8 from south to north) defined by trusses of standard 'Pratt' design (similar to those recorded in Building C), supported on RSCs to east and west and with zig-zag pattern, longitudinal bracing. To the east, the steel supports are embedded in the brickwork of the elevation, with a two bay opening at Bay 5/6 (Plate 26) onto the first floor of Building R (§.5.20), which comprises a loading bay served by the platform (Plate 61) which extends to Lodge Road to the south, served by Gate 2. The west side of the range is open to Building B2 as a single continuous space. The roof is clad with corrugated asbestos sheets carried on three tiers of RSA section purlins and includes rooflight bands to both eastern and western slopes.

The central section of the range is of 6 bays (9 to 14 from south to north) demarcated by steel trusses of double-Fink design, again supported on RSCs to east and west, here encased in projecting piers of brickwork (Plate 27). The roof is here supported on two tiers of timber purlins carried on steel cleats and a timber ridge-piece. Where exposed, the brickwork infill of the steel frame to the east is seen to be laid to Flemish stretcher bond, and includes a series of small square windows (blocked), one per bay. The western wall of the central section represents a re-facing contemporary with the erection of Buildings B and C, readily apparent externally, and all windows have been blocked internally in breeze block and/or brick. The southern end of the section is defined by a double truss, the southern truss of the central section being located immediately adjacent to the northernmost truss of the southern section. The central section does not include the zig-zag side bracing of the Bays 1-8, though an angled trimmer to the west of Bay 9 (Plate 24) is of interest; this feature is indicated on original design drawings (see Figure 16, §.5.7 below) and marks the position of the former narrowing of the range from 9m to 8m in width to respect the cone of the large glass house, still in existence at the time of construction. A wide opening off Bays 17/18 to the east (Plate 28) gives onto a small, irregular space which represents the isolated remains of a former range, illustrated on design drawings dating to 1934 (Figure 12); the eastern gable wall, in red brick laid to English bond, includes a blocked doorway and window opening (Plate 29). These features are more clearly visible from within Building K to the east (see §.5.15; Plates 48/49)

The northern part of the range extends to 8 bays (15 to 22 from south to north) demarcated by steel trusses of regular, double-fan design with longitudinal, zig-zag bracing to the western side only. Bay 17 is of double width and includes an angled truss (again of double-fan type), which respects the line of a former range which Building D formerly abutted at its northern end (see §. 5.7; Figure 16). Doorways in the west wall at Bays 16 (blocked) and 17 give access to Building C and to a lift shaft respectively (Plate 30). To the far north, the building buts up against the southern elevation of Building G, from which is partitioned by a wall of breeze-block construction.

Building D is partly represented in the design drawings prepared by Dallas and Lloyd, architects for *'extensions to glassworks'* and dated April 1934[4] (Figures 11 and 12). The design plan clearly shows the range being inserted between the existing 'large' and 'small' glasshouses to the west and east respectively, replacing the buildings shown on an earlier block plan of 1930 (Figure 10). The presence of the large glass house and associated cone

[4] Birmingham City Archives, Building Drawing Register Ref. No. 60307.

accounts for a narrowing of the building plan to the southern 8 bays, reflected in the surviving structure by the angled trimmer in Bay 9. Annotations indicate that the building was constructed to provide an additional *'new lehr'* at ground floor level to compliment an 'existing lehr' to the east; at first floor level, the plan indicates *'Shop No. 1'* and *'Shop No. 2'* occupying the middle and southern sections of the range respectively and returning to the west at the southern end of the range as *'Shop No. 3'* along the street elevation. To the north, the new structure abuts the pre-existing range indicated on the 1930s design drawings for Building K[5], the eastern end wall of which survives, with blocked window and door, in the side bay at Bay 17/18. The southern bays of the range were radically altered or rebuilt entirely, at the time of the construction of Building B2.

5.8 Building E

Building E is a rectangular, single-storey, flat roofed block of five bays (here numbered 1 to 5 from north to south), aligned approximately north to south and located to the north of the eastern end of Building C, which it abuts to the south (Plates 31-33). The structure is brick built in purple/ red brick laid to Flemish stretcher bond with 3 stretcher courses between Flemish bond courses. The east elevation has regular fenestration of large, rectangular multi-pane, steel-frame windows (7 panes high by 2 wide) beneath plain concrete lintels set flush with the wall face and with cills formed of a single course of brick headers. A single, double-door is set centrally within the northern elevation (Plate 31), apparently reduced in scale from a larger opening, blocked in red-brick. The western elevation includes tall roller door and window to Bays 1 and 2, blocked doors to Bays 3 and 5 and a blocked window to Bay 4.

Internally, Building E comprises a single, open space (Plate 33) with the exception of a small, inserted partition to the south-west corner housing a WC. Flooring to Bays 2 to 5 is in herringbone wood block, Bay 1 being floored in small red quarry tiles. The flat roof is supported on four substantial transverse RSJs supported upon projecting piers of brickwork to east and west; the ceiling is lined throughout in perforated steel tiles. Additional lighting is provided by a longitudinal, ridged and hipped, glazed rooflight set slightly off-centre to the western side of the block. At its southern end, the building abuts Building C; through access was formerly provided by paired double-width openings, now both blocked (that to the east in breeze-block, that to the west in studwork and fibreboard).

5.9 Building F

Building F comprises a small, single-storey, brick-built block located in the northwest angle between Buildings C and E (Plate 34). It is accessed via a double-width opening with plain concrete lintel in the north wall and by a single, pedestrian doorway at the south end of the west wall. The western wall has three small, square openings at low level and two similar openings at high level to the southern end of the structure (all blocked in brick). Building F is not indicated on, and thus post-dates, the Ordnance Survey edition of 1954 (Figure 8).

5.10 Building G

Building G is a large two-storey block of approximately rectangular plan, set at right angles at the northern end of Building D, which abuts it to the eastern end of its southern elevation. It is of steel-frame construction, clad externally in brick laid to a mixed bond, mainly of Flemish

[5] Birmingham City Archives, Building Drawing Register Ref. No. 52546.

stretcher bond with 3 courses of stretchers separating Flemish courses. The main block is formed of two parallel ranges, aligned north to south, the eastern (of 7 bays) being longer and projecting northwards of the western range, which is of 5 bays. Two-storey, flat-roofed extensions, set back somewhat from the main, west elevation are located to the north and south.

The principal elevation of the building faces to the west (Plate 35); it is of five bays (here numbered 1 to 5 from south to north) demarcated externally by projecting piers of brickwork with regular, large steel-framed window openings below deep, flush concrete lintels to ground and first floor level. The central bay at ground floor is occupied by a double, sliding doorway, while Bay 5 at first floor incorporates a single, pedestrian door served by an external metal fire-escape stair which rises parallel to the elevation. The south elevation is obscured for the most part by the southern extension and later structures (Building P), only the tall gables of the two pitched roof ranges being visible, here clad in corrugated asbestos sheeting (Plate 36). The eastern end of the north elevation comprises the gable end of the 7-bay east range, the upper part again being clad in corrugated asbestos. To the western end, the gable of the shorter, western range is set back behind a flat-roofed, two storey extension (Plates 36), which shares detailing of the main block, with deep concrete lintels to window and (at ground floor level) doorway openings which serve individual rooms internally.

Internally, ground floor level comprises two principal spaces (Plates 37/38), corresponding to the two separate ranges, divided by a single-skin, north to south aligned brick wall (Plate 37). The concrete first floor structure is carried on a grid of longitudinal and transverse RSJs supported on a regularly spaced RSCs. The northern extension is closed off from the body of the building by a brickwork wall, and is subdivided into a series of four individual cells, each with independent access from the body of the building and from the exterior, in a manner similar to Building M to the east (Plate 38).

At first floor level, the building essentially comprises a single, open space (Plates 39/40). This space extends to include the flat-roofed extension to the northwest (Plate 40), though the opposing extension to the south is subdivided into a series of small rooms, which house toilet facilities. The main body of the building is unencumbered by supports for the roof structure, the valley between the two ranges being supported on a deep, north to south aligned trussed girder. The level is well lit by extensive fenestration in the exterior walls, steel-framed to the north and east, wide bands with timber mullions to the east (Plate 41), and by skylight bands within the western (to E slope only) and eastern (E and W) roof structures. A wide, sliding latticed ‘concertina’ type door at Bay 1/2 of the east wall serves a mechanical hoist supported on a structural-steel frame (Plates 41/52). A pedestrian door within Bay 5 of the west wall opens onto a metal fire-escape stair.

Both roof structure of both ranges comprises a series of steel, double-inverted ‘Howe’ pattern trusses, that of the western range being asymmetrical, the western slope being longer than that to the east.

Building G is not indicated on either of the block plans accompanying design proposal drawings of 1930 and 1934 (Figures 10 and 12), though it is shown on the Ordnance Survey edition of 1954 (Figure 8). Building M, dating to the 1950s reordering of the complex (Phase VI), abuts the eastern elevation of Building G at an acute angle, implying that the latter building pre-dates the former, and a loose dating of late 1930s-1950 is thus inferred for Building G. Documentary evidence suggests that its construction probably dates to the earlier part of the range (see §.6.6).

5.11 Building H

Building H occupies a large irregular plan to the east of Building D and adjacent to the ramp descending from street level to the level of the former wharf. To the north it abuts Buildings K and I and to the south, Building R. The angled, east wall respects the alignment of the former Soho Branch Canal. It of one, high single-storey, of steel frame construction clad to the eastern exterior wall in brick, laid to English garden wall bond with 7 courses of stretchers between header courses (Plate 42). The exterior elevation includes 5 large multi-pane (6 x 6) steel-framed windows, the northern two examples being taller (7 x 6) reflecting a drop in exterior ground level. Windows share a common, projecting concrete head and display continuous cill details, at two levels dictated by the respective window heights. The lower cill level of the northernmost window has clearly been cut through and the window converted to a large doorway. The elevation is capped by a decorative eaves band, comprising recessed stretcher panels divided by projecting stretchers on end, with concrete strings above and below. All details correlate with those recorded within Buildings A, B, C and M, with which the structure, in its current form at least, is presumably contemporary. At ground level, however, the falling away of a short stretch of brick facing has exposed an area of English bond brickwork (Plate 43) suggesting that the wall represents a refacing/reuse of an earlier wall alignment, a hypothesis supported by a review of historic mapping; a wall is clearly indicated on the same alignment on the first edition Ordnance Survey map of 1889 (Figure 6), while a building occupying the present plan (the small glass house) is also indicated in this location on design proposal drawings dating to 1930 and 1934 (Figures 9—12).

The building is accessed via a wide passageway leading from the middle yard at ground floor level of Building D. Access to the former wharf area is via a wide doorway to the north end of the east elevation while a doorway in the south wall gives onto the ground floor level of Building R.

Internally, the building comprises a single, high open space (Plate 44). The concrete roof structure, which includes two longitudinal voids extending to the full length of the building, is carried on a grid pattern of steel beams supported by substantial RSCs, two alignments parallel to Building D to the west and a further angled alignment within the eastern, exterior wall, encased in the brick piers dividing the window openings. A stair (Plate 45) descends to the north of the range, south of the dividing wall with Building K, serving the complex of subterranean tunnels related to the former small glass house, described below (§.5.12).

Building H is difficult to date precisely in its present form; as noted above the line of the eastern elevation reflects a historic alignment, evident on the earliest plans of the glassworks, and the southern section at least of the present building would appear to be enclosed by the time of the Ordnance Survey 1s t edition of 1889. The block plan accompanying design proposals of 1930 (Figure 10) suggest an open yard area and coal bunkers associated with the small glass house occupying the northern part of the building footprint, though this is shown to be enclosed by the time of design proposals of 1934 (Figure 12). This secondary glass house would have been constructed to the modern standards of the day within a roofed building rather than a glasshouse cone and it is likely to have been gas rather than coal fired. It is apparent that the eastern, exterior wall was rebuilt/ refaced during the radical, early 1950s reordering of the site.

5.12 Tunnel Complex Below Building H

The tunnel complex beneath building H was composed of a series of interlinked tunnels and a larger principle central room. This complex was made up of several separate phases of construction. The primary phase was likely to constitute the surviving fabric of the 19th-century glassworks with major alterations occurring in the early-20th century during the restructuring of site. Further piecemeal alterations were likely to have occurred throughout the period of occupation of the site as the functions of the buildings changed. For ease of description the complex has been divided into separate areas, labelled H1—5 (Figure 14). This tunnel complex would have originally formed the extensive corridor system (H3 to H4) running underneath the floor of the glass cone, constructed in 1810, which was used to conduct the air and provide access to the coal bed within the centre of the furnace (Figure 15). Alterations to the corridor system (H5) would have occurred with the addition of the second glass house between 1855 and 1889. Further extensive alterations occurred later in the history of the complex during the period of the world wars including the introduction of the large open cellar (H1), interpreted as a coal bunker, which changed its arrangement and function.

The tunnel complex was constructed of a mixture of 9 x 3 inch engineering and red bricks set in an English bond within a re-pointed cement based mortar. The walls had been whitewashed to create the illusion of more light.

The flooring consisted of brick predominantly covered by the later addition of a concrete screed. The bases of the corridors were ramped. These sloped in a circular route from corridor H5 downwards to corridor H3 and then again down through corridor H2 with a former ramp within Area H1 completing the circle. This sloped construction would have enabled the easy transportation of raw materials from the former Soho branch of the canal to the centre of the glass furnaces.

The roofing of the complex was formed of two different types. The primary type was of segmental arch vaulted roofs. This form of roofing was preserved in Areas H2, H3 and H4. Reconstruction of this original roofing had occurred in corridor H5 and the main Area H1 at a later date. The roofing was replaced with concrete roof reinforced with transverse RSJs carried by RSCs.

5.12.1 Area H1

The principle central room (Area H1) was orientated northwest to southeast and included the current main access comprising an open, corroded stairway with a handrail made up of tubular steel. There were steps leading to a raised platform area on the northeastern side of the room, a scar on the wall suggesting these had replaced a shallow ramp. There was a steep ramp on the opposing side of the room (Plate 66). A blocked semi-circular arch was identified on the base of the southern facing elevation (Plate 65). This was likely to be a blocked airway leading to one of the glass furnaces.

The roof of this area was in the form of flat roofing of a concrete construction supported on transverse RSJs and carried by RSCs, contemporary with the construction of the 20th century steel framed Building H above. The RSC foundations of which had been sunk through the cellar at various intervals.

The 1934 plan suggest that this central room was a coal bunker (Figure 12). Whether this was open or enclosed is unclear but the use of narrow Rigid Steel Joists and the brickwork suggest

a date consistent with the earlier part of the 20th century prior to the 1930s plans where they are first depicted.

5.12.2 Area H2

Corridor H2 was orientated northeast to southwest. It was directly linked to areas H1, H3 and H4 and was brick walled and concrete floored. The roof was vaulted and ran widthways creating a series of arches, at the springing point of which was a contemporary steel joist (Plate 67). Rounded brickwork linked these corridors at its western end.

5.12.3 Area H3

Corridor H3 was orientated northwest to southeast and was directly linked to areas H2 and H4. At the northern end of the corridor were two blocked up passages (Plate 68), the purpose of these are at present unclear. The architects plans of 1934 (Fig. 16) note the orientation of these corridors and they are noted as *'Cave Under'* presumably meaning that they were always subterranean. The blocked passages are seen continuing to the northwest but with no defined function. This corridor and corridor H4 is likely to date to the earliest phase of the glassworks and was probably constructed contemporarily with the glass cone, confirmed to have been in existence in 1810.

5.12.4 Area H4

Corridor H4 was orientated east to west and was directly to areas H1, H2 and H3. A side room within corridor H4 was accessed through brick arches detailed with bullnose bricks and voussoirs of uncut headers (Plate 69). The roof of this corridor and side room was vaulted and ran lengthways.

There was evidence of the reuse of the corridors and adaptation as emergency shelters during World War II can be seen in the corridor (Area H4). This was principally seen as I-beam reinforcement of the ceiling and the addition of brick piers to support these I-beams. Similar reconstruction is seen in shelters at Tetnal Green and off Sheepcote Street (K. Nichol pers. comm.) Remnants of the former location of 'Wrigley Tin Shuttering' are visible adhering to one wall in the form of an economy concrete impression against the wall. Three features also support the supposition it was reused at this period. The sawn off steel runs of an escape hatch ladder are visible within one pier. Elsewhere the remains of an undated wood frame are positioned in one alcove that may be the only survival of a secluded temporary toilet. Set within one wall is a sign stating 'drinking water'. The signage is typical of those used during the period 1930—1950.

5.12.5 Area H5

Corridor H5 was orientated northeast to southwest and was directly linked to areas H1 and H4. The location of corridor H5 was adjacent to the former Soho branch of the canal which suggests the raw materials were being off loaded from the barges and barrowed directly to the centre of the glass cones. The principle central room would be the logical location for the storage of these materials. Regular brick column projections were noted along the southern elevation of this corridor (Plate 70). This tunnel is likely to have fed the *'small glass house'* constructed between 1855 and 1889. The date of this tunnel was therefore slightly later than that beneath the main glass cone.

5.12.6 Discussion

All of these extant and blocked corridors would have formed the extensive tunnel system running underneath the floor of the cone used to conduct the air and provide access to the coal bed within the centre of the furnace. The initial elements of the tunnel complex were likely to have been constructed contemporarily with the glass cone, confirmed to have been in existence in 1810 (Fig. 4). Secondary elements were constructed when the small glass house was introduced between 1855 and 1889 and further major alterations occurred during the interwar period.

5.13 Building I

Building I is a narrow, two-storey one-bay structure, appended at the northern end of Building H (Plate 46) and accessed at ground floor level via a wide opening in Bay 5 (west) of Building K. The building is brick built of highly fired red brick laid to Flemish stretcher bond. Internally, the ground floor room comprises a single space, with a straight flight stair rising to the upper level against the north wall; a small WC is located beneath the rise of the stair. The south wall of the room is of brick construction, laid to stretcher bond and, significantly, includes no apparent blockings. A wide blocked opening occupies the centre of the eastern, exterior wall, while a wide doorway at the west end of the north wall has been blocked in two phases. The structure is floored in concrete to ground and first floor levels, the first floor being supported on north south aligned RSJs, and including a square void to the west, formerly serving a mechanical hoist at first floor level. At first floor level, the structure is divided into two by a north-south aligned studwork partition wall and includes a further WC to the south-east corner. The level is lit by single windows located centrally within the east and west walls and by a ridged and hipped skylight above the eastern section. A steel beam is located above the square floor void, presumably formerly serving to support a mechanical hoist.

A building clearly occupying the plan of Building I is indicated on the detail proposal drawings for Building K of 1930 (Figure 14, where it is labelled as partly comprising the '*Boatmen's Room*') and traceable as far back as Piggot-Smith's 1855 map (Figure 5). The internal arrangements of the building in the early depictions are, however, at variance with the recorded structure: the 1930s design drawing shows the ground floor divided into three separate spaces, the eastern of which is furnished with a corner fireplace, and both north and south walls display a wide opening forming a through passage. These arrangements are not reflected in the recorded fabric, and it may be that Building I represents a later rebuild on the same plan as the earlier structure, possibly retaining some earlier fabric within the north wall (a wide doorway is shown at the western end of the north wall in the design drawing, corresponding to the blocked feature within the standing building).

5.14 Building J

Building J is a high, single-storey building appended to the north side of Building I (Plate 46). It is of steel frame construction, clad externally in a mix of orange/red and purple/red brick, laid to English garden wall bond with 8/9 stretcher courses separating headers. The east elevation of the building includes two double door openings to the south and a single, pedestrian door to the north. At high level are two steel-frame multi pane windows with a flush concrete lintel that extends the full width of the elevation. To the south, the building abuts Building I in a clear straight joint. The north elevation is plain, again laid to English garden wall bond, and includes three projecting piers of brick; the quality of the brickwork is

distinct from the at of the east elevation and would appear not to be contemporary, suggesting this wall may have been rebuilt.

Internally, the building forms a single high, open space, with a concrete roof structure carried on transverse RSJs and supported by a grid pattern of RSCs. The building is floored through out in small red quarry tiles and retains a number of settings for plant. The high level windows, present within both the east and west walls, include mechanisms for opening from ground floor and it would seem the building was never furnished with an upper level (though, see below). A blocked doorway in the south wall corresponds to that recorded within Building I, previously described. The trace of a former pitched roof line is traceable in the south wall at high level.

The building plan of Building J again corresponds to a structure indicated on the 1930s design drawings for Building K (Figure 10), though it is again difficult to correlate the standing remains with the archive drawing. A clear discrepancy is that the design drawing depicts a stair rising at the southwest corner of the building, suggesting the original presence of an upper level. In this respect the apparent scar of a former pitched roof line in the south wall may be of interest, suggesting an original building of different form, though occupying the same plan.

5.15 Building K

Building K is a rectangular, single-storey, pitched roofed building of seven bays (here numbered 1 – 7 from north to south), aligned approximately north to south and located to the east side of the long range of Building D. It is of steel frame construction, infilled with brick and lined internally with glazed white tile. Bays are demarcated by steel trusses of double-fink design (Plate 47), the roof being supported on two tiers of timber purlins and a ridge piece; it is lined internally with vertically set timber planking, and formerly included continuous bands of patent glazing to both eastern and western slopes.

The building is entered via a small pedestrian opening (partly blocked) within the east wall of Bay 7, and has two, double width openings within the northern elevation (to the exterior and to Building L to east and west respectively). A blocked doorway was recorded in the east wall of Bay 1 while the walling of Bays 6 and 7 (west) appears to have been altered on a number of occasions; the most recent features comprise a pedestrian door and window, though it would appear that the full two-bay width may originally have been. Bay 5 (east) is open, giving on to the ground floor of Building I.

The western wall of Bays 4 and 5 comprise a two-storey section of walling which projects slightly from the adjacent wall plane (Figure 16, Plate 48), and represents the eastern end gable wall of a former east to west aligned range against which Building K was erected. The walling at ground floor is again lined in glazed white tile, obscuring any original features, though at first floor level it is seen to be of brick laid to English bond and includes a window and door to south and north respectively (Plate 49). A concrete platform with steel hand-rail projects before the doorway and was formerly served by a rising stair, an arrangement most clearly seen externally (Plate 50).

Building K is represented by the design drawings prepared by Dallas and Lloyd, architects for *'new stores'* and dated October 1930[6] (Figures 11 and 12). The design plan illustrates that the stores were constructed against the eastern end wall of a pre-existing range (housing

[6] Birmingham City Archives, Building Drawing Register Ref. No. 52546.

'Earnshaw's Cutting Shop' at ground floor level) and further indicates that Bays 6 and 7 were indeed originally open to the west. The form of the elevation surviving in the west of Bays 4 and 5 is illustrated in the *'Section on Line C-C'* (Figure 11) while the *'Section on line B-B'* illustrates the form of the buildings formerly standing to the north; these were of two storeys, the ground floor level having window and door openings with segmental arched heads. The date of the range including *'Earnshaw's Cutting Shop'* is difficult to define precisely though it is certainly not present on the Ordnance Survey edition of 1905 (Figure 17).

5.16 Building L

Building L comprises a small, single-storey, infill block of red brick construction, laid to stretcher bond, located to the north of Building K in the angle with Buildings D and G (Plate 51). The building is accessed from the south via a double-width opening from Building K and has two double-width doors opening to the exterior yard within its east wall. The building has a mono-pitch roof, with six tiers of RSA section purlins supported by two sloping RSJs set into the brickwork walls to east and west; the roof is clad in moulded asbestos sheeting and includes a glazed panel.

Internally, the building is floored throughout in small red quarry tiles overlaid in places by a thin concrete screed. The western wall includes two blocked doorways to the south, formerly serving Building D, and three small, closely set openings at high level to the north. The building houses a substantial steel frame for a mechanical hoist (steelwork by Lanarkshire Steel Co. Ltd). Building L is not indicated on, and thus post-dates, the Ordnance Survey edition of 1954 (Figure 8).

5.17 Building M

Building M comprises a single-storey, flat-roofed range, located to the northeast of the development site. It is aligned approximately northwest to southeast, parallel to the northeast boundary wall and abuts Building G at its western end. The building is of steel-frame construction, clad externally in brick laid to stretcher bond (Plate 54). The southwestern elevation displays regular fenestration of 3 steel-framed windows with continuous, concrete head and cill bands with a double, pedestrian doorway and small window opening to the west end, adjacent to Building G. The eaves level is again enhanced by a frieze of recessed stretcher panels divided by stretchers on end, in a fashion similar to that recorded within Buildings B, C and D. The northeast elevation displays a regular pattern of single, metal doorways each with an associated window opening (Plate 55), lighting a total of five original individual cells within the northern side of the building. A narrow, exterior passageway runs the length of the range bounded to the northeast by the site boundary wall (Plate 55). Internally, through access is provided by a lateral corridor running along the southern side of the range (Plate 56), again with doorway and window openings to each cell; the passageway has been blocked part way along by an inserted wall of breeze-block construction. At the western end of the range, internal transverse partitions have been removed and three original units have been formed into a single space (Plate 57), which abuts the eastern wall of Building G at an angle. Two surviving units to the eastern end of the range have been interconnected by the creation of a wide doorway within the transverse partition; the creation of this doorway reveals the partitions to be of double-skin, cavity construction. The flat roof is supported on a series of transverse RSJs carried on RSCs within the exterior walls and a further, mid-span alignment, most clearly evident within the western open space (Plate 57). Flooring throughout is in small, square quarry-tiles, while the walls retain (in places), a cladding of perforated metal panel.

A crane, housed within a two bay, pitched-roofed shelter of steel-frame construction clad in corrugated asbestos sheeting, abuts the south-east elevation of the range (Plate 54), while a further small two-storey, brick-built structure is appended at the northeastern corner of the range (Plate 53).

5.18 Building N

Building N comprises a simple, single-storey, two-cell structure in brick, laid to Flemish stretcher bond and capped by a flat concrete coping, located adjacent to (and abutting) the north-east site boundary wall to north of Building G. Each interior cell is accessed via opposed doors within the north-west and south-east walls, each furnished with by metal-plate fire-doors (Plate 58), and is lit by a rectangular void within the flat, concrete roof.

The structure is not indicated on, and presumably post-dates, the Ordnance Survey edition of 1954 (Figure 8).

5.19 Buildings O, P and Q

Buildings P and Q comprise ad-hoc, late infill buildings erected between Buildings G to the north and C to the south. Building P is a secondary, plant room structure in brick, laid to stretcher bond, appended to the southwest of Building G and abutting the southern extension of the latter building (Plate 36/59). It exists to first floor level only, being supported on a series of square concrete piers, and is accessed solely via the head of a fire-escape stair, there being no direct link between it and Building G. To the south of Building P, Building Q is a simple, windowless, rectangular block with mono-pitch roof abutting the northern long elevation of Building C; it is of brick construction, laid to English garden wall bond with 3 courses of stretchers separating header courses, and is accessed via a pair of double doors within the west elevation. To its eastern end it abuts the western, exterior elevation of Building D, here rebuilt in breeze-block (Plate 59). Building O forms a simple covered space at ground floor level between the southern extension of Building G and the north side of Building P (Plate 59); it comprises a simple, mono-pitch corrugated iron roof.

5.20 Building R

Building R forms a small, two-storey, 3-bay annexe to Building D (Plates 60/61), aligned perpendicular to and opening off the eastern side of Bays 5 and 6 of the latter structure at first floor level (Plate 26); at ground floor level, the building is accessed form the southern side of Building H. The building is of steel-frame construction, clad externally in brick, laid to English garden wall bond with 7 courses of stretchers between header courses; the continuous, decorative eaves band of the east elevation of Building D extends onto the southern elevation of Building R. The southern elevation of the structure includes a wide doorway to the central bay with a metal, 'concertina' type sliding door (Plate 61), allowing access from the exterior, street level platform area to the first floor of Building D, flanked by a single window to the west (blocked internally). The lower part of the elevation includes three narrow windows lighting the ground floor of the structure (accessed from Building H to the north) and two straight-flight stairs to east and west, serving the lower levels of Buildings R and D respectively. The east elevation of the structure includes a single window set centrally at first floor, and two, low windows at ground level, lighting the ground floor of the structure, which is set somewhat below the level of the ramp (Plate 60).

Internally the building is plain, with concrete slab floors to ground and first floor level. The flat roof, also of concrete construction, is carried on RSJs supported to north and south by RSCs set into the brickwork of the walls.

Building R is first indicated in its current form in the Ordnance Survey edition of 1954 (Figure 12) and presumably represents a part of the major 1950s remodelling of the factory complex, though it may retain earlier fabric at ground floor level.

5.21 Building S

Building S (Plate 62) is a small pitched-roofed structure located to the southeastern corner of the development site, set perpendicularly to Lodge Road at the head of the ramp descending to the former Soho Basin and Wharf, adjacent to Gate 3. It is of brick construction, laid principally to English bond with alternate courses of red stretchers and blue-grey headers in a fashion common to the 19th century site boundary walls to east and northeast of the site (Plate 64). The west elevation varies in that is laid to Flemish stretcher bond, with 3 courses of stretchers between Flemish courses, and includes three window openings and a single doorway to the head of the ramp, all with segmental-arches formed of double header-courses. The north-eastern angle of the building is formed of blue-grey, rounded bull-nose bricks. To the east, the building is double-height, with brickwork extending down to wharf level; there is however, no means of access to any lower room, the east elevation displaying only two (flat-headed) window openings at high level. Internally, the building is divided by brick-built walls to form three interconnected spaces; the doorway gives onto a larger, full-width room which occupies the northern part of the building, while the southern part is sub-divided to form two small rooms facing to east and west respectively.

Although Building S displays characteristics of a structure contemporary with the canal basin, reference to early maps reveals that it was not constructed until some point between the Ordnance Survey editions of 1905 (Figure 7) and 1918.

6 DEVELOPMENT OF THE STANDING BUILDINGS

6.1 **Outline Phasing** (See Figure 17)

The recorded, upstanding buildings occupying the site have been broken down into a total of seven phases of development these overlap slightly reflecting the different sources used to define them (OS mapping, design drawings etc), The phases of development are as follows:

- Phase 0: Early to mid-19th century
- Phase I: Late-19th century
- Phase II: 1905-1918.
- Phase III: 1930.
- Phase IV: 1934.
- Phase V: *c.* 1930-1950.
- Phase VI: Early 1950s.
- Phase VII: Post 1954.

6.2 Phase 0

The upstanding buildings do not reveal any evidence for structures prior to the late-19th century. However, the subterranean tunnels appear to be of an earlier date. The northwest to southeast tunnel (**Area H3**) that ran beneath the large glass cone was probably contemporary with the cone and could date to the early 19th century. The section of tunnel that ran southwest to northeast (**Area H4**) was of marginally later construction and was presumed to be associated with the construction of a second glass house between 1855 and 1889.

6.3 Phase I

With the exception of parts of the eastern and northeastern boundary walls, blue-grey engineering brick structures relating to the construction of the Soho Branch canal and the Wolverhampton to Birmingham Railway, no above-ground structures have been identified that can be reasonably dated to the 19th century, and specifically to the glassworks phase of occupation of the site. It is apparent from an analysis of historic maps, however, that a number of the standing buildings have been erected to respect former structures and may incorporate earlier fabric within them. A specific case in this respect is illustrated by the small area of English bond brickwork exposed at the base of the exterior wall of **Building H** (§.5.11; Plate 43). Where English bond brickwork has been noted on the site it has been in early contexts and its presence within the eastern wall of **Building H** implies that, although the exterior aspect of the building in its present form dates to the 1950s reorganisations of the factory complex, the wall probably incorporates, at least at low level, fabric from the 19th-century glassworks buildings as illustrated on early maps.

6.4 Phase II

Two buildings, or part buildings, on the site can be dated to the early years of the 20th century, specifically to the period between the Ordnance Survey editions of 1905 and 1918. Of these, **Building S** adjacent to the ramp serving the former wharf survives complete; although a small rectangular structure appears to be indicated in the location of **Building S** on the 1905 map, the plan form is clearly smaller than the surviving building, which is first evident in its present state on the later edition.

The second Phase II structure comprises the small area recorded off Bays 17/18 (E) of Building D at first floor level and visible from within **Building K**. The structure comprises the eastern end gable wall of a former east-west aligned range, shown in detail in the design drawings for Building K of 1930 (labelled *'Earnshaws Cutting Shop'*) and implied on the Ordnance Survey map of 1918. The southern sections of **Building D** were built up against the south face of the range in 1934, though the subsequent extension of **Building D** to the north involved the demolition of the western part of the range leaving the surviving wall in relative isolation.

It is unclear at present but the remainder of the subterranean tunnel system (**Areas H1, H2 and H5**) would probably have been constructed in the early part of the 20th century. They are first depicted on the 1930s drawings but were certainly constructed at an earlier date.

6.5 Phase III

The third identifiable phase of development is represented by **Building K**, firmly dated by surviving design proposal drawings (Figures 13/4) to 1930. The building was erected as a *'new stores'*, and presumably represents part of William Riley's programme of investment and expansion (see §.4.2).

6.6 Phase IV

Building D also dates to the first half of the 1930s, with original design drawing dated to 1934 (Figures 15/6), and represents another part of Riley's programme of expansion, providing an additional lehr between the two glass houses. The range was subsequently extended to the north (Phase V) and the southern section reorganised, probably in the early 1950s when the glass cone was demolished and **Building B1/2** was erected to the west. Of particular interest is the angled trimmer at first floor level (§.5.7), clearly reflecting the survival of the large glass cone at the time of the construction of this range.

6.7 Phase V

Development occurring in the period between the mid-1930s design drawings and the early 1950s Ordnance Survey map (Figure 8) include the northern extension of **Building D**, the large double-range block of **Building G** to the north end of the site and the northern extensions I and J at the to the north of **Building H**. **Building I** would appear to occupy the footprint of an earlier building, traceable back to plans of the mid-19th century (see §.5.13). The exterior form of **Building G**, plain and utilitarian relative to the stylistically unified additions of the 1950s (Phase VI) suggesting that this building does not form part of the same phase of work; this is confirmed by the arrangements of **Building M** to the east, which abuts the eastern wall of **Building G** at an acute angle, necessitated by the pre-existence of the

latter structure. The relative decline in the fortunes of the glassworks in the years following the Second World War (§.4.2) suggests that the Phase V additions would probably have been made within the earlier part of the date bracket, before or perhaps during the war years.

6.8 Phase VI

The major phase of redevelopment on the site occurs after the dated design drawings of the 1930s and before the Ordnance Survey edition of 1954, and is logically associated with the take-over of the premises by the Ford Motor Company in 1952. A radical reordering involved the removal of a large part of the former glassworks buildings, particularly to the southern side of the site, and the creation of a new complex in a Modernist style (the construction of the front office range, B1, would have necessitated the demolition of the original, large glass house cone). Buildings of this phase are identifiable by their use of a common architectural vocabulary, including distinctive patterns of brick bonding and details such as extensive fenestration with continuous concrete window cills and heads, and the decorative frieze band of recessed panels of stretcher bricks. This phase is represented by **Buildings A**, **B1**, **B2**, **C** and **M**, together with an external remodelling/ re-facing of **Building H**. The construction of **Building D2** involved the widening, and associated re-roofing of the southern 8 bays of **Building D**.

6.9 Phase VII

Development on the site post dating the Ordnance Survey edition of 1954 (Figure 12) appears piecemeal and includes a number of simple infill buildings (**Buildings L**, **F**, **O**, **P** and **Q**) and small, isolated structures (**Building N**) together with the introduction of simple, additional hoists and cranes to serve pre-existing buildings (**Buildings G** and **M**).

7 ARCHAEOLOGICAL EVALUATION

7.1 Introduction

In the following sections both feature (cut) and context numbers are highlighted in bold. Full context details are available in the project archive and a list of contexts is available in Appendix D. This section is separated into trenches in numerical order. Each individual trench is then described stratigraphically beginning with the earliest deposits. A representative sample of trench plans and sections are illustrated at the back of this report. These have been chosen to illustrate the significant archaeological deposits/ structures described for each trench.

The same general pattern of deposition was encountered across the five trenches, although there was generally more structural evidence from within the core of the factory buildings. All of the five evaluation trenches were situated within current yard surfaces or outside of the modern layout of these buildings (Figure 18). The site stratigraphy consisted of a primary natural subsoil layer of orange sand with frequent inclusions of rounded pebbles, located at a height of 137m—137.5m AOD. Much of the natural was obscured by intrusions from structural deposits and deposits above. This was overlain by mixed layers of demolition rubble overburden of varying depths. The trenches were capped with tarmac or concrete yard surfaces.

The spread of archaeological features broadly confirmed the evidence preserved in the historical and cartographic sources. The majority of archaeological features were present within the anticipated areas and the preservation of these features was good. Evidence of the external walls of the glass-cone and the workshop buildings around the periphery of the glass works were all exposed as was the evidence of the residues of the glass manufacturing process, the dismantled structure of a furnace and examples of the products produced.

7.2 Results

7.2.1 Trench 1 (Figure 19, Plate 71)

Trench 1 was situated within the front yard of the extant buildings, adjacent to the present entranceway. It was orientated northwest to southeast and was 12.5m in length by 4m in width. The trench was located to examine the presence of workshops at the south of the site as defined on the plans of 1935.

The natural orange sand and gravel subsoil (**104**) was encountered across the entire trench at a depth of 137.7m AOD. An abandoned modern ceramic and concrete encased drain with large circular ceramic inlets (**103**) was cut into this natural. The trench was sealed by 0.15m thick rubble layer (**102**), whole brick and former paving brick inclusions were noted. Two further contemporary deposits covered the trench, the first of these was a mixed hardcore layer composed of crushed brick (**101**), followed by a final layer of tarmac which made up the modern front yard surface.

7.2.2 Trench 2 (Figure 19, Plate 72 & 73)

Trench 2 was situated within the main courtyard of the extant buildings. It was orientated northwest to southeast and was 15m in length by 4m in width. The trench was designed to

examine the survival of the former large glass cone, the position of which was identified from the historic mapping and documentary sources.

The natural orange sand and gravel subsoil (**203**) was again encountered across the whole trench at a depth of 137.69m AOD. Several intrusions were cut into the natural which had occurred throughout the period of occupation of the factory. The primary structural evidence encountered within the trench was the truncated external elevation of the glass cone (**207**), the wall of which was curved and inversely corbelled to form the beginnings of a cone shape. The wall was composed of hand-made, unfrogged, 9 x 4 x 2¾ in. orangey-red, bricks set in an English bond within a cement based mortar, it had been truncated down to its foundations which were of a stepped brick construction. Projecting the line of the curve, the diameter of the glass cone would have been in excess of 20m. Set up against internal southern elevation of the cone was a rectangular concrete platform upon which a large rectangular sandstone block was set. This may have provided an internal buttress function for the cone.

Separated from the external elevation of the cone base was an irregularly laid, brick floor surface (**209**), possibly contemporary with the primary build of the glass cone. This was overlain by the corner of a structure (**208**), which may have once attached to the outer elevation of the glass cone and may represent one of the buildings known to have been attached to its external face. The exact relationship was lost due to the truncation by the later drainage system, but this is likely to represent a secondary phase of construction based upon the interpretation of the bricks. The wall was constructed of machine-made, unfrogged 9 x 4½ x 3 in. orangey-red bricks, set in an irregular stretcher bond within a cement based mortar, again in a curving fashion. This building form including the glass cone and its attached extension is represented in the historic mapping from 1855 onwards (Fig. 7). A possible re-facing and extension to this secondary building was observed on the northeastern elevation (**212**), this ran beneath the northern baulk of the trench.

The remains of a corner of further building (**210**) and its foundation cut (**211**) and fill (**214**) were identified within the north facing section. This was constructed of machine-cut, unfrogged, 8¾ x 4½ x 2¾ in. red bricks set in an English bond within a cement based mortar. The wall ran roughly east to west and may represent part of the internal walling of the secondary building.

The glass cone and secondary building were severely truncated by a modern drainage pipe and associated inspection hatches. The cut (**213**) was linear and was orientated northwest to southeast through the centre of the trench, the pipe itself was ceramic and encased in concrete (**206**).

The trench was sealed by a series of levelled demolition deposits, the primary of which was a dark brown sandy clay (**202**). This was overlain by a further more mixed layers of crushed brick and rubble within a sandy clay matrix (**201**, **204**, **205**). A thick concrete yard surface, partially composed of reinforced concrete overlay the entire trench, into which a decorative brick pattering was set. This yard surface dates to the 1950s factory reconstruction period.

7.2.3 Trench 3 (Figure 20, Plate 74)

Trench 3 was situated along the western edge of site between the present site boundary and the present buildings. It was orientated northeast to southwest and was 20m in length by 1.8m in width. The trench was designed to examine workshops on the west of the site.

A series of contemporary and rebuilt brick surfaces were exposed within Trench 3, all of which are likely to relate to the 19th century warehouse buildings identified on the historic mapping.

An accurate chronology of construction proved difficult due to the restricted nature of the trench but the surfaces could be placed into four groups defined by their differing constructions and distinct separation. These surfaces may represent separate rooms within the range of workshops on this northeastern side of site.

The surface at the southwestern end of the trench (**302**) was irregularly laid and composed of machine cut, unfrogged 9¾ x 4 x 2¾ in. red bricks laid without any bonding material upon a silt bedding material (**303**). A further larger area of brick surface (**304**) was located in the centre of the trench. This was constructed of 9¾ x 4 x 3 in. engineering bricks laid in a stretcher pattern. The remains of a step was identified upon the eastern side of this and the surface had been divided into two parts by a contemporary red brick wall (**305**) running north to south through the surface. This wall was two courses thick and truncated down to its foundations, a contemporary wall (**306**), running east to west, was identified at the northern end of this wall. A further L-shaped single course wall (**307**) was identified on the southern elevation of wall **306**, and another two course truncated wall (**308**) orientated north to south was identified on the northern elevation of wall **306**. A contemporary quarry tile surface (**309**) abutted the eastern elevation of wall **308**. Each of these walls was composed of machine-cut, unfrogged, 8¾ x 4 x 3 in. red and engineering bricks set within cement based mortars. A further extensive very irregularly laid floor surface (**310**) was present further north. No construction pattern was used and it looked as if it was hastily laid. The northern edge of this surface was defined by a wall (**313**) orientated east to west, the stepped foundations of which were exposed on the northern side. On the northern side of this wall was a final regularly laid stretcher pattern engineering brick surface (**311**). This abruptly stopped at the northern end of the trench.

All of these surfaces were overlain by the same deliberately laid rubble levelling deposit (**312**/ **301**). This deposit was composed of large blocks of masonry, deliberately placed to create a level infill suitable for building a yard upon. Examples of glass, sieges and furnace bricks were found within this deposit (§10). The trench was sealed by a tarmac layer (**300**) which made up the modern yard surface. The floor surfaces identified within this trench correlate directly with the plans of 1930 and 1934, which clearly show the range of separate rooms and buildings (Figs. 10 & 12).

7.2.4 Trench 4 (Figure 20, Plate 75)

Trench 4 was located towards the northern end of site in an area between the modern buildings. It was orientated northeast to southwest and was 10m in length by 1.8m in width. The trench was designed to examine the extent of workshops to the north of the site.

A silty subsoil and overburden deposit (**402**) was identified at the northern end of this trench. This was a relatively clean and showed little sign of disturbance. This was overlain at the southern end by a regularly laid, machine-cut, unfrogged 9¾ x 4 x 3 in. engineering brick surface (**403**) defined along the northern edge by a regular line of bricks. This location of this surface again matched the plans of 1930 and 1934 (Figs 13 & 15). Covering these deposits were modern demolition overburden deposits. These were a mixture of silty, carbon-rich and brick rubble deposits (**401**), out of which evidence of glass making were recovered. This included refractory bricks and lumps of un-worked glass (§.9.1).

7.2.5 Trench 5(Figure 20, Plate 76)

Trench 5 was located at the far northeastern side of site in an area between the modern peripheral buildings. It was orientated north to south and was 10m in length by 1.8m in width. The trench was designed to examine the possible survival of buildings depicted on the Piggot-Smith maps of 1852 in the northwest of the site.

The natural orange sand and gravel subsoil (**503**) was encountered across the trench at a depth of 137.7m AOD. The corner of a wall (**504**) was identified at the western end of the trench. This structure was composed of machine-cut, unfrogged, 9¾ x 4 x 2¾ in. red bricks, set in a random bond within a cement based mortar. The wall was truncated down to its foundations which were composed of crushed brick and mortar. The wall and subsoil layer were overlain by two contemporary deposits of demolition overburden deposits (**501**/ **502**). These were composed of demolition rubble within a silty clay matrix. The trench was sealed by reinforced concrete surface (**500**).

8 SUMMARY OF ARCHAEOLOGICAL FEATURES

Archaeological features and process related residues and construction materials were found within four of the five trenches. These features confirmed the presence and preservation of the glasshouse structures identified within the historic mapping. The principal dated features were:

- The foundations of the outer elevation of the glass cone and its later phases of alteration, observed in Trench 2. The glass works is mentioned in the documentary sources as having been established in 1805 and the cone itself is first evident in the Kempson map of 1810 (Figure 4).
- A series contemporary and successive floor surfaces and structures dated to the early 19th to 20th centuries observed in Trenches 3 and 4.
- The corner of a brick structure of 19th to 20th century origin observed in trench 5.
- A range of process residues and construction materials relating to the period of the glassworks identified in trenches 3 and 4.

9 THE FINDS

A range of residues and construction materials relating to the glassworks were identified, all of which came from overburden deposits related to the abandonment of the glassworks, in particular the furnace. This artefactual evidence supports the historic and archaeological evidence of the existence, use and systematic destruction of the glass furnace. The artefacts themselves cannot be directly attributed to the glassworks in its functioning lifespan. However, they provide an important indicator of the potential for further analysis at the next phase of work.

9.1 Glass

The discarded remains of the glass products, broken during the time of blowing or during the finishing processes, were recovered from the brick rubble layer (**312**) from within Trench 3. A

variety of forms and colourings were identified including clear, blue and pink, some of which appeared to have been moulded glass forms (Plate 81).

Broken lumps of raw glass which had not been formed or gathered were identified from within the brick rubble layer (**401**) from within Trench 4. These lumps were found in a range of colours from blue through green, red and clear. These showed the variety of colours being produced (Plate 79).

Full details of the analysis of the glass from contexts (**312**) and (**401**) are provided in Appendix D.

9.2 Sieges (Plate 77)

Several vitrified glass coated sieges were recovered from the overburden of Trench 3. These sieges were placed within the centre of the furnace for the placement of the crucible pots (Crossley 1990, 238). The sieges were conical in shape, formed by a series of fused together, stacked circular ceramic blocks. They ranged in size from 0.10m depth x 0.3m in diameter to 0.4 depth x 0.4m in diameter. Some were partially coated in spilled glass and all had been subjected to significant degrees of sustained temperature causing them to fuse and vitrify.

9.3 Furnace bricks (Plate 78)

Refractory bricks were recovered from two of the five trenches. These were of composed of differing types. Recovered from within the brick rubble layer of trench 4 (**401**) were several ordinary 9 x 4½ x 3 in. mid yellow, fire bricks with two types of makers marks; TIMMIS STOURBRIDGE and NETTLE stamped on their faces. Accumulations of spilled glass were adhered to the surface of some of these fire bricks confirming their original purpose as being part of a furnace construction. The firebrick stamped TIMMIS was manufactured by a company called Messrs. Timmis and Company of Lye, Stourbridge, established in 1869 (http://www.tom.cockeram.clara.net). The firebrick stamped NETTLE was possibly manufactured by a company in Manuel, Lanarkshire named Stein Refractories which was established in the late-19th century (http://www.28dayslater.co.uk/forums/ showthread. php?t=21823).

A wide range of types of furnace blocks were also recovered from Trench 3. These ranged in size and shape from 9 ½ x 7 x 3 inches to 22 x 18 x 10 inches in size. They varied in shape from rectangular to trapezoidal and there were groups of types. These blocks had stamps printed onto their surfaces, this included a numbering and lettering system which would have enabled the builders to construct the furnace following a numbered plan. The marks included the name LAVA and numbers 14, 16, 17, 18 and 20, followed by different letters. Many of these blocks were complete suggesting a deliberate dismantlement of the furnace. They had also been regularly stacked and laid upon the abandoned yard surface within trench 3 to create a raised level sufficient for the laying of a later surface.

9.4 Vitrified Glass Residues (Plate 80)

Also found within Trench 4 were glass-like materials, which may have resulted from the clearance of the impurities which floated of the top of the batch of the crucibles. These were white and black and had a more bubbly and slag like appearance.
(Barker and Cranstone (Eds) 2004, 20)

10 DISCUSSION

Assessment of the upstanding buildings occupying the site revealed a total of seven phases of development, beginning with the late-19th century and ending with the final elements of construction post-1954, a number of the upstanding buildings were erected to respect former structures and may incorporate earlier fabric within them.

Of the remaining buildings, few related to the works when it was used as a glassworks, with the majority relating to its later adaptation as the Ford Motor Research Works in the 1950s. Survival prior to the 20th century was limited to a single gable façade of a former building incorporated into the later construction of structure K. The works were remodelled extensively during the 1930s as shown on plans for the renovation (Figs 9—12) and elements of this final phase of the glassworks are revealed within the surviving fabric of the buildings.

Structure D in particular is known to have been part of the former a series of two lehrs running north to south through the site and is depicted on the 1930s plans. Elements of the present build date to this period. However, extensive remodelling and adaptation have led to little evidence surviving for their use during the glassworks. However, the plan form as presently seen closely matches that of the depicted plans. The lehr was used to allow the slow cooling of formed glass to prevent stress fractures associated with rapid cooling. These would have been a long linear open space that could have been adapted within the later Ford works for a production line or workshop.

Although original fabric generally did not survive within the works residual evidence for the former layout of the works did. In particular structures H, I, J and K correspond closely to earlier layout and suggest replacement of structures was a gradual process of replacement and infilling and was rarely wholesale. In particular structure H in its present form is known to have been a direct replacement of the second glass house referred to as the *'small glass house'* on the 1930s plan (Figure 10). There is no structure depicted on the Piggot-Smith Map of 1855 (Figure 5) but the area has been built on by the 1st Edition Ordnance Survey Map of 1889 (Figure 6). Glass cones had fallen out of use in the early years of the 19th century. This structure would have been a louvered ventilated roofed building with a central vent or more probably a stub chimney over the furnace. This may be indicated on the first floor plan by the smaller circle to the right. Parallels can be seen from the derelict Cannington Shaw Bottle Works St Helens. Given it was probably built in the 1860s it was likely to have been coal fired. Larger manufacturers of sheet glass such as Chance and Pilkington were making producer gas onsite from about that date but this would not apply in Walsh Walsh's case and is too early to use a town's gas supply. The tunnels that ran beneath this glass cone are the key to understanding the firing technology. It is possible that at this date we are seeing the transitional period from manual to semi-automatic stoker mechanism (P. Bone Pers Comm).

Several phases of earlier fabric were revealed by further analysis beneath structure H of the subterranean elements of the building. These surviving cellars related to tunnels beneath the glassworks which would have formed the extensive tunnels running underneath the floor of the cone, serving the dual purpose of transportation of the raw materials and conduction of the air to the coal bed within the centre of the furnace. The tunnels are depicted on the 1930s plans (referred to as caves). The earliest phase of the tunnel complex (H3 to H4) ran directly under the central furnace of the glass cone. It is likely to date to the earliest phase of the glassworks and was probably constructed contemporarily with the glass cone, confirmed to have been in existence in 1810. Cellars located beneath structure B run in the same direction as these tunnels and may be adaptations of pre-existing tunnels associated with the glass cone.

The *'small glass house'* appeared to be served by a tunnel that ran diagonally from the tunnel above directly beneath the furnace (structure H5). The date of this tunnel was slightly later than that beneath the main glass cone (H3).

Directly beneath structure H the area was a large open cellar. The 1934 plan suggest that this was a coal bunker (Figure 12). Whether this was open or enclosed is unclear but the use of narrow Rigid Steel Joists and the brickwork suggest a date consistent with the earlier part of the 20th century prior to the 1930s plans where they are first depicted.

The natural geological substrate was identified at approximately 0.8m below present ground level and well preserved archaeological features relating to the period of the glassworks were present at a depth of 0.2m below the present ground level. The archaeological features identified were predominantly of early-19th to 20th century date and they confirmed both the location and preservation of the glasswork buildings noted in the historical sources. Archaeological features and process related residues and construction materials were found within four of the five trenches. These features confirmed the presence and preservation of the glasshouse structures identified within the historic mapping.

Trench 1 provided limited evidence of human intervention apart from the insertion of a modern ceramic and concrete drainage pipe. Trenches 2 to 5 revealed structural and residual evidence of the 19th century glassworks buildings including the main areas of manufacturing (glass cone) and the workshop areas around the periphery.

The truncated foundations of the circular glass cone, along with the remains of a building extension attached to its exterior were exposed in Trench 2. The glass works is mentioned in the documentary sources as having been established in 1805 and the cone itself is first evident in the Kempson's map of 1810 (Figure 4). The identified remains are likely to represent two phases of construction from this early-19th century period. A series of brick floor surfaces constructed over the early-19th to 20th century periods, were exposed in Trenches 3 and 4. These represent the remains of workshop buildings likely to have housed the glass finishing processes. Further structural evidence, of 19th to 20th century origin, was identified within Trench 5.

Interestingly, a range of process residues and construction materials relating to the period of the glassworks were identified in Trenches 3 and 4. These can be grouped into the discarded remains of the glass products, broken lumps of raw glass, sieges and furnace bricks. These materials came predominantly from destruction layers associated with the adaptation of the works to its final function as the Ford Motor Research Works. As such they cannot be directly associated with the processes occurring within the glassworks. However, they are representative of the potential assemblages located within the site and the potential for further analysis of these samples.

The assemblage of glass and glassworking debris from this site provide some significant insights to the sorts of glassworking which took place, however, these first analyses also pose questions which cannot be answered at this point.

Lead was a significant component of all but one sample of the glass and glassworking debris and there can be little doubt that most of the material recovered so far relates to the manufacture of lead or flint glass. The disparity between the composition of the flint glassworking debris and the flint glass vessels is surprising and can only be reconciled with further investigations of samples from this site.

The use of soda in addition to potash for the manufacture of much of the flint glass can be seen in the samples analysed. The available documentary evidence suggests that this phenomenon may be limited to the First World War and a few years afterwards. This would be consistent with dates given for the final period of expansion of the glassworks in the early part of the 20th century and would date the brick-rubble deposit (**312**) to this period.

The red lump of glass (from **401**) has a most unusual chemical composition and may have been an experimental batch. The use of selenium and cadmium to provide the red colour of this glass indicate that it was manufacture during the 20th century. The Walsh Walsh works were famous for their red tinted glass products and this may indicate further experimentation during the 20th century.

11 IMPLICATIONS

Confirmation of the existence and state of preservation of the Soho Glassworks has been achieved through a combination of archaeological evaluation and building recording. The redevelopment of the site following the extensive reconstructions of the early 20th century has destroyed the above ground evidence of the glassworks. However, below ground remains pertaining to the tunnel complex of the glass cone is retained as cellaring. The evaluation has successfully characterised the archaeological remains between the areas of upstanding buildings. Partial remains of the glass cone itself were also exposed beneath the current yard surface. The remains of associated workshops were preserved beneath the yards around the periphery of site. Evidence of process residues and construction materials were exposed within the overburden deposits supporting the preserved structural evidence.

The foundations, furnaces, flues and firing tunnels of an early 19th-century glassworks were typically quite substantial, brick built and extended up to two metres below surface. Therefore the survival of cellaring beneath the existing buildings which relate to the flues and firing tunnels of the furnace suggest further survival may be possible. The main furnace would have originally been coal fired, although this may have been changed to gas during the 1930s rebuild. Evidence of the coal store, firing mechanism and ash pits may survive beneath the existing buildings. There would also have been a batching room and storage for colours and chemicals, which may also be preserved. The majority of Walsh Walsh glass was cut or engraved, this would have had a separate building. Walsh Walsh only made limited use of pressing or chemical (Hydrofluoric Acid) etching, although these could have been used on some of their wartime work.

The study of the post-medieval glass industry has tended to concentrate on product rather than process. Glass fragments survive well and a glass typology provides useful dating evidence. Many complete pieces survive in excellent condition from the 17th century onwards and there are private and public collections which provide good examples. The changes to process are less well understood and documented than the changes to product.

Many works closed in the last quarter of the 20th century and few examples of this type of glassworks are known to survive even as below ground remains. The Soho Glassworks site could contribute significantly to our understanding of later glass processes since it spans a vital period from the early-19th to the mid-20th century (P. Bone Pers. Comm.).

Further evidence is likely to be preserved beneath the present factory buildings and yard surfaces. A certain amount of below ground disturbance is anticipated due to the alterations and extensions to the 19th-century tunnel complex and the foundations of the 20th-century factory buildings. It is anticipated though, that further 19th-century glasswork remains are

likely to continue beneath the present factory buildings. There is also the potential for the recovery of further process residues.

As part of the original brief produced by Birmingham City Council (Appendix A) the work covered in this report constitutes Phase 1 of the archaeological process. Phase 2 will involve full excavation to follow the demolition to slab level of the upstanding buildings. Where the buildings overlie the excavation area demolition should be done under archaeological supervision in the form of a watching brief. Following consultation on site with Mike Hodder of Birmingham City Council in view of the results of the evaluation, an area of excavation has been recommended that incorporates the dimensions of the 'Large Glass House' and the area of the 'Small Glass House' and subterranean structures beneath. Evaluation was deemed sufficient regarding the structures noted on the 1930 plan to the north and west of the main Glass Cone as these were associated with post-production finishing processes and storage and the archaeological trace left by these would be unlikely to further enhance our knowledge of 19th-century glass manufacture.

The extent of the area suggested for excavation is indicated on figure 21.

The key questions to be addressed by the excavation should be;

1. The extent of the survival of the glass cone and associated furnace as revealed in Trench 2.
2. The extent and relationship of structures associated with the glass cone.
3. Processes associated with the glass cone.
4. The relationship between the surviving glass cone and the subterranean structures and what these reveal about the function of these structures.
5. Processes specific to the glassworks as revealed by scientific analysis of residues collected during excavation.

12 ACKNOWLEDGEMENTS

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APPENDIX A: Birmingham City Council Brief

BIRMINGHAM CITY COUNCIL
DEVELOPMENT DIRECTORATE
Application number C/04024/03/OUT
112 Lodge Road, Hockley

Site of Soho Glassworks (SMR 20052; grid ref SP 051883)
Design Brief for Archaeological Investigation required as a condition of planning permission

1. Summary
Proposed development at 112 Lodge Road includes the site of Soho Glassworks and is therefore likely to affect below-ground archaeological remains including the glass cone and other buildings. This brief is for building recording and archaeological excavation in advance of commencement of development, followed by analysis and publication of the results, as a condition of planning permission.

2. Site location and description
The site is on the north side of Lodge Road and is currently occupied by some derelict former workshops and some still in use, with yard surfaces around them.

3. Planning background
Application number C/04024/03/OUT is for residential development. The application site includes most of the former glassworks site.
Because the site is likely to include archaeological remains which would be affected by the proposed development, conditions have been placed on planning permission requiring implementation of a programme of archaeological investigation in advance of commencement of development. This will consist of recording existing visible above and below ground structures and archaeological excavation.

This is in accordance with Policy 8.36 of the Council's Unitary Development Plan, government advice in Planning Policy Guidance Note 16, Archaeology and Planning, and the City Council's Archaeology Strategy (Supplementary Planning Guidance).

4. Existing archaeological and historical information
The Soho Glassworks was established in 1805. It was owned by Shakespear, Johnson and Berry, cut and plain glass and glass toy manufacturers, and was taken over by John Walsh Walsh in 1852/3. It was rebuilt in 1934-36 and was out of use in 1952. Kempson's map of 1810 shows the glass cone set back from the road, workshops its west, north and east, and a canal arm to its east. An illustration of 1865 shows the cone behind buildings on the road frontage. Although none of the 19th century glassworks buildings survives above ground, remains of them are likely to survive below ground, including the base of the cone and passages or caves leading into it and footings of workshops.
An archaeological desk-based assessment was carried out in 2004. This suggested that the ground level had been raised when the glassworks was built, and that there was therefore high potential for survival of part of the base of the cone and associated flues and structures under the existing yard areas, and also under the existing buildings.

5. Requirements for work
The building recording and archaeological excavation are required to ensure that archaeological remains on the site are fully investigated and recorded in advance of damage or destruction by the proposed development.

In particular, the building recording and archaeological excavation must address the following:
Structural details of the glass cone and other structures belonging to the glassworks;
Evidence for alterations and additions to the structures over time and their relationship to the processes and products of the industry;
Similarities and differences between the structural remains and those at other surviving and excavated glassworks in the West Midlands;
The implications for the likely survival and significance of below-ground archaeological remains at other glassworks sites in Birmingham.

6. Stages of work

(i) Building recording:

A written, drawn and photographic record is to be made of all visible above and below-ground structures before any demolitions take place. This is to consist of

- A photographic record of as much of the structures as is safely accessible;
- Measured plans and elevations at an appropriate scale;

A written analytical description, identifying structures belonging to the glassworks, phases of development and modifications after the glassworks went out of use

(ii) Excavation: evaluation

The first stage of excavation is to be undertaken before any demolitions take place. It will consist of excavated trenches in current open parts of the site, located so as to sample each part of the proposed development site and to examine particular features of the site suggested by the desk-based assessment and recording of visible structures, including the cone and workshops. The exact location and size of each trench is to be agreed on site with the Planning Archaeologist prior to commencement. Surface deposits in each trench are to be mechanically removed, under archaeological supervision. Subsequent excavation is to be entirely manual. Excavation in each trench is to be sufficient to define, record and sample all archaeological features encountered. The potential of industrial residues must be assessed. Finds are to be cleaned, marked and bagged and any remedial conservation work undertaken.

(iii) Excavation: Area excavation

The extent of area excavation will be determined by the results of the evaluation and building recording. It will follow demolition of existing structures to slab only. No foundations are to be grubbed out. The slab and all surface deposits are to be mechanically removed, using a toothless bucket, under archaeological supervision, and exposed archaeological features and deposits are to be manually cleaned and planned. A strategy for the excavation is to be agreed with the Planning Archaeologist. Deposits likely to contain provide environmental data or industrial residues are to be sampled and analysed. 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).

(iii) Post-excavation Analysis:

Following assessment, analysis of the results of the project, including dating and interpretation of recorded buildings and structures and excavated features, and the relationship between the recorded buildings and excavated features, analysis of industrial residues and other finds

analysis, and discussion of the results in their local, regional and national context. The excavation results are to be combined with the results of building recording and analysis.

(iv) Preparation of a report for publication in an archaeological journal:
A written report combining the building recording and excavation and 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.Staffing
The building recording and archaeological excavation are to be carried out in accordance with the Code of Conduct, Standards and Guidelines of the Institute of Field Archaeologists, 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 of Field Archaeologists.

8.Written Scheme of Investigation
A written scheme of investigation for the building recording and excavation 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. Monitoring will include the following:

(i) Site visits during building recording, at least weekly;
(ii) Consideration of building recording report;
(iii At least one site visit during the evaluation stage of excavation;
(iv) Consideration of proposals for area excavation;
(v) Consideration of area excavation strategy following machining;
(vi) Site visits during area excavation, at least weekly;
(vii) Consideration of post-excavation assessment report;
(viii) Monitoring post-excavation analysis;
(ix) 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 the Department of Human History, 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.Publication
In addition to the full report described in Part 6 above, the contractor must submit a short summary report for inclusion in West Midlands Archaeology and summary reports to appropriate period journals such as Post Medieval Archaeology and Industrial Archaeology News.
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

Date prepared: 20 October 2006

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SohoGlassworksBUILDINGRECORDINGANDEXCAVATION201006.doc

APPENDIX B: Written Scheme of Investigation

Winson Green, Birmingham.

THE UNIVERSITY OF BIRMINGHAM

ARCHAEOLOGICAL EVALUATION AND HISTORIC BUILDING RECORDING:
WRITTEN SCHEME OF INVESTIGATION

Planning application reference no.
C/0424/03/OUT
Developer: Morris Homes (West Midlands Ltd)

Archaeological Contractor: Birmingham Archaeology

Birmingham Archaeology

1 INTRODUCTION

This document describes the programme of work required to undertake an archaeological investigation at the above site. It forms the written scheme of investigation for the work, which is a requirement of the brief prepared by Birmingham City Council (Hodder 2006). Any variation in the scope of work would be agreed with the Mike Hodder, City Archaeologist, Birmingham City Council before implementation

A planning application (Planning application reference no. C/0424/03/OUT) has been approved by Birmingham City Council for the proposed residential development of 112 Lodge Road, Winson Green, Birmingham. As the proposed development site is of possible archaeological significance a programme of historic building recording and an archaeological evaluation has been recommended by the Mike Hodder, City Archaeologist, Birmingham City Council and placed upon the terms of the planning condition. This is in accordance with Policy 8.36 of the Council's Unitary Development Plan, government advice in Planning Policy Guidance Note 16, Archaeology and Planning, and the City Council's Archaeology Strategy (Supplementary Planning Guidance).

The historic building recording and archaeological evaluation represent the first stage of the programme of archaeological work. These will help inform further archaeological excavation work required by the approved planning consent and outlined in the brief (Hodder 2006) to be carried out on termination of the demolition to slab level and prior to any grubbing out of foundations or below ground structures. A programme of post-excavation analyses and publication will follow this and the second phase of work will be subject to a second approved written scheme of investigation.

2 SITE DESCRIPTION AND LOCATION

The site is located on the northern side of Lodge Road to the east of the centre of the suburb of Winson Green, Birmingham, and is centred on NGR SP 051883.
The present character of the site is upstanding derelict factory buildings of the former Ford Motor Company, with areas of concrete and tarmac hard-standing inbetween. The site naturally slopes from south to north with the area at the north of the site built-up to accommodate the factory. The eastern side of the site is dominated by the basin of a derelict canal. The site is bounded to the south by Lodge Road and to the north by the mainline railway between Birmingham and Wolverhampton.

3 ARCHAEOLOGICAL AND HISTORICAL BACKGROUND

The Soho Glassworks was established in 1805. It was owned by Shakespear, Johnson and Berry, cut and plain glass and glass toy manufacturers, and was taken over by John Walsh Walsh in 1852/3. It was rebuilt in 1934-36 and was out of use in 1952. Kempson's map of 1810 shows the glass cone set back from the road, workshops its west, north and east, and a canal arm to its east. An illustration of 1865 shows the cone behind buildings on the road frontage. By the late-19th century it was known as the Soho and Vesta Glassworks and two furnaces were operating both dedicated to the production of fine glass. Although none of the 19th century glassworks buildings survives above ground, remains of them are likely to survive below ground, including the base of the cone and passages or caves leading into it and footings of workshops. Evidence for the earlier structures may exist in the upstanding buildings on the site at present.
An archaeological desk-based assessment of the glassworks was undertaken in 2004 (Ramsey 2004). This suggested that the ground level had been raised when the glassworks was built, and that there was therefore high potential for survival of part of the base of the cone and

associated flues and structures under the existing yard areas, and also under the existing buildings.

4 AIMS AND OBJECTIVES

The principle aim of the historic building recording and evaluation is to determine the character, extent, date, state of preservation and the potential significance of any upstanding and buried archaeological and historical remains.
In particular the programme of work will aim to record and understand the following:
Structural details of the glass cone and associated structures belonging to the glassworks.
Evidence for alterations and additions to the structures over time and their relationship to the processes and products of the industry.
Similarities and differences between the structural remains and those at other surviving and excavated glassworks in the West Midlands.
The implications for the likely survival and significance of below-ground archaeological remains at other glasswork sites in Birmingham.

5 METHODOLOGY

Building recording:
A written, drawn and photographic record will be undertaken of all visible above and below-ground structures before any demolitions take place. This will consist of
- A photographic record of as much of the structures as is safely accessible;
- Measured plans and elevations at an appropriate scale;
- A written analytical description, identifying structures belonging to the glassworks, phases of development and modifications after the glassworks went out of use

Specifically the following methodology will be adopted for each element;

Photographic Survey

The photographic survey will be carried out with a 35mm camera using black and white film and a photographic scale, and will be supplemented by colour digital coverage. The survey will consist of both general external and more detailed internal photographs including fixtures and fittings. Photographs will be recorded on pro forma register sheets indicating location, scales used, orientation, photographer and date.

Measured Survey

A measured survey will be made of the current layout of the building including below ground passages and cellars and a reflectorless total station survey of specific elevations within the building that relate to earlier phases of the glassworks. If deemed the most suitable technique the option to use a Cyrax Laser Scanner may be adopted for certain areas on consultation with the Planning Archaeologist. These will conform to a standard equivalent to RCHME Level 3 (RCHME 1996). The drawings will include plans, elevations and sections. The survey will be placed within a Geographic Information System (ArcGIS) in order to accurately overlay historic mapping data and plans and aid analysis.

Written Record

An analytical description will be compiled on pro forma building and room record sheets, and will involve a systematic elevation by elevation, and room by room, treatment. These field notes will be used as basis for the definitive account.

The analytical description will aim to identify structures belonging to the glassworks, phases of development and modifications after the glassworks went out of use.

Evaluation

The Phase 1 evaluation will be undertaken before any demolitions take place. It will consist of c. 80m length of excavated trenches c. 1.8m width in currently open areas of the site. Trenches will be located to in order to attempt to locate 19th-century survival of the glassworks as defined on the historical map evidence outlined in the desk-based assessment (Ramsey 2004). Trial-trenches will be surveyed-in using an EDM total station or other appropriate survey instruments.
This will specifically involve the following trenches;

- Trench 1 20m x 1.8m – designed to examine workshops at the south of the site as defined on the plans of 1935.
- Trench 2 15m x 3.6m – designed to examine the survival of the former glass cone.
- Trench 3 20m x 1.8m – designed to examine workshops on the west of the site.
- Trench 4 10m x 1.8m – designed to examine the extent of workshops to the north of the site.
- Trench 5 10m x 1.8m – designed to examine the possible survival of buildings depicted on the Piggot-Smith maps of 1852 in the northwest of the site.

All topsoil and modern overburden will be removed using a JCB type mechanical excavator with a toothless ditching bucket below the hard-standing material, under direct archaeological supervision, down to the top of the uppermost archaeological horizon or the subsoil. Subsequent cleaning and excavation will be by hand. A representative sample of archaeological features and deposits will be manually sample excavated sufficiently to define their character and to obtain suitable dating evidence. Generally, 50% of pits or postholes and a 1m section of linear/ curvi-linear features will be excavated. Archaeological deposits will not be completely excavated unless this is unavoidable. The depth of archaeological deposits across the site will be assessed, although the full length of every trench will not necessarily be excavated down to natural.

All stratigraphic sequences will be recorded, even where no archaeology was present. Features will be planned at a scale of 1:20, and sections will be drawn of all cut features and significant vertical stratigraphy at a scale of 1:10. A comprehensive written record will be maintained using a continuous numbered context system on pro-forma context and feature cards. Written records and scale plans will be supplemented by photographs using monochrome, colour slide photography for archive supplemented by high quality digital photography.
Bulk 20 litre soil samples will be taken from suitable datable archaeological features for the recovery of environmental or industrial residues. The environmental sampling policy follows the guidelines contained in the Birmingham Archaeology Guide to On-Site Environmental Sampling and the Report of the Association for Environmental Archaeology Working Party on Sampling and Recovery, September 1995. The sampling of industrial residues will comply with the guidelines set out in the Science for Historic Industries (English Heritage 2006).
Specifically these will aim to;
Sieved samples of working surfaces to recover glass fragments.
Glass samples from in and around the cone for identification of type and raw material.
Sample deposits of material for identification (clay for crucibles, glass raw materials).
Sample fuel for identification.
At the evaluation stage sampling will seek to identify the potential for analysis within further stages of archaeological work.

Recovered finds will be cleaned, marked and remedial conservation work will be undertaken as necessary. Treatment of all finds conformed to guidance contained within 'A strategy for the care and investigation of finds' published by English Heritage.
The full site archive will include all artefactual and/or ecofactual remains recovered from the site. The site archive will be prepared according to guidelines set down in Appendix 3 of the Management of Archaeology Projects (English Heritage, 1991), the Guidelines for the Preparation of Excavation Archives for Long-term Storage (Walker 1990) and Standards in the Museum Care of Archaeological collections (Museum and Art Galleries Commission, 1992). Finds and the paper archive will be deposited with Department of Human History, Birmingham Museums and Art Gallery subject to permission from the landowner. They will be deposited in the standard boxes used by the City Museum and accompanied by archive lists.

6 STAFFING

The project will be managed and directed for Birmingham Archaeology by Chris Hewitson (or a Birmingham Archaeology Project Manager of equivalent experience) the evaluation will be supervised in the field by Will Mitchell and the historic building recording will be supervised by Shane Kelleher assisted by a team of three experienced site assistants (or other suitably qualified and archaeologists, details to be notified, prior to the commencement of the fieldwork).

Specialist on-site advice regarding the glassworks will be provided by Peter Bone, an independent specialist in Industrial Archaeology with specific reference to manufacturing industries. He has worked for over 40 years within the manufacturing industries and lectures for the Ironbridge Institute.

Specialist staff will be, where appropriate:

Stephanie Rátkai- Saxon, medieval and post-medieval pottery, Honorary Research Associate and Finds Researcher, University of Birmingham.

Erica Macey-Bracken- Small finds, Birmingham Archaeology, University of Birmingham

Dr Andrew Howard– Archaeo-Geomorphology, Lecturer in Archaeo-Geomorphology and Remote Sensing, Institute of Archaeology and Antiquity, University of Birmingham.

Dr James Greig- English Heritage Archaeological Scientist - pollen and plant macro-fossils.

Dr Wendy Smith- Charred plant remains, Honorary Research Fellow in Archaeo-Botany, University of Birmingham.

Matilda Holmes- Animal bone, freelance consultant archaeozoologist.

Dr David Smith- Micro-fauna, Institute of Archaeology and Antiquity, University of Birmingham.

Dr Megan Brickley- Human Bone, Institute of Archaeology and Antiquity, University of Birmingham.

Dr Roger White- Coins and brooches, Project Manager, Lecturer and Assistant Director (Development), Institute of Archaeology and Antiquity, University of Birmingham.

Rod MacKenzie - slag and industrial residues, freelance consultant.

Rowena Gale- charcoal and wood, freelance consultant.

7 REPORT

A report would be produced for each of the three phases of evaluation. On completion of the fieldwork post-excavation work for each phase, including finds processing/ conservation, analysis and primary research, will be undertaken. A site archive will be compiled and an illustrated report will be prepared. This report would be in the format required by the Management of Archaeological Projects 2 (published by English Heritage), to include:

(a) Summary.
(b) Description of the archaeological background.
(c) Method.
(e) A narrative description of the results and discussion of the evidence, set in their local, regional and national research context, supported by appropriate plans, sections and photographs.
Summary of the finds and environmental evidence.
Specialist assessments of the finds and environmental evidence.
Impact assessment and recommended mitigation strategy

The written report will be made publicly accessible, as part of the West Midlands Sites and Monuments Record within six months of completion. Two copies of the report will be lodged with the Mike Hodder, Planning Archaeologist, Birmingham City Council. A digital copy on CD-ROM will be provided. A summary report may be submitted for inclusion in West Midlands Archaeology. If the results are considered of regional or national importance it may be appropriate to publish the report in an archaeological journal.

8 TIMETABLE

At least one weeks notice of the start of fieldwork will be given to Mike Hodder, Planning Archaeologist, Birmingham City Council. Review/ monitoring meetings will be arranged during the fieldwork.

Week 1: Building recording/ Site surveying of upstanding remains.
Week 2: Building recording/ machine excavation.
Week 3: Machine excavation/ manual excavation
Week 4: Final week of manual excavation and recording/ backfilling of trenches
Weeks 5-6: specialist reports and report preparation

A timetable has not been agreed at present.

9 GENERAL

All project staff will adhere to the Code of Conduct of the Institute of Field Archaeologists. The project will follow the requirements set down in the Standard and Guidance for Archaeological Field Evaluation (Institute of Field Archaeologists 1994, revised 2001).

A detailed Risk Assessment will be prepared prior to the commencement of fieldwork. All current health and safety legislation, regulations and guidance will be complied with. All archaeological work will conform to the Management of Health and Safety at Work Regulations 1992 and Health & Safety in Field Archaeology Manual (SCAUM 1991, revised 2007).

All finds which may constitute 'treasure' under the Treasure Act, 1997 will be removed to a safe place and reported to the local Coroner. If removal is not possible on the same working day as discovery, appropriate security arrangements will be provided to keep the finds safe from theft.

10 REFERENCES

Association for Environmental Archaeology 1995 Report of the Association for Environmental Archaeology Working Party on Sampling and Recovery

Department of the Environment (DoE) 1990 Planning Policy Guidance Note 16: Archaeology and Planning

English Heritage 1991 Management of Archaeological Projects 2

English Heritage 2006 Science for Historic Industries: Guidelines for the Investigation of 17th to 19th-century industries.

Hodder, M 2006 Site of Soho Glassworks Design Brief for Archaeological Investigation, Birmingham City Council

Institute of Field Archaeologists (IFA) 1994 Standards and Guidance for Archaeological Evaluations. Revised 2001

Museums and Galleries Commission. 1992 Standards in the museum care of archaeological collections. London: Museums and Galleries Commission

Ramsey, E 2004 Soho Glassworks, Winson Green, Birmingham: An Archaeological Desk Based Assessment, Birmingham Archaeology Report No. 1230

Standing Conference of Archaeological Unit Managers (SCAUM), 1991 Health & Safety in Field Archaeology Manual. Revised 1997

Walker, K. 1990 Guidelines for the preparation of excavation archives for long-term storage. UKIC, London.

Appendix C: Context Database

Strat. No	Context Type	Description
100	Layer	Black tarmac yard surface
101	Layer	Orangey- red crushed brick hardcore
102	layer	Grey/ red-orange rubble
103	Structure	Concrete and ceramic drainage pipe
104	Layer	Natural orange sand and gravels
200	Layer	Concrete yard surface
201	Layer	Orangey brown sandy clay levelling layer
202	Layer	Brown sandy clay levelling layer
203	Layer	Natural orange sand and gravels
204	Layer	Black and pink hardcore layers
205	Layer	Brown sandy clay levelling layer
206	Fill	Fill of modern service (drainage) trench
207	Structure	Red brick wall of glass cone
208	Structure	Red brick wall of glass cone extension
209	Structure	Red brick floor surface
210	Structure	Red brick corner wall
211	Cut	Cut for wall foundation (210)
212	Structure	Red brick wall
213	Cut	Cut for modern service (drainage) trench
214	Fill	Fill around wall 210 foundation trench
300	Layer	Grey tarmac yard surface
301	Layer	Orange-brown rubble layer
302	Structure	Red brick floor surface
303	Fill	Brown silt bedding layer for surfaces 302 & 304
304	Structure	Staffordshire blue brick floor surface
305	Structure	Truncated red brick wall
306	Structure	Red brick wall
307	Structure	Red brick wall
308	Structure	Red brick wall
309	Structure	Red quarry tile floor surface
310	Structure	Red brick floor surface
311	Structure	Staffordshire blue brick yard surface
312	Layer	Grey, red and black rubble levelling layer
313	Structure	Red brick wall foundations
400	Layer	Black tarmac yard surface
401	Layer	Grey and red rubble levelling layer

Strat. No	Context Type	Description
402	Layer	Grey silt levelling layer
403	Structure	Staffordshire blue brick levelling surface
500	Layer	Concrete yard surface
501	Layer	Orangey-red brick rubble levelling layer
502	Layer	Brown, silty clay levelling layer
503	Layer	Natural orange sand and gravels
504	Structure	Red brick wall

Assessment Report

on

Glass and Glassworking Debris from the Soho and Vesta (John Walsh Walsh) Glasshouse, Birmingham

for

Birmingham Archaeology

by

David Dungworth
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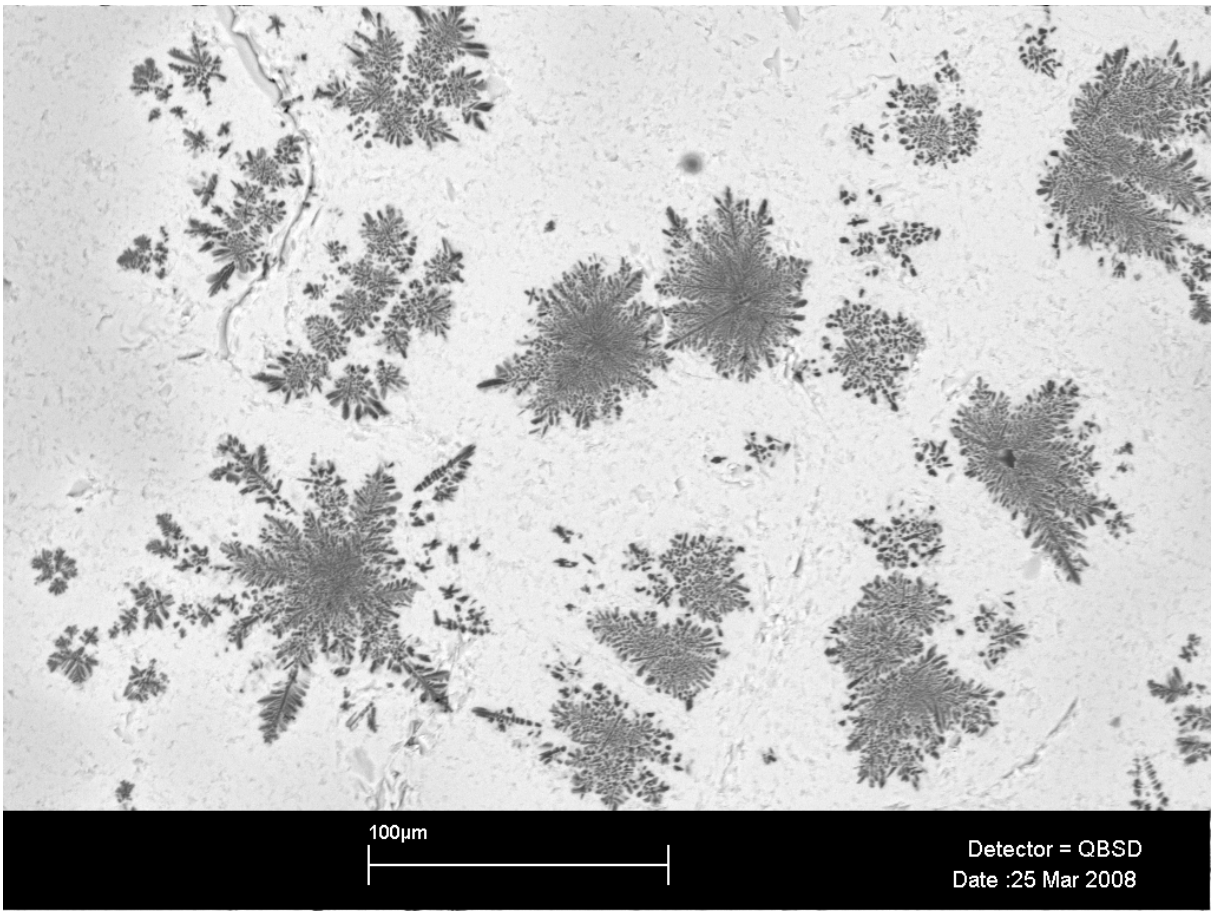

Introduction

This report provides a technical assessment of samples of glass and glassworking debris recovered during the archaeological investigation of a 19th to 20th century glasshouse. The glass vessels are exclusively made of lead or flint glass with some interesting compositional variations. The glassworking debris shows greater compositional variation than the glass vessels and, unexpectedly, none of the glassworking debris shares the same chemical composition as any of the glass vessels.

Background

The site of the Soho & Vesta (Walsh Walsh) Glasshouse in Birmingham has been the subject of archaeological investigation by Birmingham Archaeology. The glasshouse had its origins in the early 19th century and initially produced utilitarian containers and tablewares. From 1850, under the ownership of John Walsh Walsh, the glasshouse began to produce increasing quantities of coloured flint glass. A trade card of 1855 describes the glasses produced as including ‘flint, opal, enamel and colored glass . . . of every description’. The glasshouse continued to produce a wide variety of coloured glass tablewares up to 1951 when it closed. Examples of glass produced by this glasshouse are now prized by collectors.

Methods

The assessment was undertaken on approximately 15kg of glass and glassworking debris recovered from two archaeological contexts. The assessment consisted of the visual examination of all of the submitted material and the chemical analysis of a 25 selected samples. The selected samples were mounted in resin, ground and polished (to a 3-micron finish) and analysed using EDXRF and SEM-EDS.

Flint Glass

The assemblage of vessel glass submitted for examination includes a large proportion of colourless flint glass (Figure 1). A small proportion appears to have been freeblown but most was clearly press-moulded. The vessel forms that could be easily identified include fluted bowls and pedestal bases. The glassworking debris included only one lump of colourless glass waste (sample #04), but several samples of coloured glass waste samples had similar compositions (#03, #05, #06) and are included here. Sample #03 turned out not to be a deliberately coloured glass but had acquired its colours due to devitrification (see cover photo) and the presence of tiny bubbles. The deliberately coloured flint glass vessels present include blue, red and white glass (Figure 2). In some cases the colour is found throughout the glass while in others it is found as a thin layer adhering to colourless flint glass (a technique known as flashing).

Figure 1. Colourless flint glass vessels

Figure 2. Coloured flint glass

Chemical analysis confirms that all of the flint glass is alkali-lead-silicate glass (Figures 3 and 4) but there are variations in the proportions of all major components. The most striking variations are the differences between the glassworking debris and the glass vessels and the variations in soda and potash.

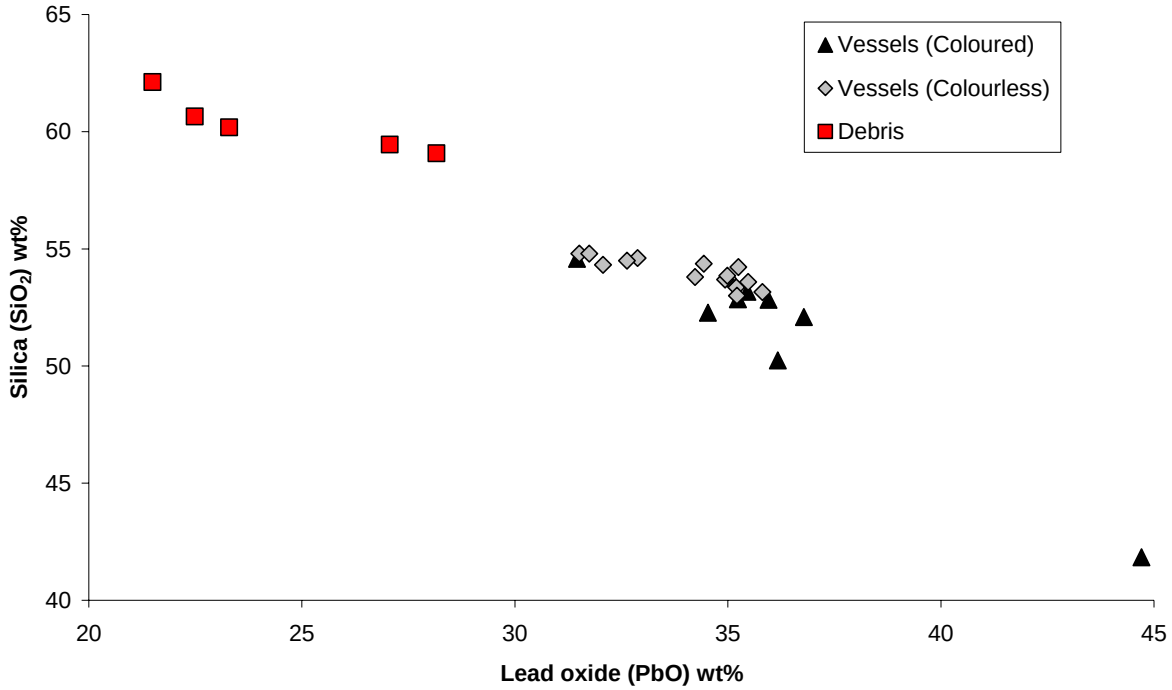

Figure 3. Lead oxide and potash concentrations in the flint glasses.

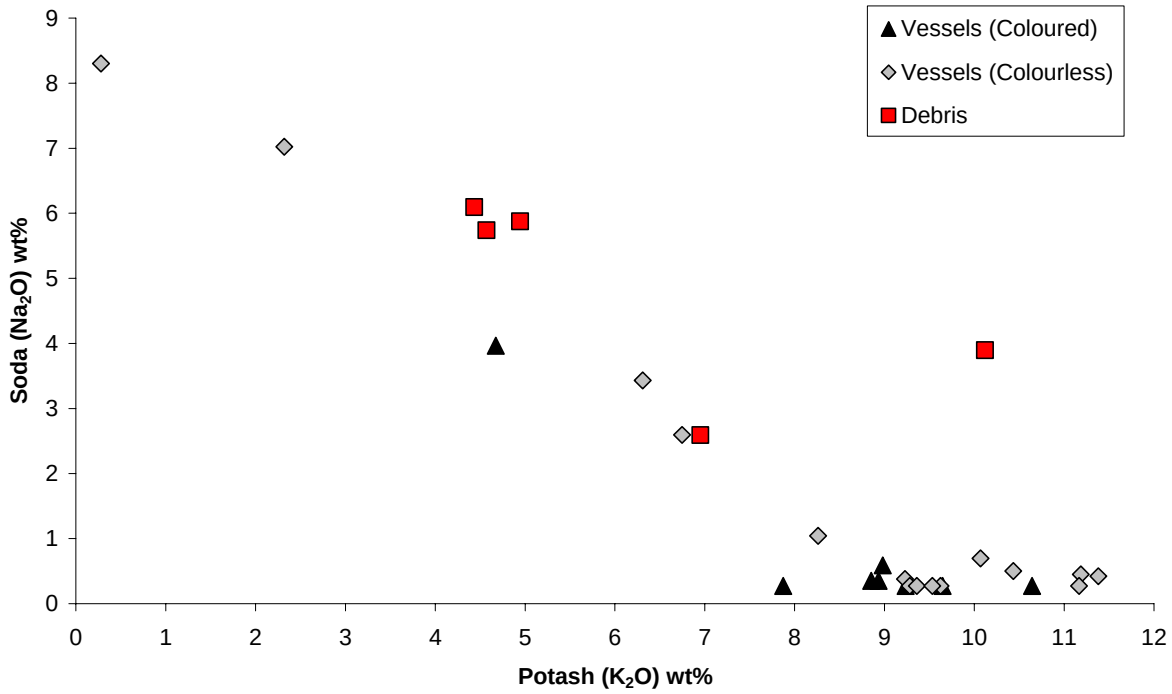

Figure 3. Potash and soda concentrations in the flint glasses

None of the glass vessels recovered from this site share the same composition as any of the glassworking debris. Most of the glass vessels contain around 55% silica and 30–35% lead oxide, while the glassworking debris contains around 60% silica and 20–30% lead oxide. The concentrations of silica and lead oxide in most of the vessels are close to that which would be predicted from batch recipes given in 19th- and 20th-century sources (e.g. Pellatt 1849; Muspratt 1860; Powell *et al.* 1883; Marson 1920). Most of these sources indicate that flint glass was usually made using 3cwt of silica, 2cwt of litharge and 1cwt of potash.

The second striking result of the chemical analyses is the fact that soda is present at more than negligible concentrations in many of the samples of glass vessel and glassworking waste. Surviving 19th-century accounts refer only to the use of purified potassium salts (carbonate, pearl ash, nitre, etc) and give no indication of the use of sodium salts, however, the First World War led to difficulties in obtaining potassium salts (Stassfurth in Germany had been a significant provider) and soda appears to have been used in its place (Rosenhain 1919, 40). Marson states that ‘a second-rate quality of crystal glass for table ware may consist of a silicate of lead and soda’ (Marson 1920, 25), and the proportions given would yield a glass with approximately 8wt% Na_2O, 36wt% PbO and 55wt% SiO_2.

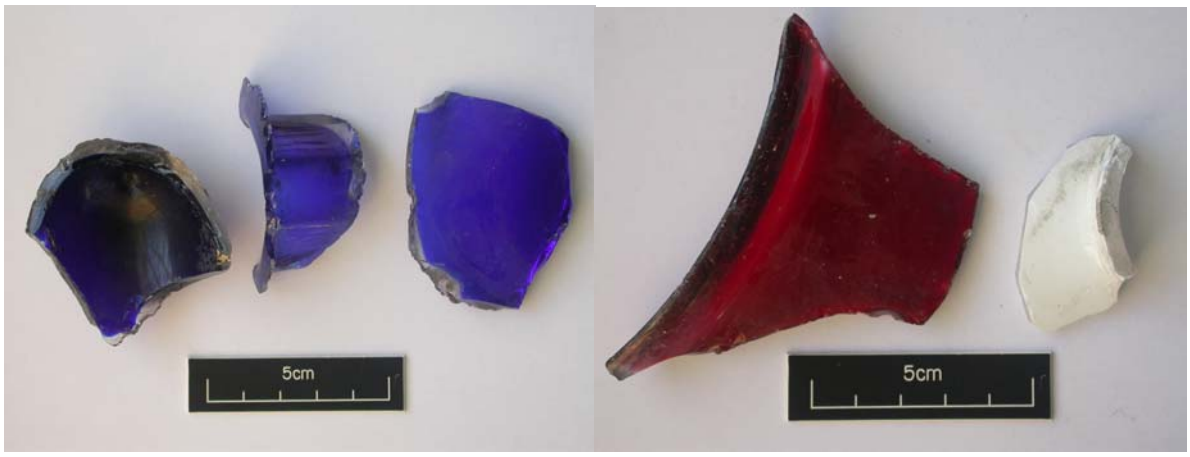

Figure 4. Some of the flash-coloured glass vessel fragmnets

The blue flint glasses are coloured by the presence of cobalt. The entirely blue glasses (#13–15) contain low levels of cobalt (~0.15wt% CoO) as well as some manganese, while the glasses with a flashed blue coating (#10–12) contain greater proportions of cobalt (0.4–1.4wt% CoO) as well as some manganese. The white flashed glass (#09) appears to have been opacified with arsenic and antimony. The red flashed glass (#08) is somewhat puzzling as the only colourants detected are manganese and antimony.

Red glass lump

The large lump of red glass (#02) has a composition which is unparalleled among samples recovered from archaeological excavations of historic glasshouses. It contains much higher levels of soda than are normally seen and appears to be deficient in stabiliser oxides (in most glasses the stabilisers are MgO, CaO and/or PbO). The zinc (ZnO) in this sample may have helped to give the glass some stability. The red colour of this glass appears to be due to the presence of cadmium and selenium. The use of these oxides as colourants in glass is not known to have been common before the beginning of the 20th century.

Figure 5. Lump of red glass

Vitrified furnace fragments

Samples 1 and 7 appear to be fragments of furnace bricks, coated and/or impregnated with glass. These samples contain a wide range of oxides, some of which derive from the refractory clays used to manufacture furnace bricks and some of which certainly derive from the glass(es) melted.

Figure 6. Samples 1a (bottom) and 1b (top)

Oxides that are usually associated with refractory clays are strongly correlated in these samples (Figure 7). The other oxides present in these samples, which are likely to derive from the glasses melted, are numerous (including soda, potash, lime and lead oxide) and may not relate to a single glass type produced on this site. These oxides may have derived from multiple spillages of several different types of glass. The microstructures of both sample #01a and #01b are varied and

complex (Figure 8). The presence of numerous different crystalline phases indicates that this material has spent long periods at elevated temperatures.

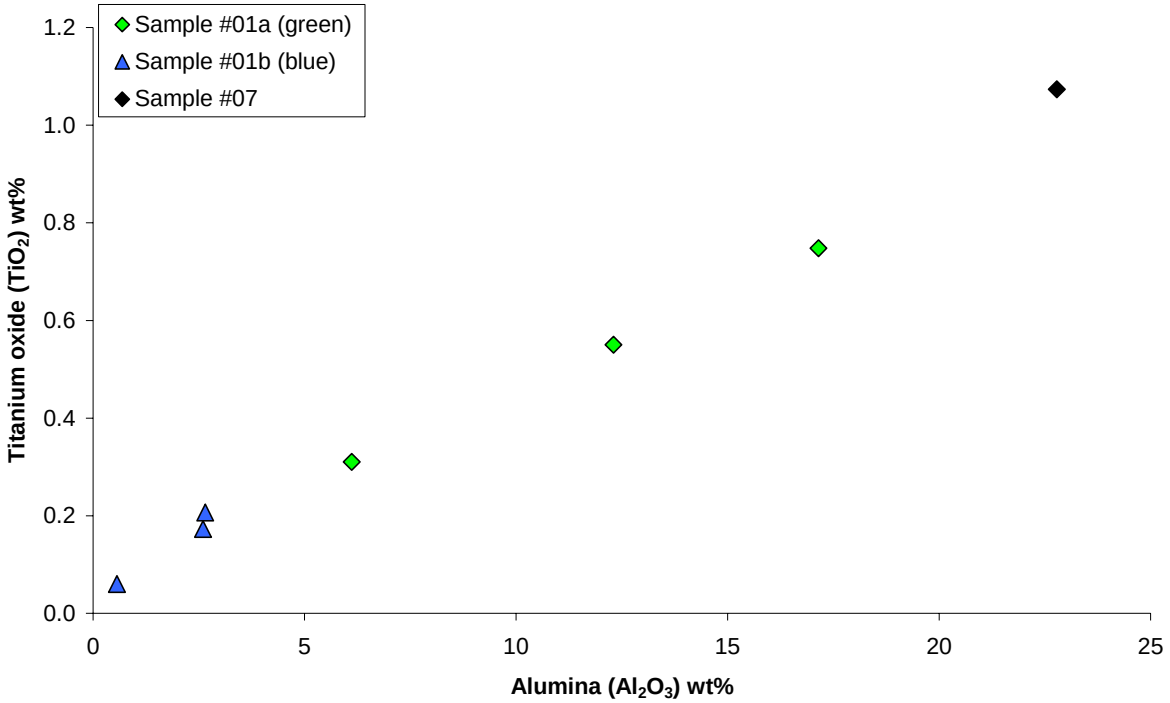

Figure 7. Alumina and titanium oxide content of samples 1 and 7

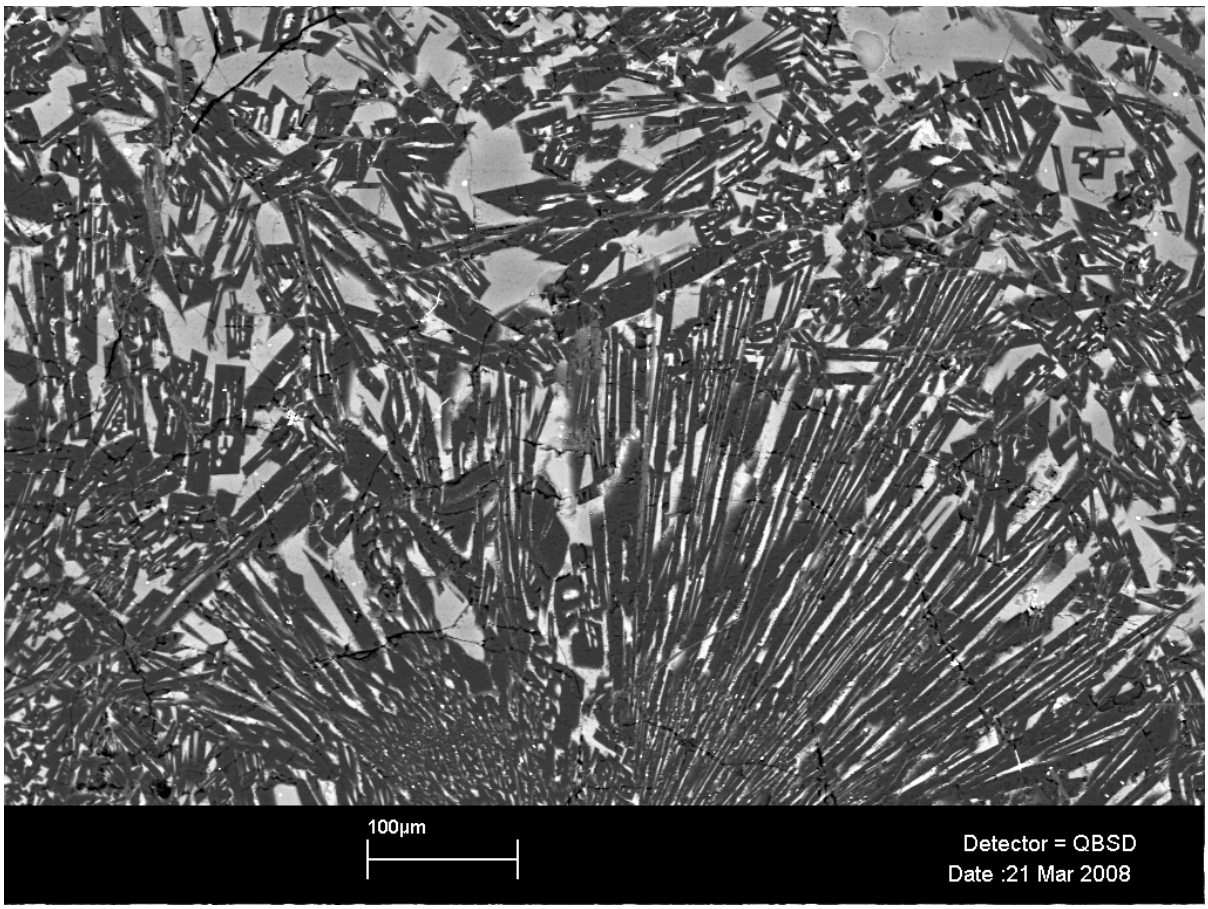

Figure 8. The microstructure (SEM image) of sample 1a (sodium-aluminium-silicate crystals)

Conclusions

The assemblage of glass and glassworking debris from this site provide some significant insights to the sorts of glassworking which took place, however, these first analyses also pose questions which cannot be answered at this point.

Lead was a significant component of all but one sample of the glass and glassworking debris and there can be little doubt that most of the material recovered so far relates to the manufacture of lead or flint glass. The disparity between the composition of the flint glassworking debris and the flint glass vessels is surprising and can only be reconciled with further investigations of samples from this site.

The use of soda in addition to potash for the manufacture of much of the flint glass can be seen in the samples analysed. The available documentary evidence suggests that this phenomenon may be limited to the First World War and a few years afterwards.

The red lump of glass has a most unusual chemical composition and may have been an experimental batch. The use of selenium and cadmium to provide the red colour of this glass indicate that it was manufacture during the 20th century.

References

Marson, P 1920 *Glass and Glass Manufacture*. London: Pitman

Muspratt, S 1860 *Chemistry. Theoretical, Practical and Analytical*. Glasgow: Mackenzie

Pellatt, A 1849 *Curiosities of Glass Making*. London: Bogue

Powell, H J, Chance, H and Harris, H G 1883 *The Principles of Glass-Making*. London: Bell and Sons

Rosenhain, W 1919 *Glass Manufacture*. London: Constable

Chemical composition of samples

#	Description	Area	Na_2O	MgO	Al_2O_3	SiO_2	SO_3	K_2O	CaO	TiO_2	MnO	Fe_2O_3	CoO	ZnO	As_2O_3	CdO	Sb_2O_3	BaO	SeO2	SrO	ZrO2	PbO
1a	Vitrified brick with adhering green glass	black	5.3	0.4	17.1	63.6	<0.2	3.4	2.2	0.75	0.14	2.63	<0.05	0.28	<0.5	<0.2	<0.2	<0.2	<0.2	0.09	0.08	1.3
		green	6.4	0.3	6.1	64.2	<0.2	5.3	3.4	0.31	<0.05	1.21	<0.05	0.12	<0.5	<0.2	<0.2	<0.2	<0.2	<0.05	0.02	9.5
		pale green	5.8	0.2	12.3	63.9	<0.2	5.6	1.7	0.55	0.08	1.73	<0.05	0.19	<0.5	<0.2	<0.2	<0.2	<0.2	0.05	0.05	5.0
1b	Opalescent blue and white glass	blue	12.6	0.1	2.6	67.5	<0.2	1.2	8.1	0.17	0.11	0.78	0.35	0.15	<0.5	<0.2	<0.2	<0.2	<0.2	0.09	0.02	2.3
		pale blue	13.6	0.1	2.7	67.4	<0.2	0.6	8.1	0.21	0.13	0.51	0.23	0.05	<0.5	<0.2	<0.2	<0.2	<0.2	<0.05	0.02	2.3
		white	15.0	<0.1	0.6	68.5	<0.2	0.6	7.6	0.06	0.20	0.00	<0.05	<0.05	<0.5	<0.2	<0.2	<0.2	<0.2	<0.05	0.00	3.0
2a	Red glass lump		21.2	<0.1	0.5	65.6	0.4	0.5	0.1	0.10	<0.05	0.00	<0.05	6.33	<0.5	0.6	<0.2	<0.2	0.57	<0.05	0.00	<0.2
2b	Red glass lump		21.1	<0.1	0.3	66.1	0.3	0.4	<0.1	0.08	<0.05	0.00	<0.05	6.24	<0.5	0.6	<0.2	<0.2	0.57	<0.05	0.00	<0.2
3a	Pale green glass waste		6.1	<0.1	0.5	59.5	<0.2	4.4	0.2	<0.05	0.13	0.00	<0.05	<0.05	<0.5	<0.2	<0.2	<0.2	<0.2	<0.05	0.03	27.1
3b	Opaque white glass waste		5.7	<0.1	0.3	59.1	<0.2	4.6	<0.1	<0.05	0.07	<0.02	<0.05	<0.05	<0.5	<0.2	<0.2	<0.2	<0.2	<0.05	0.03	28.2
4	Colourless glass waste		3.9	<0.1	0.1	60.6	<0.2	10.1	<0.1	<0.05	0.05	<0.02	<0.05	<0.05	<0.5	<0.2	<0.2	<0.2	<0.2	<0.05	0.03	22.5
5	Blue glass waste		2.6	<0.1	3.8	62.1	<0.2	7.0	0.2	0.17	0.85	0.44	0.20	<0.05	<0.5	<0.2	<0.2	<0.2	<0.2	<0.05	0.03	21.5
6	Blue-green glass waste		5.9	<0.1	1.3	60.2	<0.2	4.9	1.4	0.14	<0.05	0.35	<0.05	0.06	<0.5	<0.2	<0.2	<0.2	<0.2	<0.05	0.04	23.3
7	Vitrified waste		4.4	0.3	22.8	61.1	<0.2	2.5	1.5	1.07	0.11	3.12	<0.05	<0.05	<0.5	<0.2	<0.2	<0.2	<0.2	0.28	0.16	0.7
8	Red glass flashed onto colourless	body	0.7	<0.1	<0.1	54.6	<0.2	10.1	<0.1	<0.05	<0.05	<0.02	<0.05	<0.05	<0.5	<0.2	<0.2	<0.2	<0.2	<0.05	0.04	32.9
		surface	0.3	<0.1	<0.1	50.2	<0.2	9.6	<0.1	<0.05	0.47	<0.02	<0.05	<0.05	<0.5	<0.2	1.8	<0.2	<0.2	<0.05	0.04	36.2
9	White glass flashed onto colourless	body	0.5	<0.1	0.1	54.5	<0.2	10.4	<0.1	<0.05	0.07	<0.02	<0.05	<0.05	<0.5	<0.2	<0.2	<0.2	<0.2	<0.05	0.02	32.6
		surface	0.3	<0.1	<0.1	41.8	<0.2	7.9	<0.1	<0.05	<0.05	<0.02	<0.05	<0.05	4.2	<0.2	0.6	<0.2	<0.2	<0.05	0.03	44.7
10	Blue glass flashed onto colourless	body	0.3	<0.1	<0.1	53.4	<0.2	9.6	<0.1	<0.05	<0.05	<0.02	<0.05	<0.05	<0.5	<0.2	<0.2	<0.2	<0.2	<0.05	0.02	35.2
		surface	0.3	<0.1	0.2	52.3	<0.2	9.2	<0.1	<0.05	0.62	0.00	1.41	<0.05	<0.5	<0.2	<0.2	<0.2	<0.2	<0.05	0.02	34.5
11	Blue glass flashed onto colourless	body	0.4	<0.1	<0.1	54.3	<0.2	11.2	<0.1	<0.05	<0.05	<0.02	<0.05	<0.05	<0.5	<0.2	<0.2	<0.2	<0.2	<0.05	0.02	32.1
		surface	0.3	<0.1	0.2	54.6	<0.2	10.6	<0.1	<0.05	0.32	0.00	0.75	<0.05	<0.5	<0.2	<0.2	<0.2	<0.2	<0.05	0.02	31.5
12	Blue glass flashed onto colourless	body	7.0	<0.1	0.2	53.7	<0.2	2.3	<0.1	<0.05	0.09	<0.02	<0.05	<0.05	<0.5	<0.2	<0.2	<0.2	<0.2	<0.05	0.03	35.0
		surface	4.0	<0.1	0.1	52.1	<0.2	4.7	<0.1	<0.05	0.42	<0.02	0.42	<0.05	<0.5	<0.2	<0.2	<0.2	<0.2	<0.05	0.02	36.8
13	Blue glass		0.6	0.1	<0.1	52.8	<0.2	9.0	<0.1	<0.05	0.64	<0.02	0.14	<0.05	<0.5	<0.2	<0.2	<0.2	<0.2	<0.05	0.03	35.2
14	Blue glass		0.4	<0.1	<0.1	52.8	<0.2	8.9	<0.1	<0.05	0.47	<0.02	0.16	<0.05	<0.5	<0.2	<0.2	<0.2	<0.2	<0.05	0.03	36.0
15	Blue glass		0.4	<0.1	<0.1	53.2	<0.2	8.9	<0.1	<0.05	0.59	<0.02	0.15	<0.05	<0.5	<0.2	<0.2	<0.2	<0.2	<0.05	0.03	35.5
16	Colourless fluted vessel (pressed?)		8.3	<0.1	0.2	54.2	<0.2	0.3	<0.1	<0.05	0.08	<0.02	<0.05	<0.05	<0.5	<0.2	<0.2	<0.2	<0.2	<0.05	0.04	35.2
17	Colourless square pedestal (pressed)		0.4	<0.1	<0.1	53.0	<0.2	9.2	<0.1	<0.05	<0.05	<0.02	<0.05	<0.05	<0.5	<0.2	<0.2	0.3	<0.2	<0.05	0.03	35.2
18	Colourless square pedestal (pressed)		0.3	<0.1	<0.1	53.2	<0.2	9.3	<0.1	<0.05	<0.05	<0.02	<0.05	<0.05	<0.5	<0.2	<0.2	<0.2	<0.2	<0.05	0.01	35.8
19	Colourless vessel with small round foot (incomplete?)		0.3	<0.1	<0.1	54.4	<0.2	9.4	<0.1	<0.05	<0.05	<0.02	<0.05	<0.05	<0.5	<0.2	<0.2	<0.2	<0.2	<0.05	0.02	34.4
20	Colourless small cylindrical vessel		3.4	<0.1	<0.1	53.7	<0.2	6.3	<0.1	<0.05	0.09	<0.02	<0.05	<0.05	<0.5	<0.2	<0.2	<0.2	<0.2	<0.05	0.03	34.9
21	Colourless stopper?		0.4	<0.1	<0.1	54.8	<0.2	11.4	<0.1	<0.05	<0.05	<0.02	<0.05	<0.05	<0.5	<0.2	<0.2	<0.2	<0.2	<0.05	0.02	31.5
22	Colourless vessel		0.3	<0.1	0.2	53.8	<0.2	9.5	<0.1	<0.05	<0.05	<0.02	<0.05	<0.05	<0.5	<0.2	<0.2	<0.2	<0.2	<0.05	0.03	34.2
23	Colourless conical stem		2.6	<0.1	0.2	53.9	<0.2	6.7	<0.1	<0.05	<0.05	<0.02	<0.05	<0.05	<0.5	<0.2	<0.2	<0.2	<0.2	<0.05	0.03	35.0
24	Colourless round foot		0.3	<0.1	0.1	54.8	<0.2	11.2	<0.1	<0.05	<0.05	<0.02	<0.05	<0.05	<0.5	<0.2	<0.2	<0.2	<0.2	<0.05	0.03	31.7
25	Colourless vessel		1.0	<0.1	<0.1	53.6	<0.2	8.3	<0.1	<0.05	0.06	<0.02	<0.05	<0.05	<0.5	<0.2	<0.2	<0.2	<0.2	<0.05	0.03	35.5

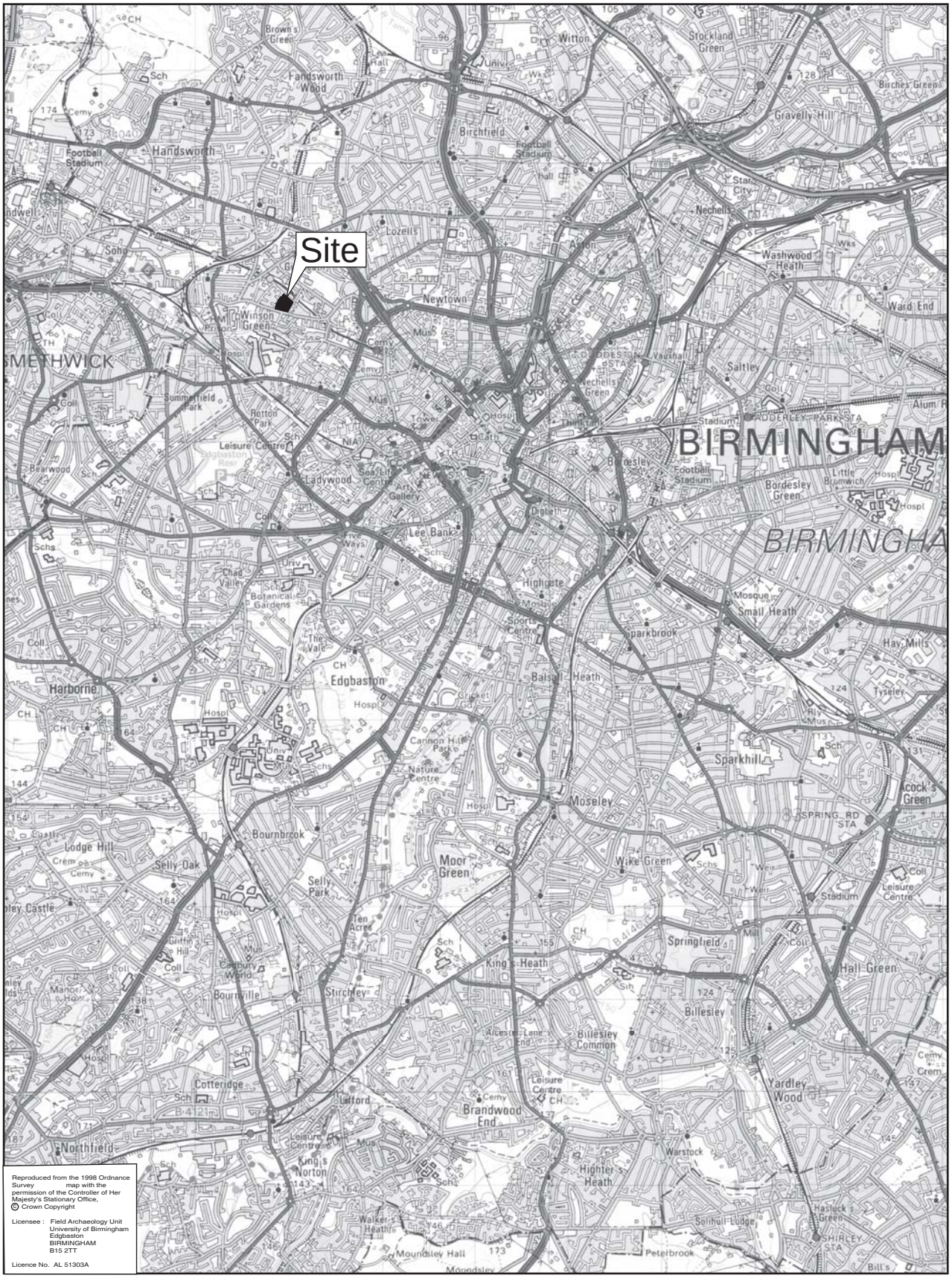

Figure 1: Site Location

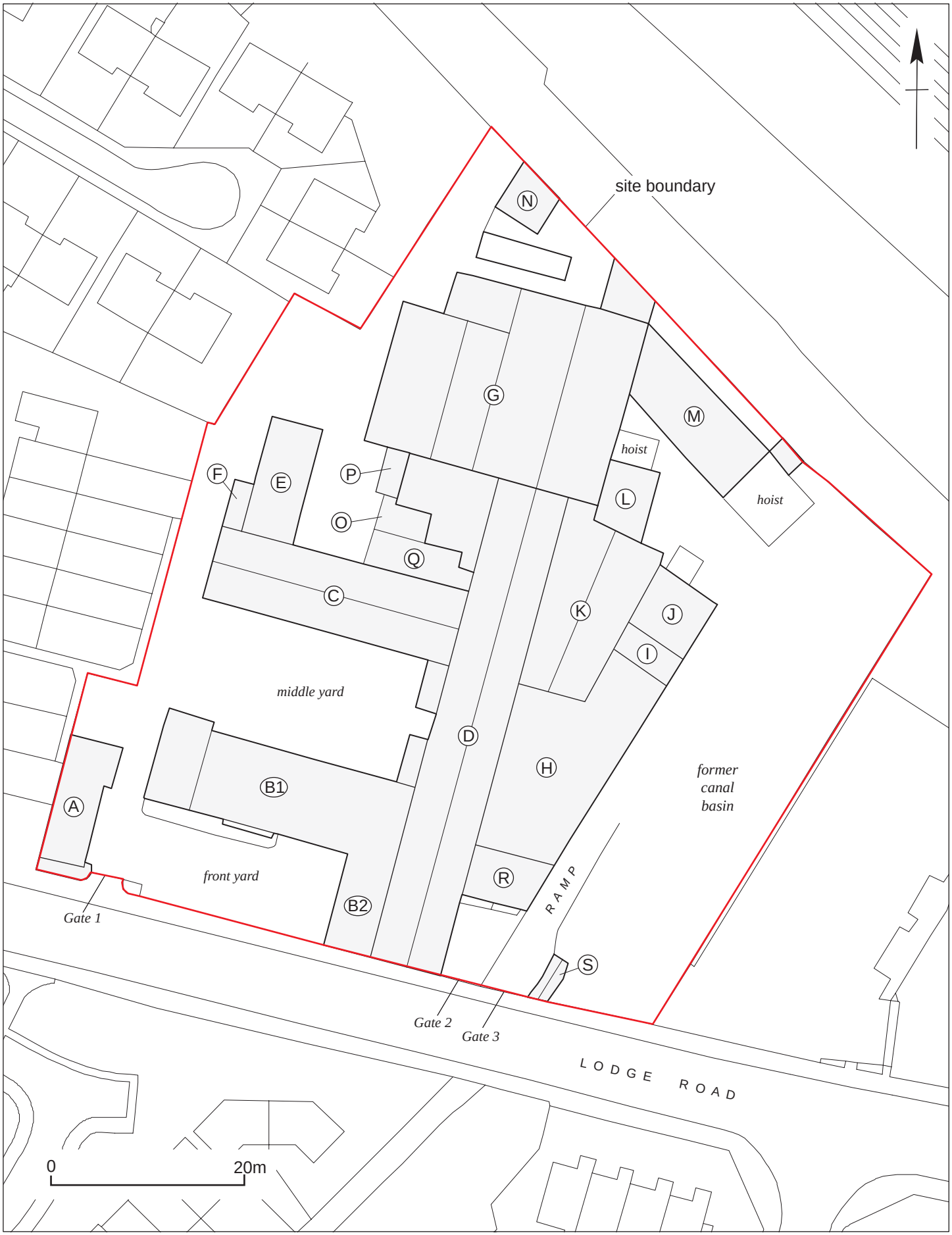

Figure 2: Site Layout and Building Reference System

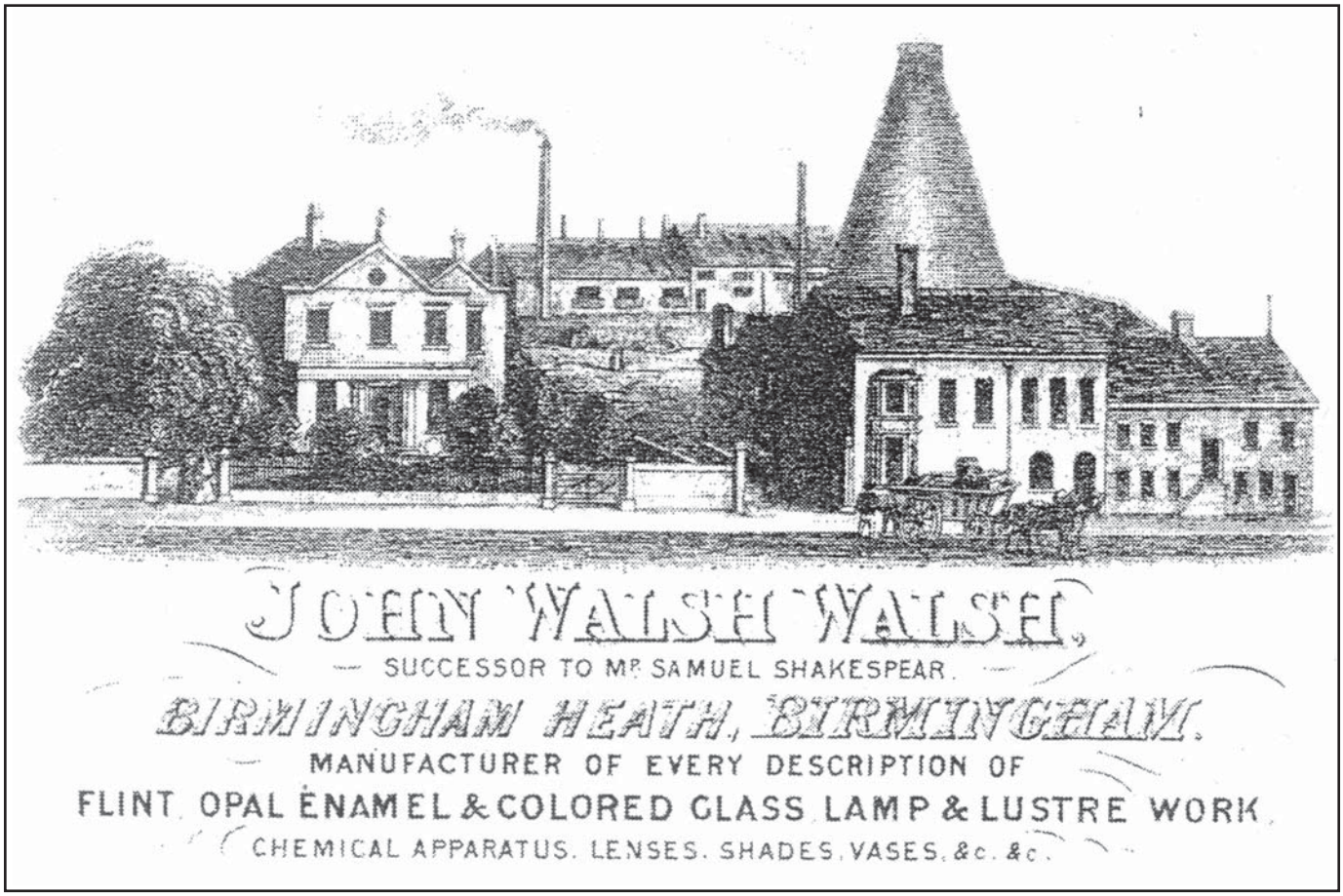

Figure 3: Letterhead of John Walsh Walsh, c.1855

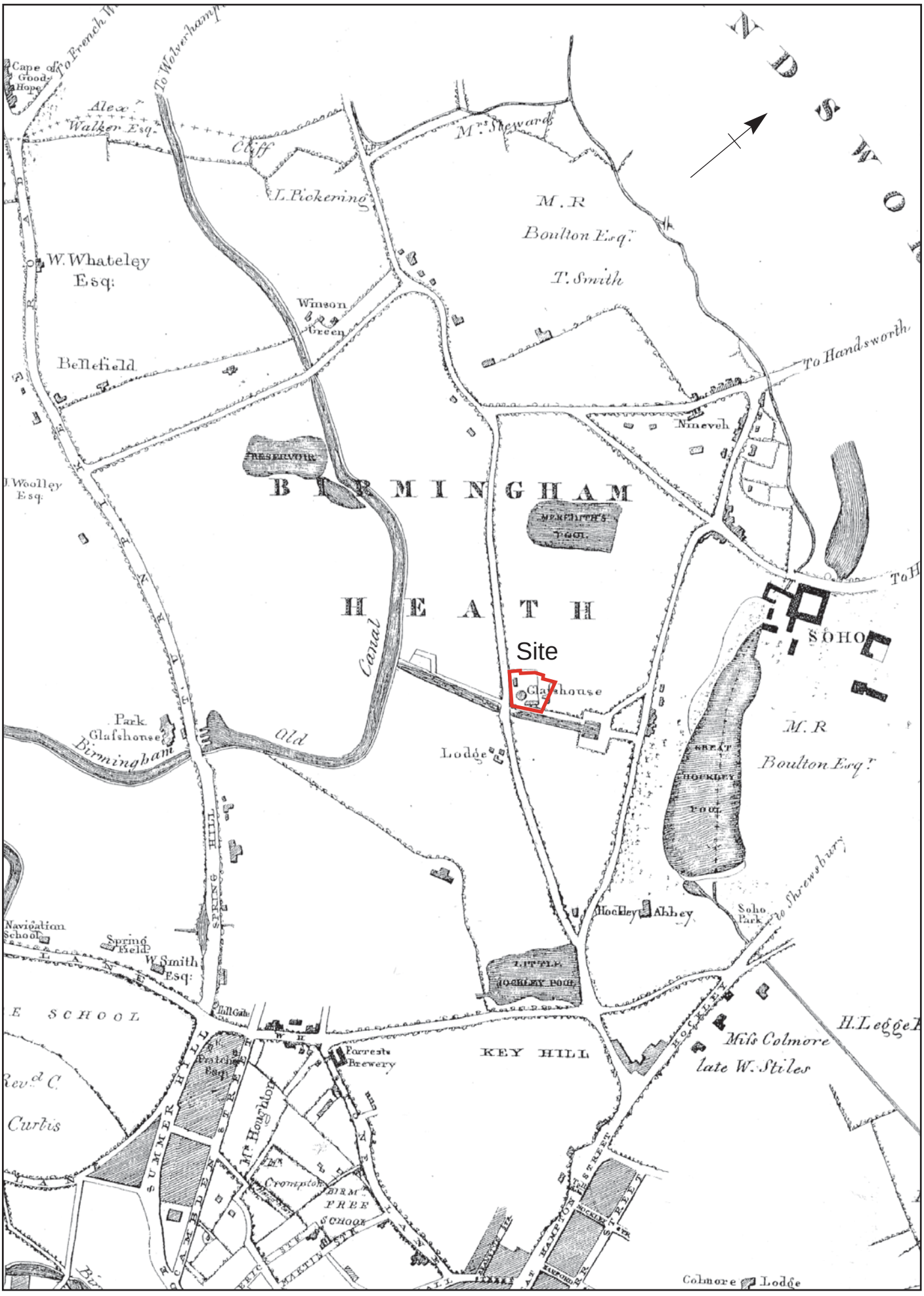

Figure 4: Kempson's Map of Birmingham, 1810 (extract)

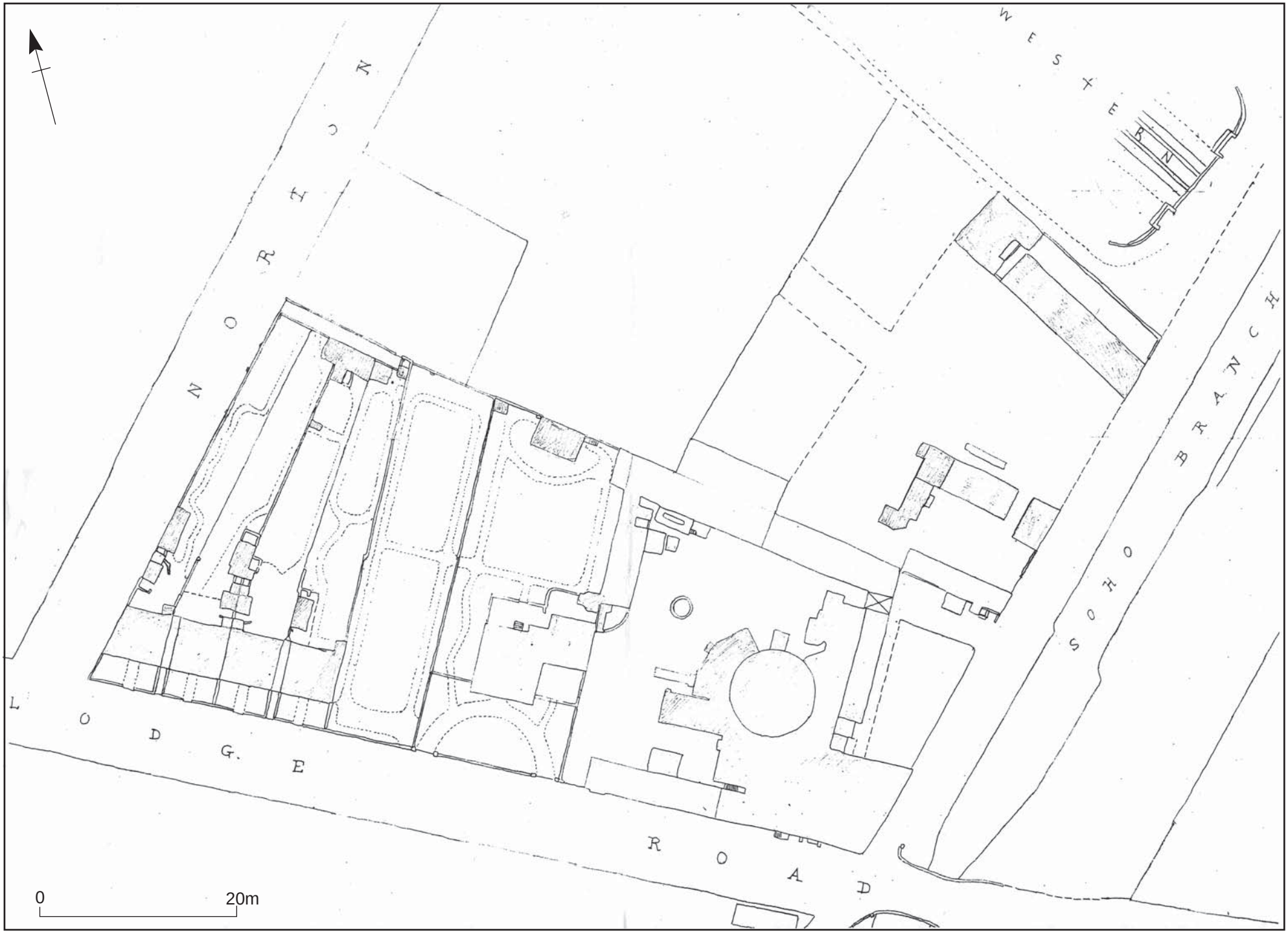

Figure 5: Pigott-smith's Map of Birmingham, 1855 (extract)

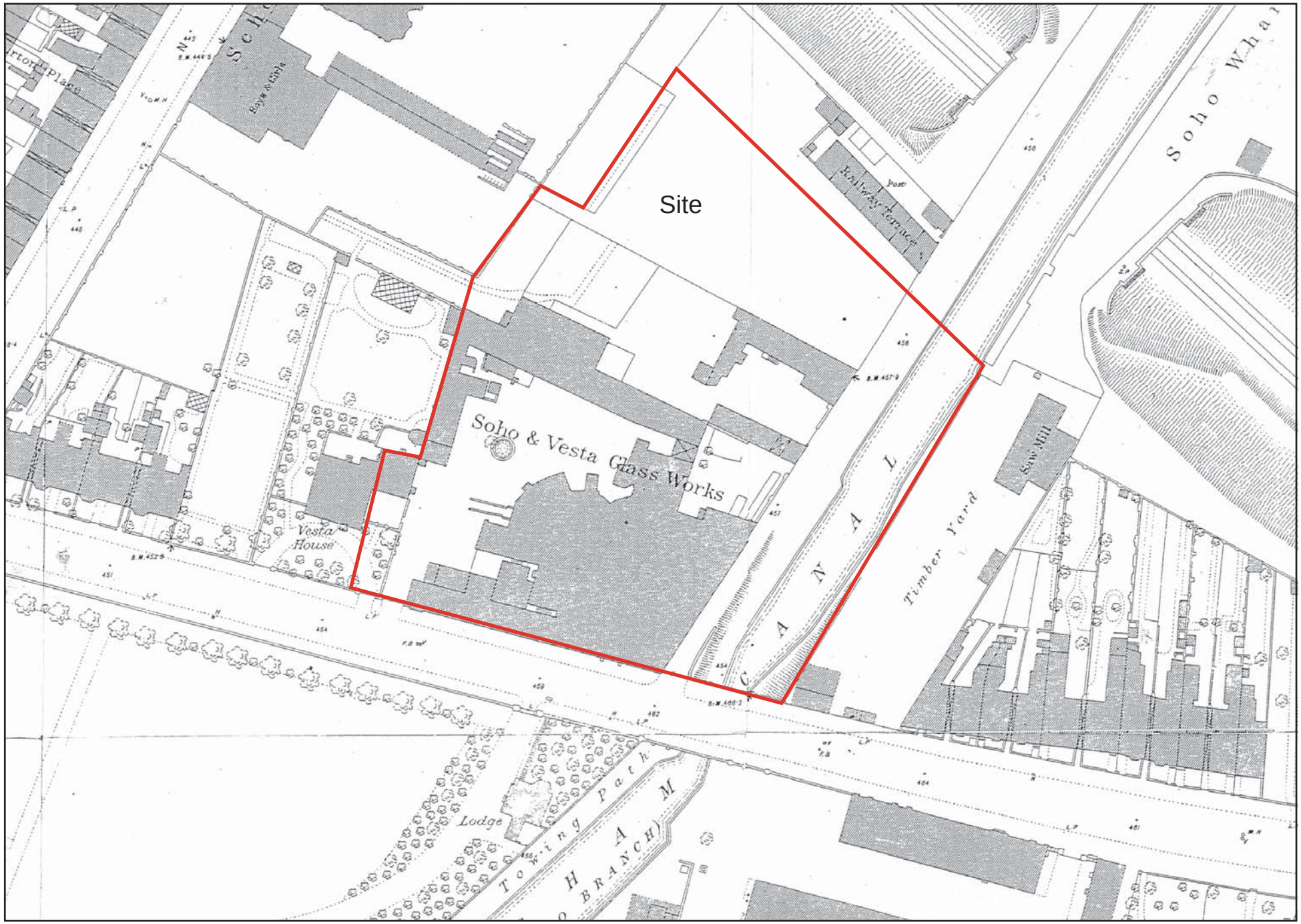

Figure 6: Ordnance Survey 1st Edition 1:500 map of 1889

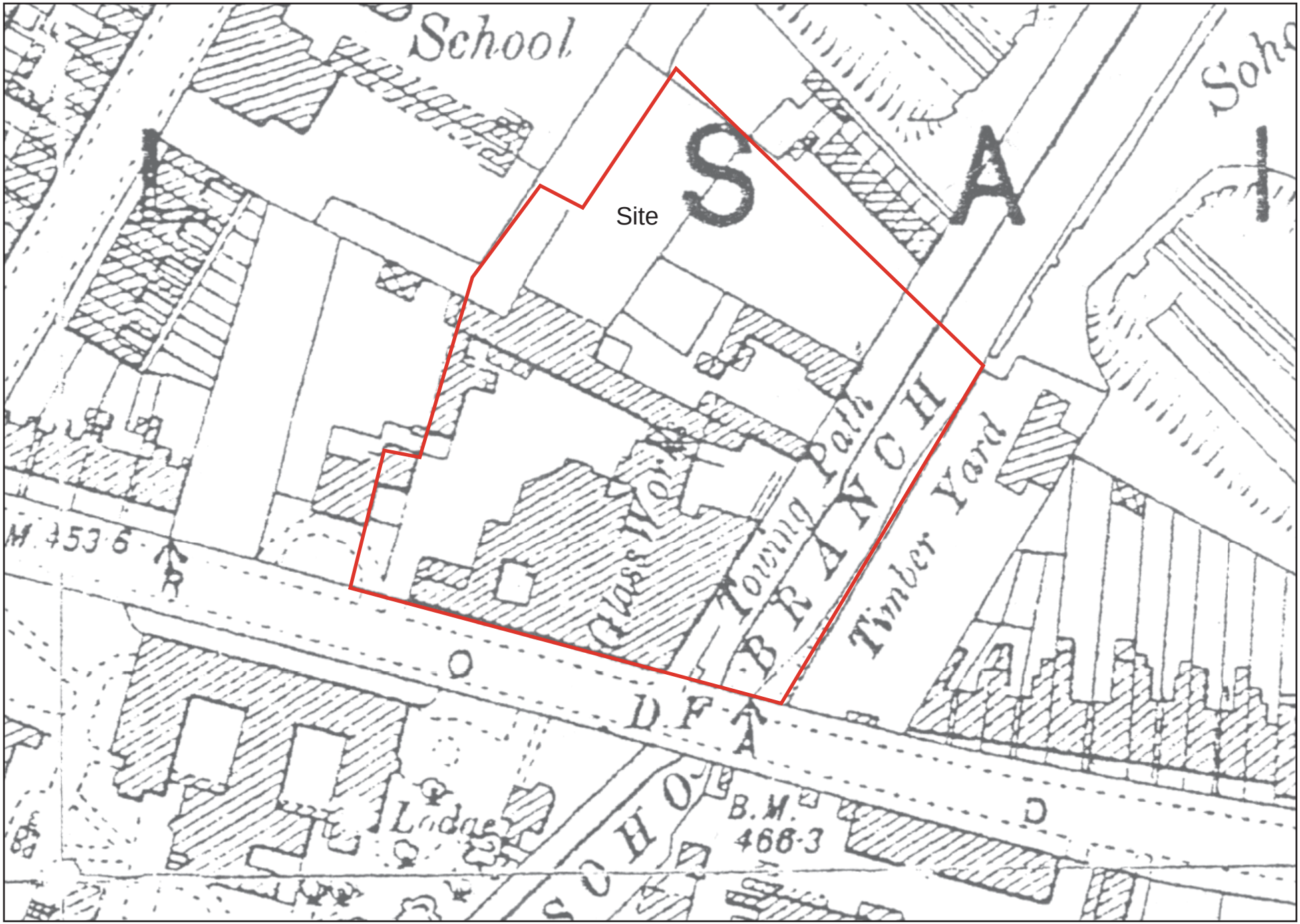

Figure 7: Ordnance Survey County Series 1st Revision 1:2500 map of 1905

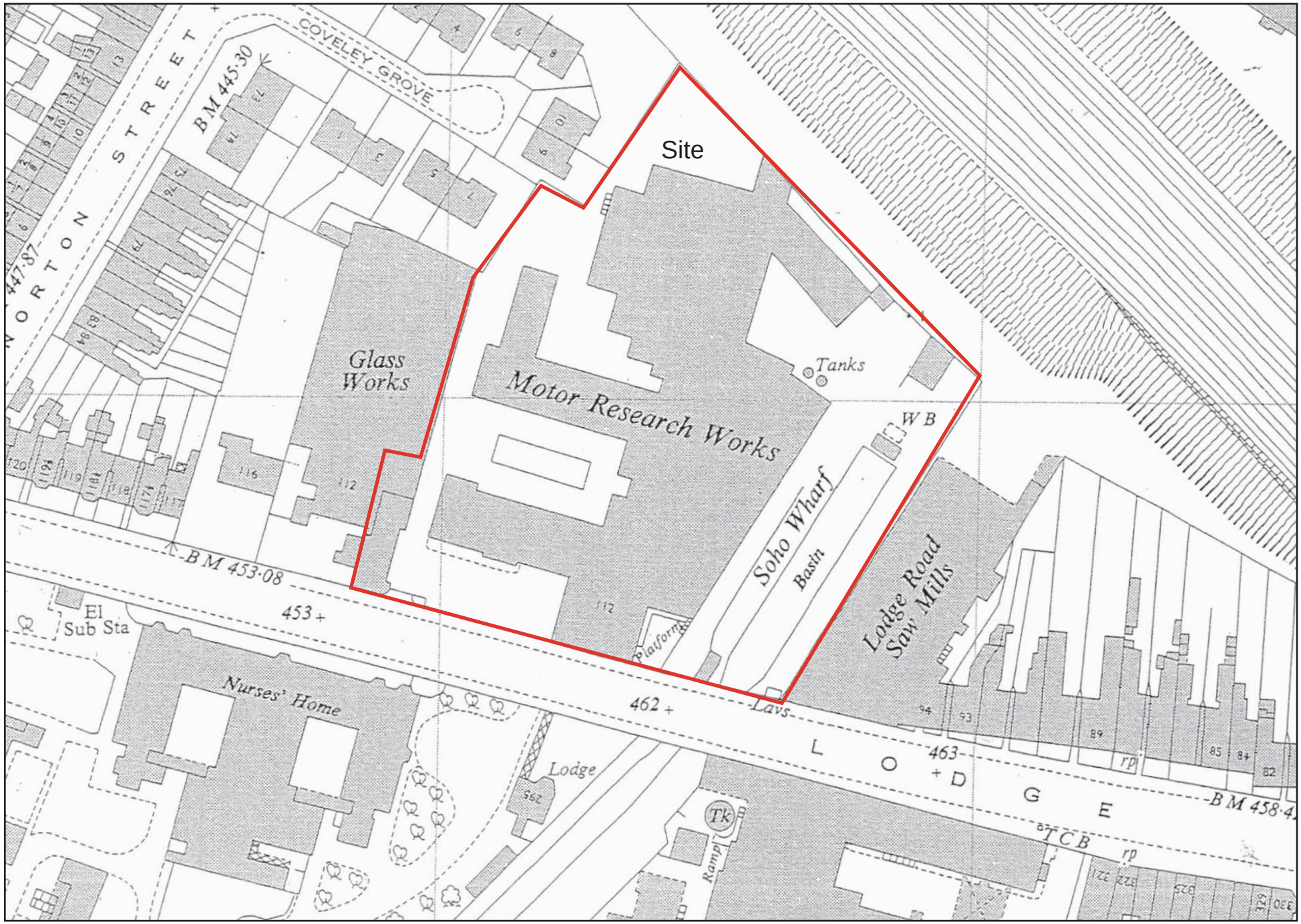

Figure 8: Ordnance Survey National Grid Series 1st Edition 1:1250 map of 1954

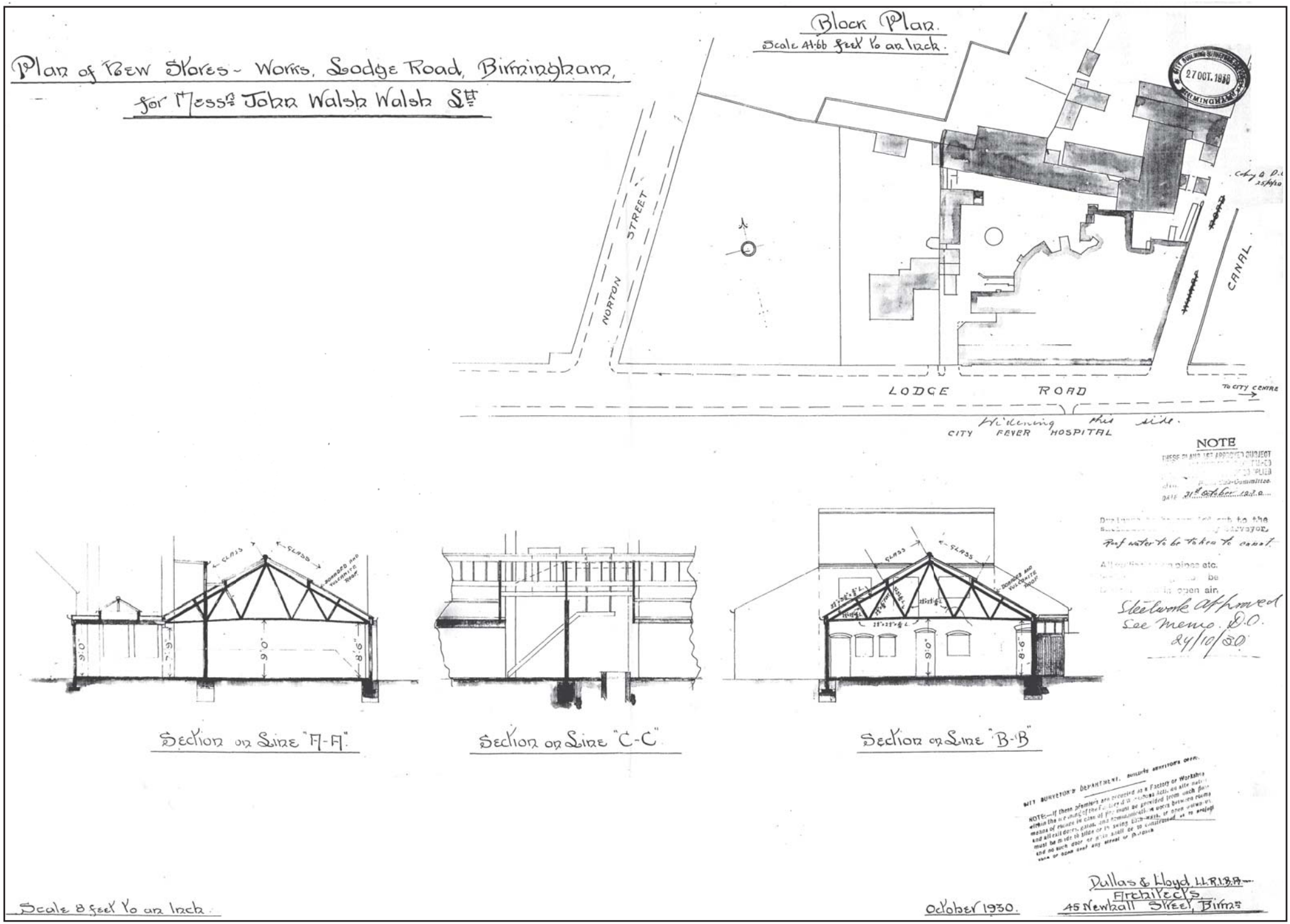

Figure 9: Design Drawings for Building K: Block Plan and Sections October 1930

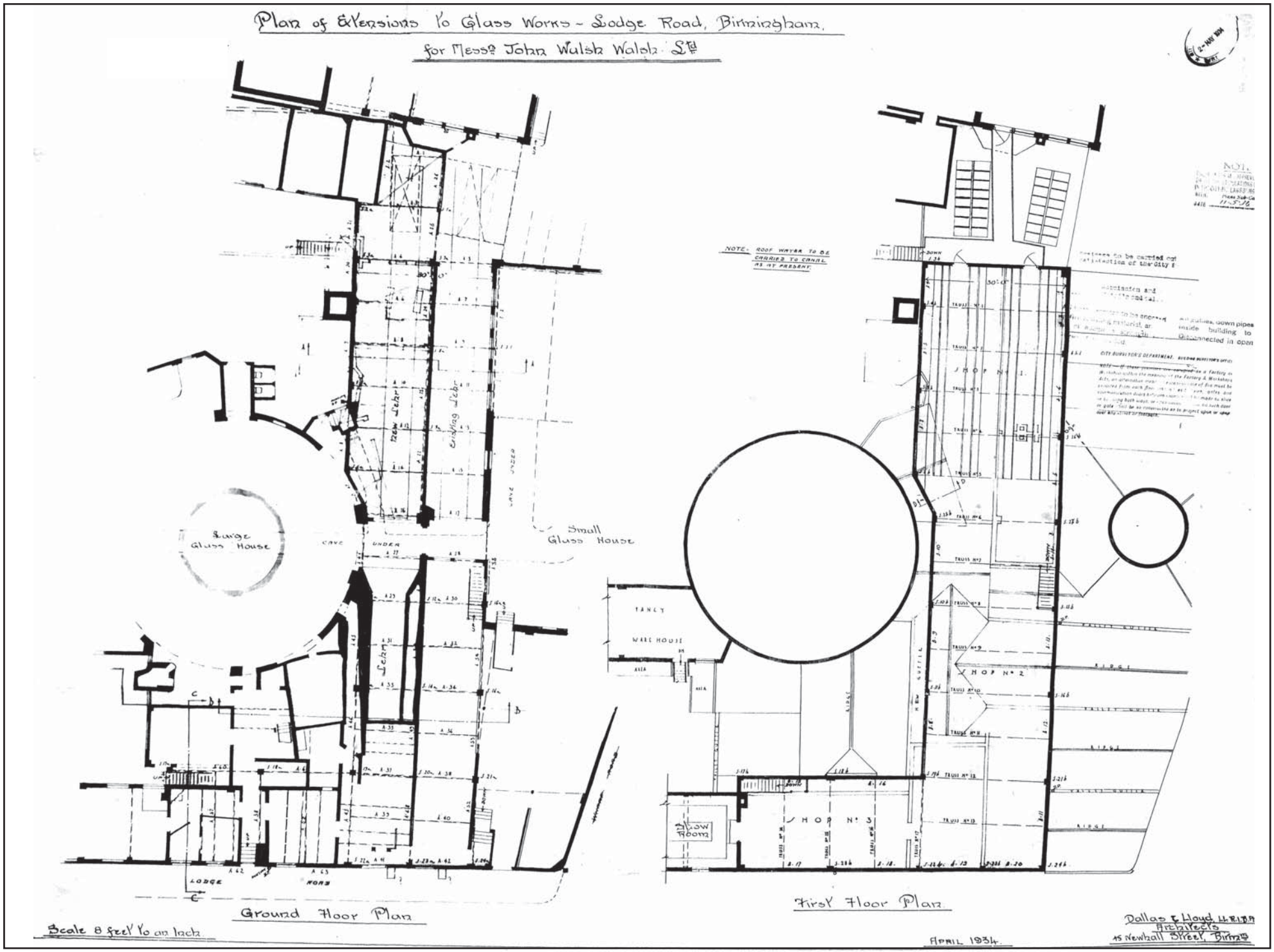

Figure 10: Design Drawings for Building K: Ground Floor Plan, October 1930

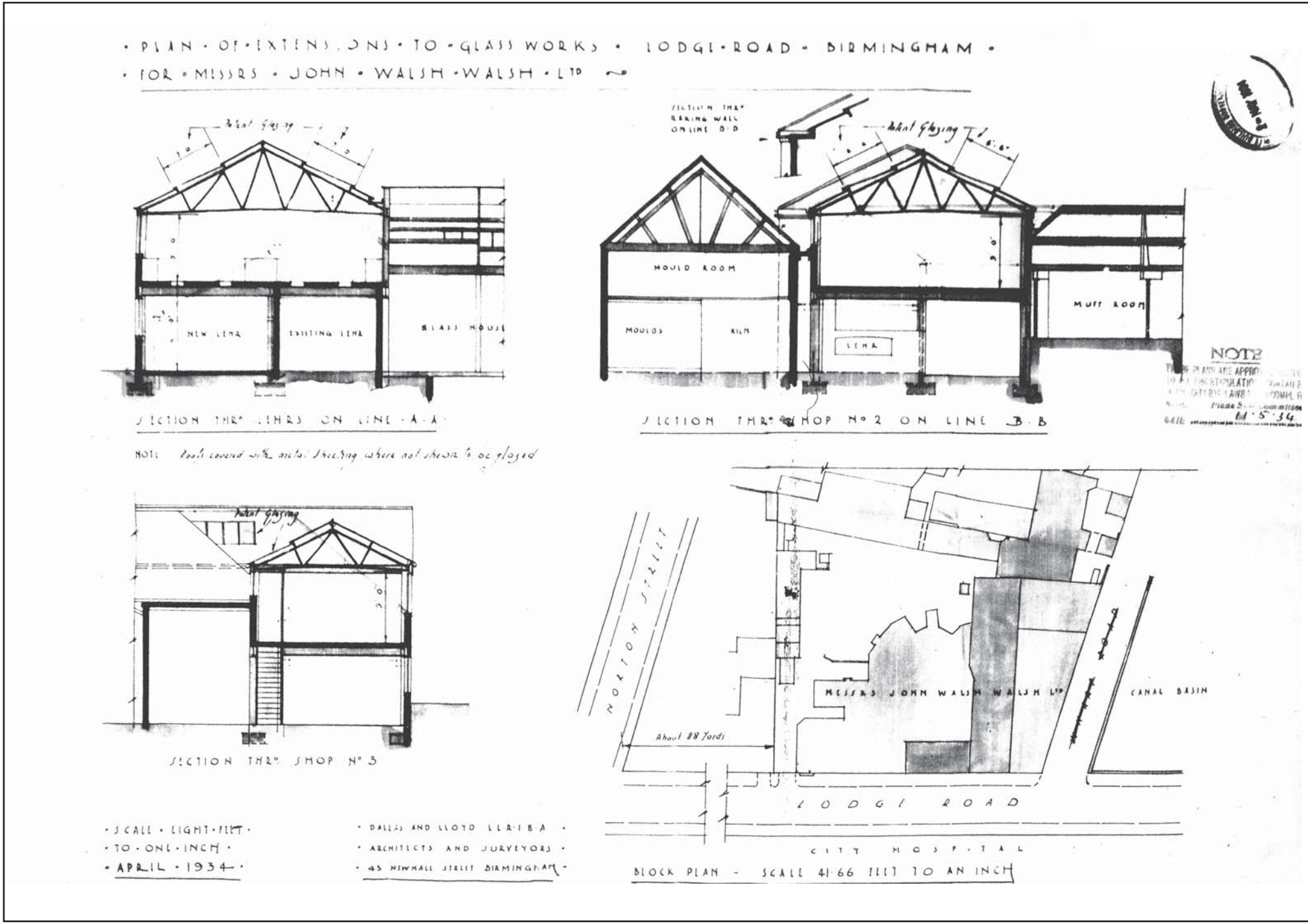

Figure 11: Design Drawings for Building D: Block Plans and Sections April 1934

Figure 12: Design Drawings for Building D: Floor Plans, April 1934

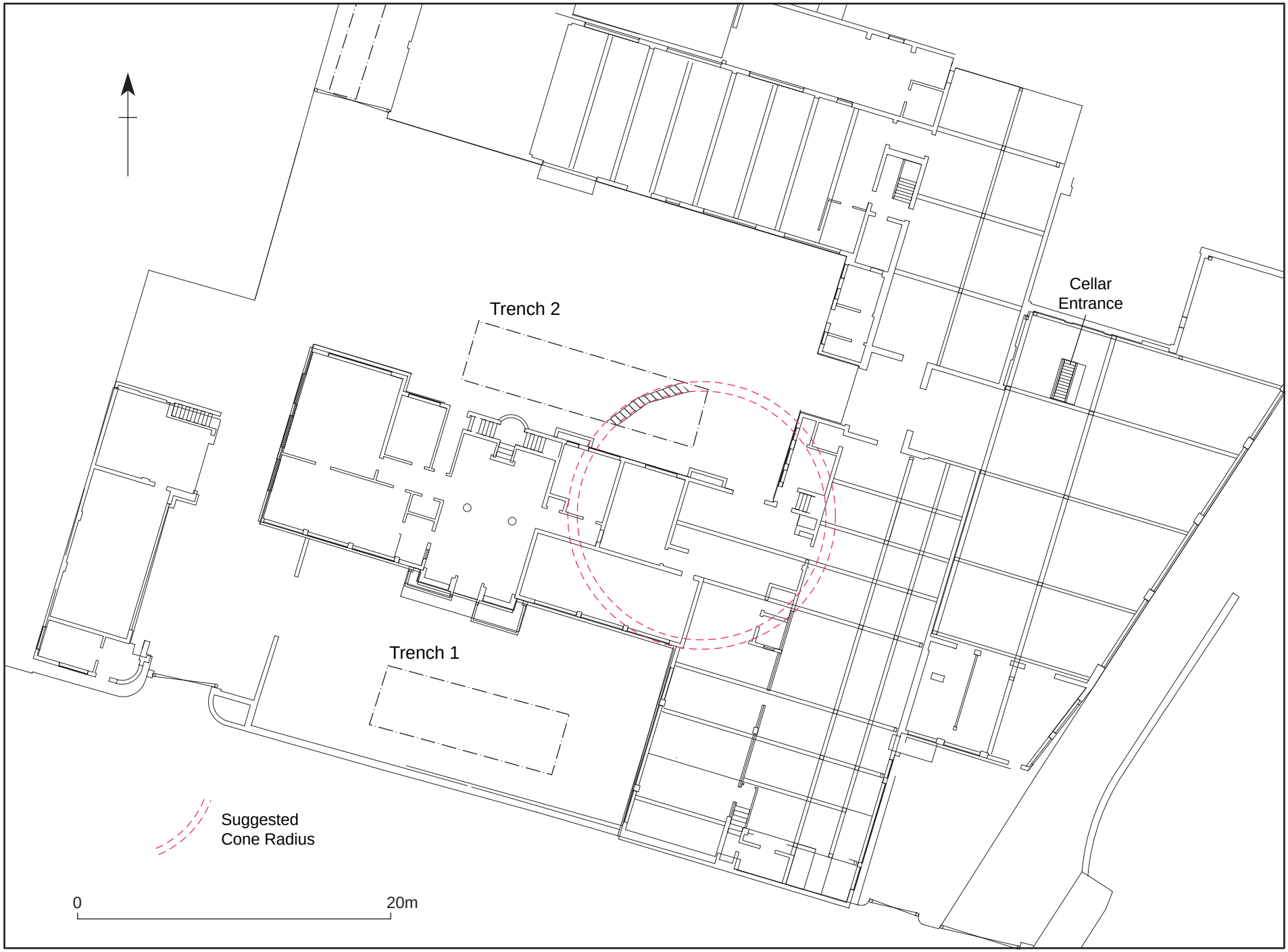

Figure 13: Ground floor Plan

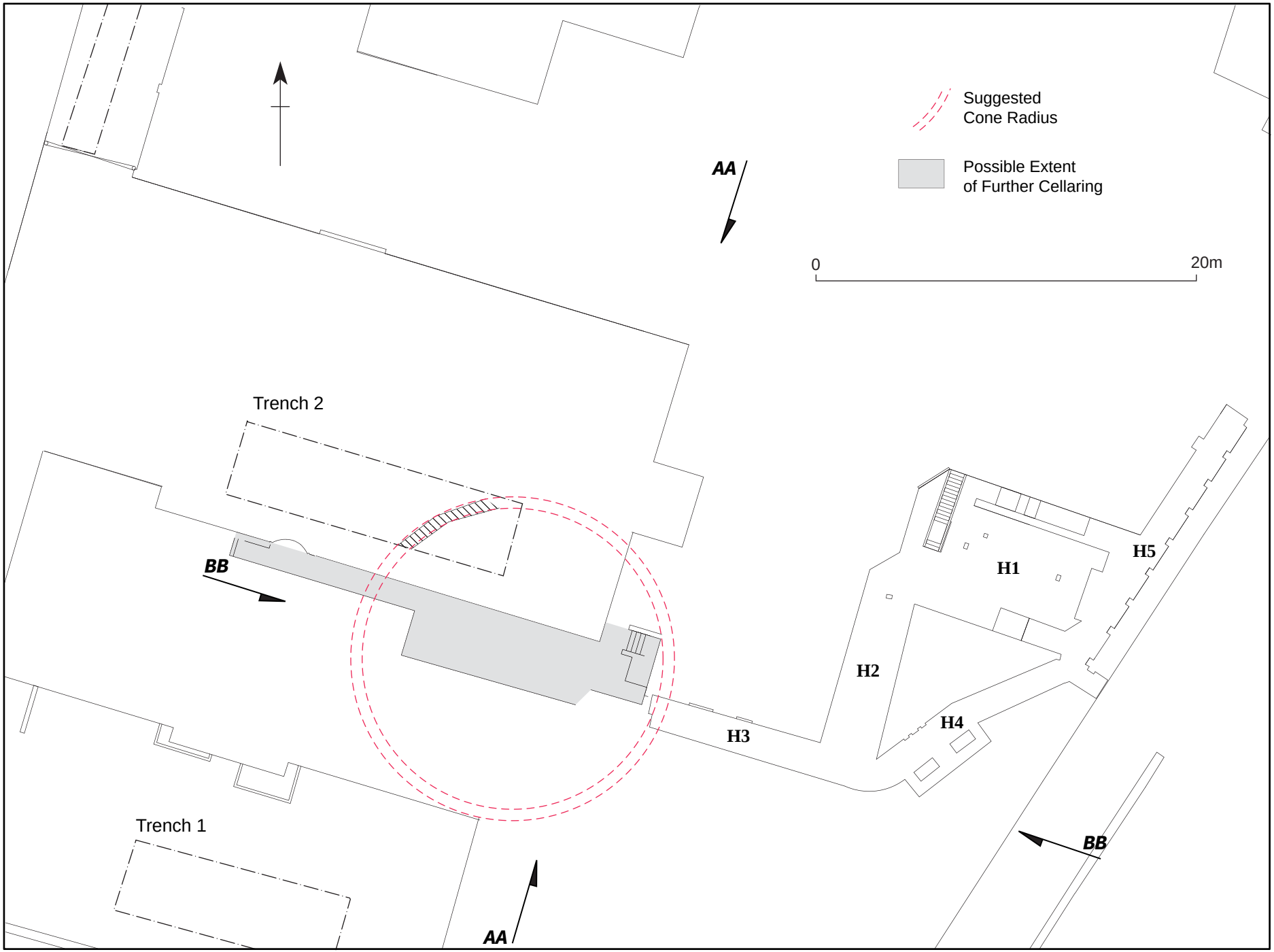

Figure 14: Cellar Plan

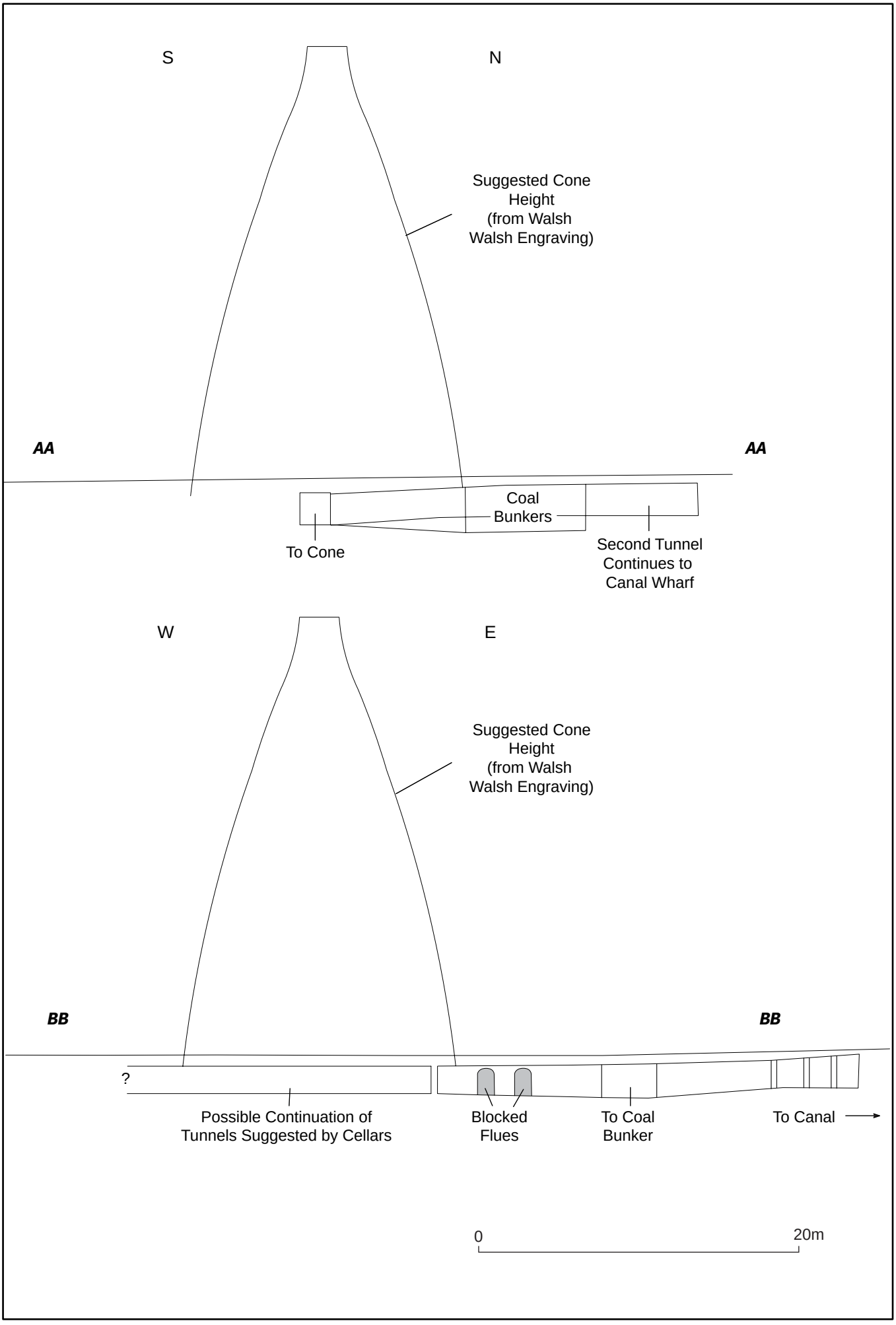

Figure 15: Cross - Sections of Tunnels

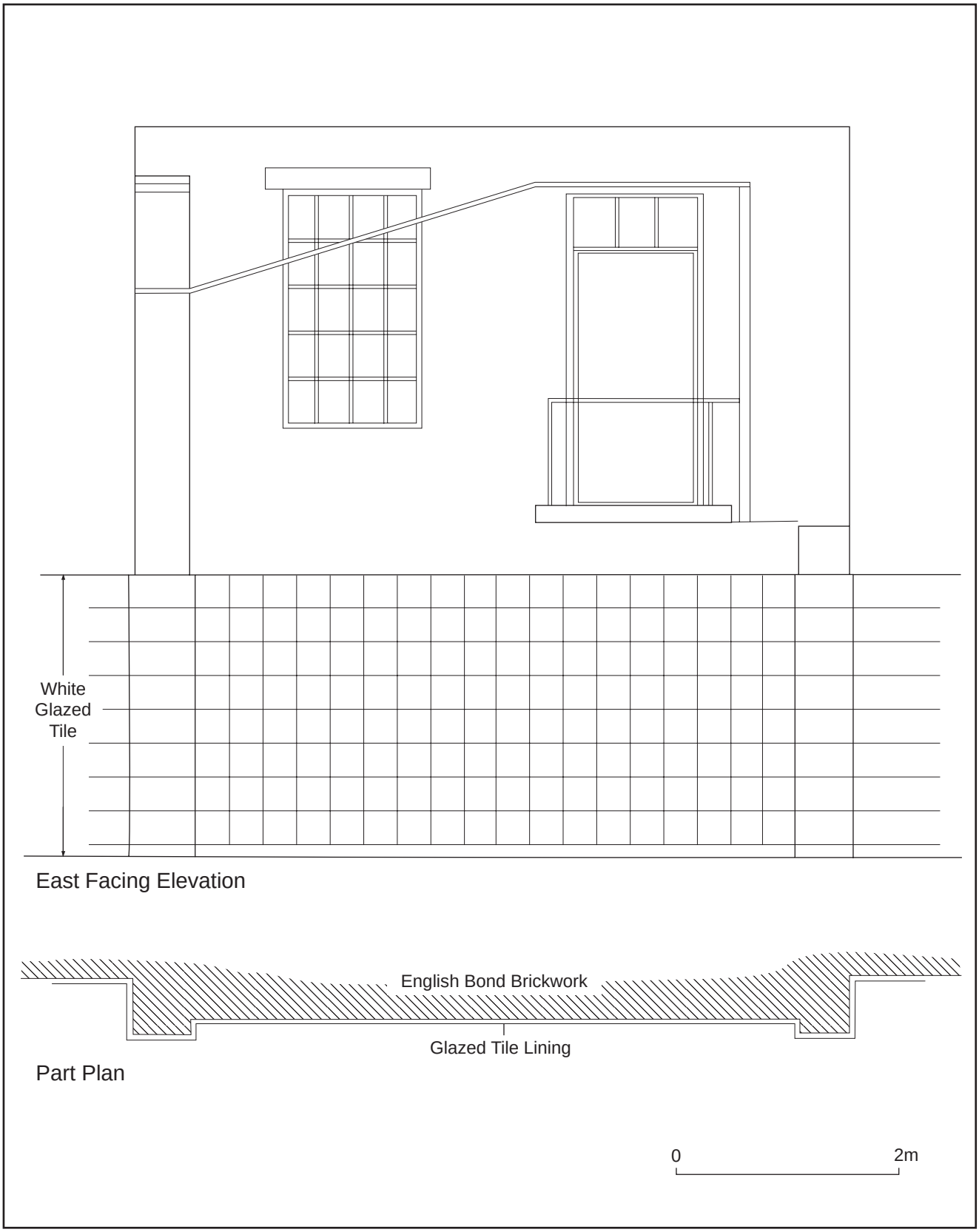

Figure 16: Building K detail of early 20th century fabric elevation

Figure 17: Phasing of up-standing buildings

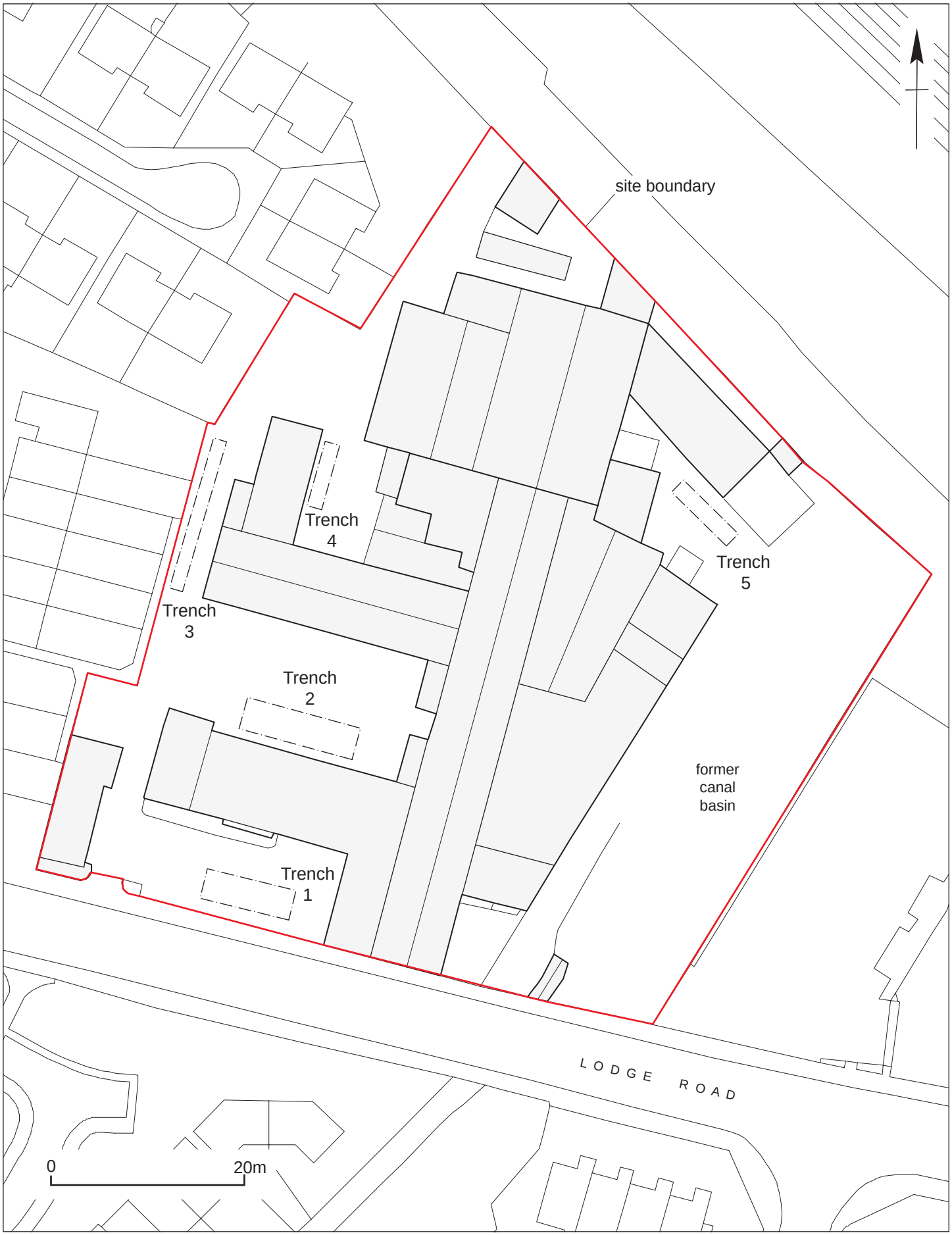

Figure 18: Site Layout and Building Reference System

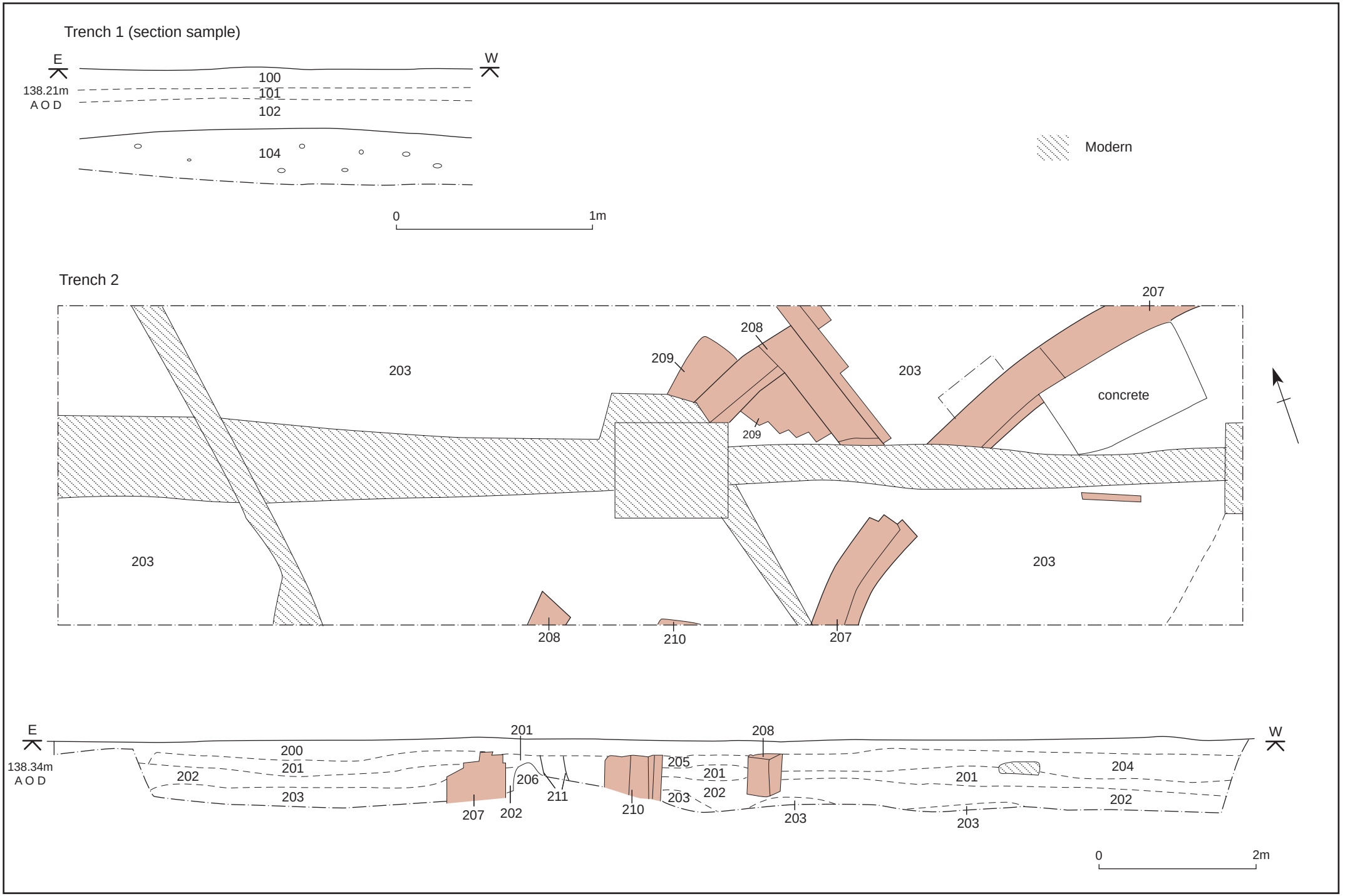

Figure 19: Trench 1 section , Trench 2 plan and section

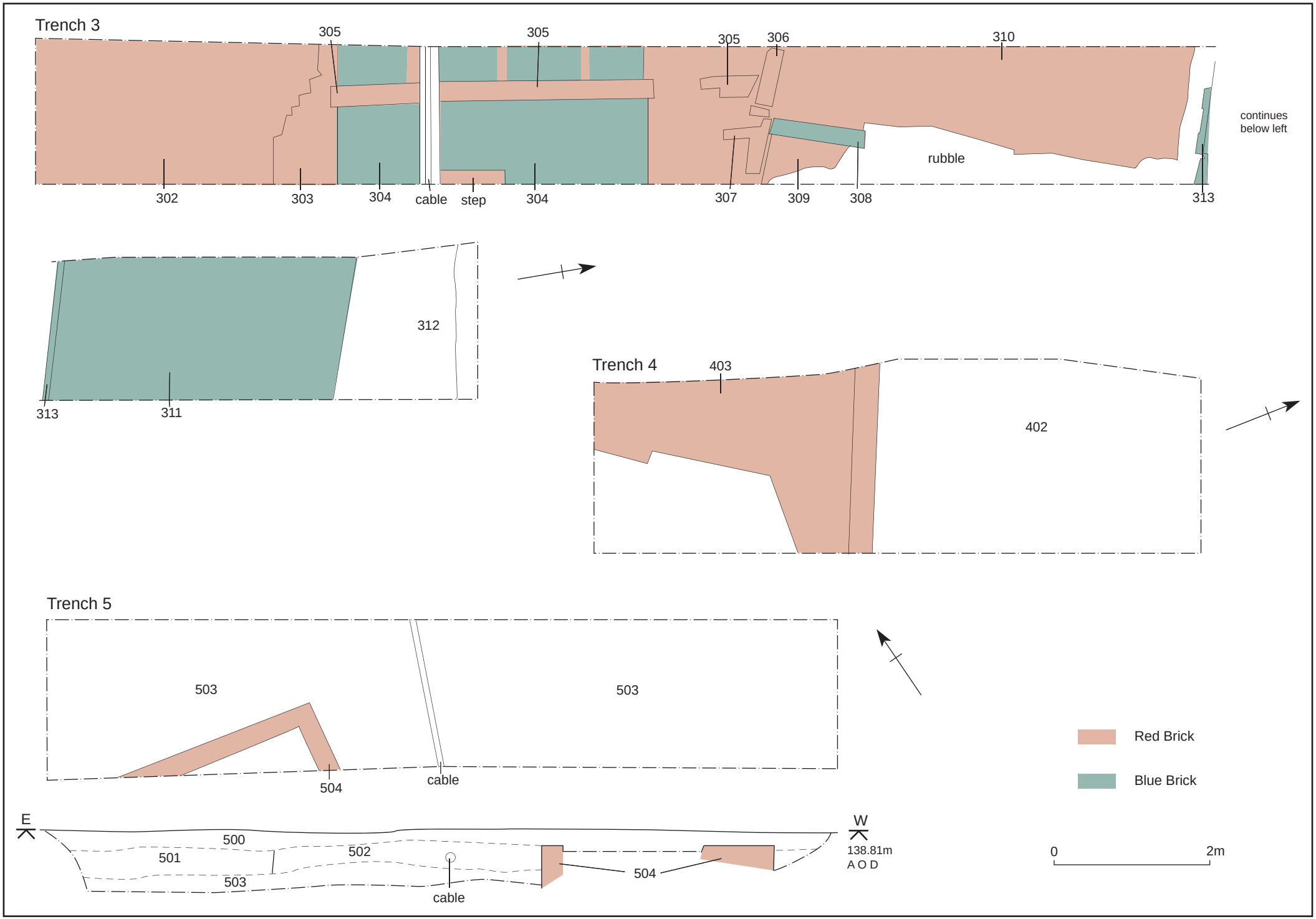

Figure 20: Trench 3 plan , Trench 4 plan , Trench 5 plan and section

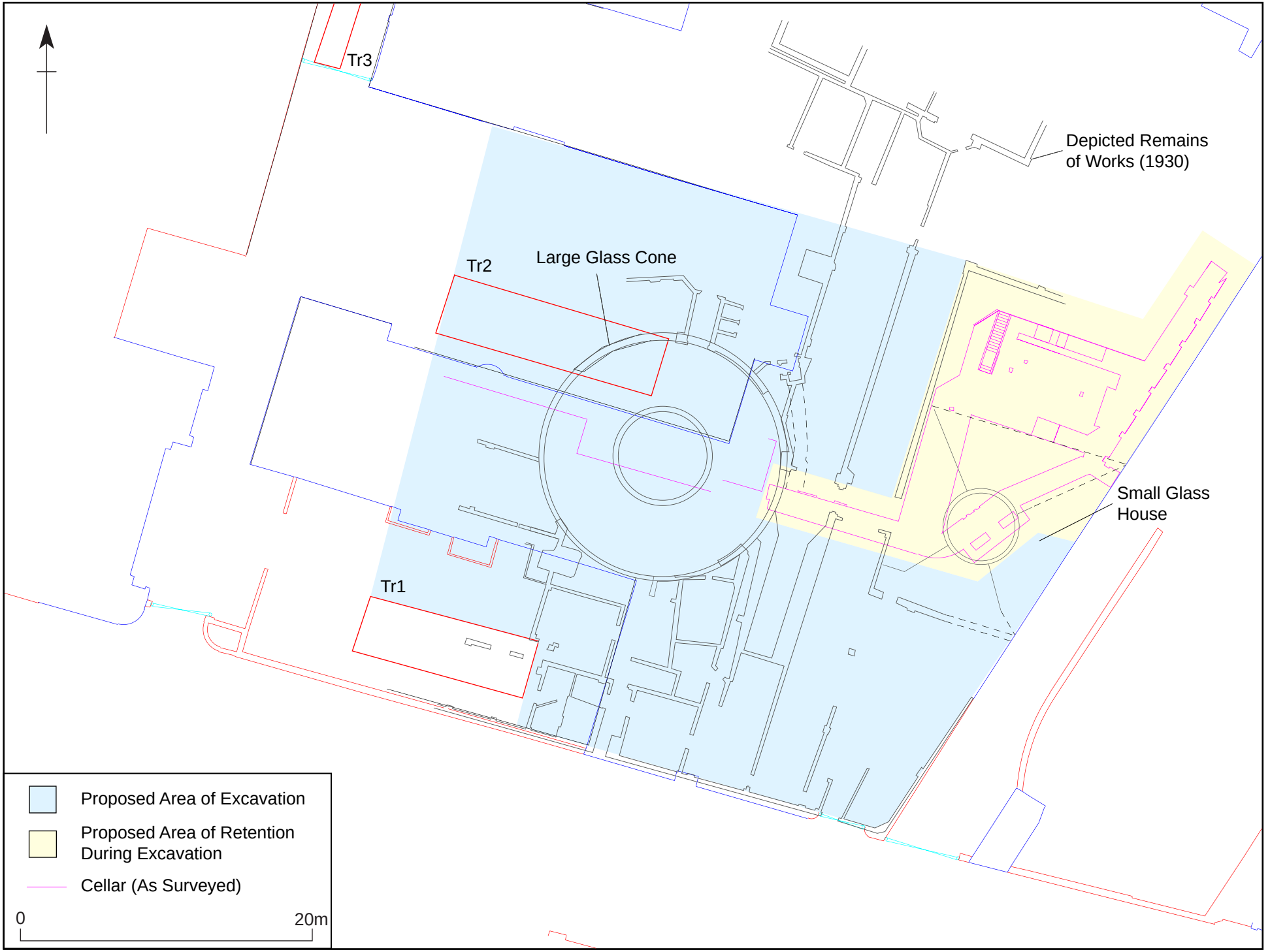
Tr3
Depicted Remains
of Works (1930)
Tr2
Large Glass Cone
Small Glass
House
Tr1
Proposed Area of Excavation
Proposed Area of Retention
During Excavation
Cellar (As Surveyed)
0
20m

Figure 21

Plate 1: General view of southern (street) aspect, from the southwest.

Plate 2: Building A, oblique view from southeast.

Plate 3: Building A, east elevation to yard.

Plate 4: Building B1, oblique view from the southwest.

Plate 5: Bldg. B1, glass block window . above central entrance

Plate 6: Bldg B1; Detail of glass brick window pier.

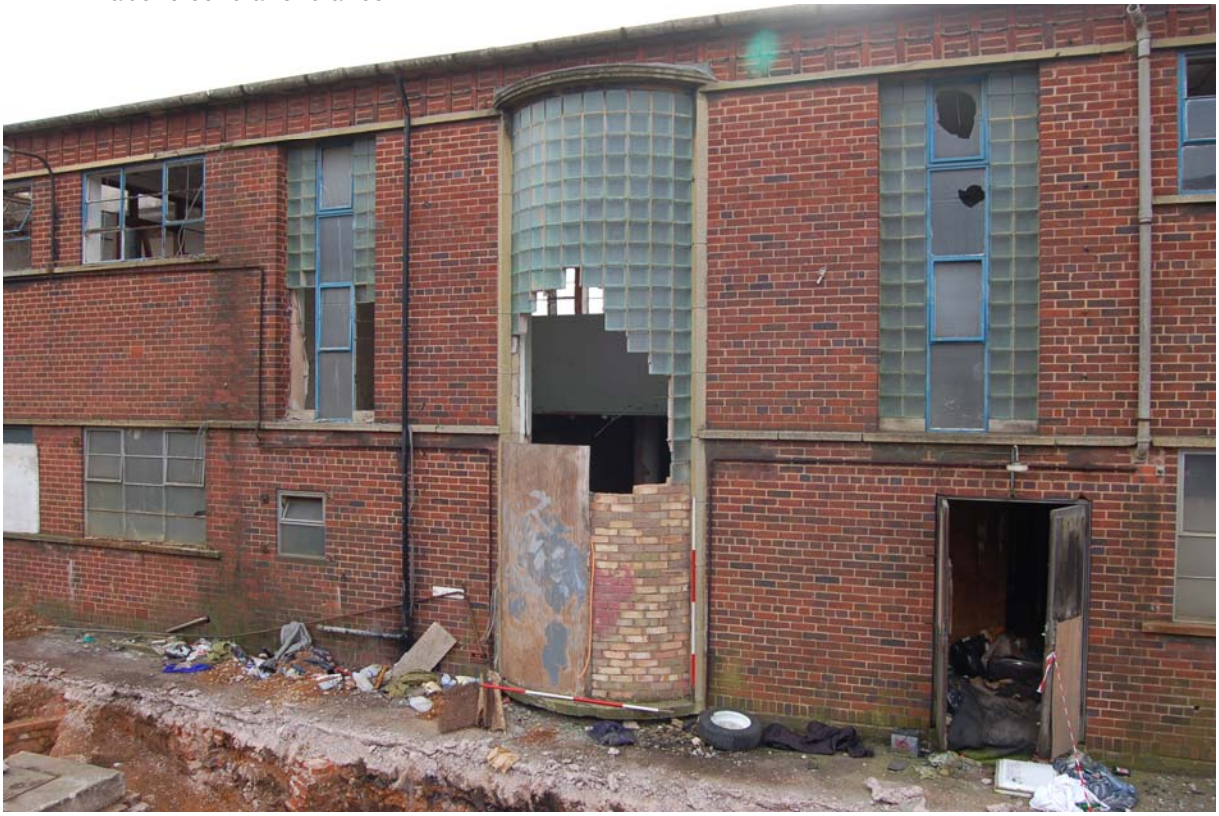

Plate 7: Building B1, rear elevation; detail of apsidal, glass block window lighting principal stair.

Plate 8: Building B1, pier supports to balcony of principal stair.

Plate 9: Building B1, principal stair.

Plate 10: Building B1, first floor. (Note continuous glass-block walling to left).

Plate 11: Bldg B1, 1st Floor; central window, South elevation.

Plate 12: Bldg B1, 1st Floor, blocked doorway to B2.

Plate 13: Buildings B2 (left, flat roof) and D (right, gabled); southern (street) elevation. (NB. banded brickwork).

Plate 14: Building C, general view of south elevation, seen from first floor of Building B1.

Plate 15: Bldg C, oblique view from southwest. lighting stairwell.

Plate 16: Bldg C, window with decorative panel

Plate 17: Building C, ground floor looking east.

Plate 18: Building C, first floor looking west.

Plate 19: Building C, north elevation from roof of Building E, note lift shaft.

Plate 20: Building D and angle structures, west elevation.

Plate 21: Building D, ground floor looking south.

Plate 22: Building D, ground floor; detail of glass-block division wall with Building B2.

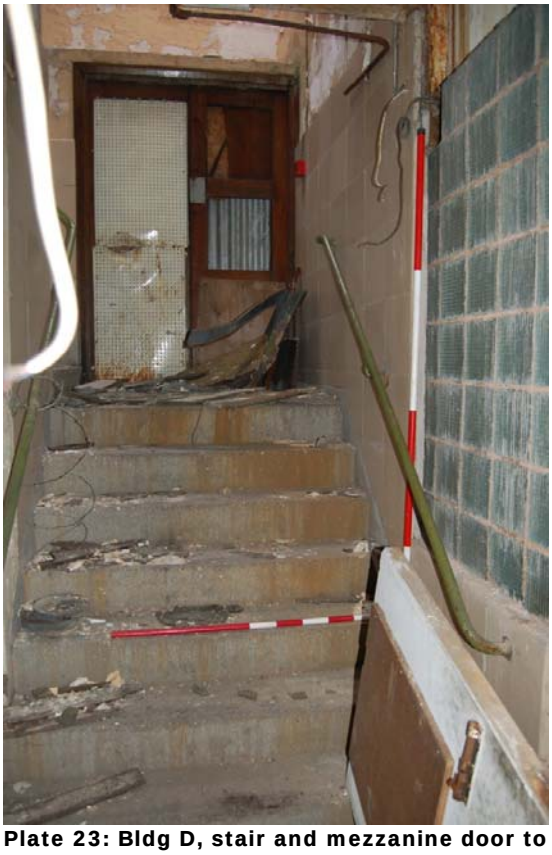

Plate 23: Bldg D, stair and mezzanine door to exterior.

Plate 24: Bldg D 1st floor, angled trimmer (Bay 9) respecting location of former glass cone.

Plate 25: Building D, first floor looking north.

Plate 26: Building D, first floor; entrance bay to Building R.

Plate 27: Building D, first floor central section.

Plate 28: Building D, first floor, east; side bay retaining early fabric.

Plate 29: Bldg D, 1st floor; early fabric in side bay.

Plate 30: Bldg D, 1st floor, west. Blocked doors to Bldg C.

Plate 31: Building E, oblique view form northwest.

Plate 32: Building E, east elevation oblique view.

Plate 33: Building E, interior looking north.

Plate 34: Building F, oblique view from northwest.

Plate 35: Building G, west elevation.

Plate 36: Building G, south elevation (with additions) seen from roof of Building E.

Plate 37: Building G, ground floor (west), looking east.

Plate 38: Building G, ground floor, enclosed room to north side.

Plate 39: Building G, first floor (E) looking north.

Plate 40: Building G, first floor (W) looking north. Note asymmetrical roof profile.

Plate 41: Building G, first floor (E); hoist mechanism

Plate 42: Building H, east elevation; oblique view from south.

Plate 43: Building H, east elevation; (early ? C19th) English bond brickwork exposed at base of wall.

Plate 44: Building H, interior looking south.

Plate 45: Building H; stairwell descending to basement area.

Plate 46: Buildings J (right), I (central bay) and H (left); oblique view from northeast.

Plate 47: Building K interior looking north.

Plate 48: Building K, west wall; surviving early-c.20th fabric, lined with white glazed tile at ground level.

Plate 49: Building K, west wall; surviving early-c.20th fabric including window (left) and door (right).

Plate 50: Upper part of early-c.20th (?) gable wall and associated stair (centre), observed from first floor level of Building I, looking west.

Plate 51: Building L, east elevation.

Plate 52: Hoist serving 1st floor of Building G.

Plate 53: Two-storey structure to NE of Bldg. M.

Plate 54: Hoist at east end of Building M

Plate 55: Building M, north elevation, oblique view.

Plate 56: Building M, lateral corridor.

Plate 57: Building M, interior west end abutting angled east wall of Building G.

Plate 58: Building N, oblique view from the west.

Plate 59: Late infill buildings (P. O, Q) to north of Building C.

Plate 60: Building R, oblique view from southeast.

Plate 61: Building R, south elevation viewed from loading platform.

Plate 62: Building S from the west.

Plate 63: View south along former canal basin (infilled) towards Lodge Road.

Plate 64: Northeast boundary wall of site.

Plate 65: Tunnel complex beneath building H, Area H1- Blocked Arch, looking north

Plate 66: Tunnel complex beneath building H, Area H1, looking south

Plate 67: Tunnel complex beneath building H, Area H2, looking northwest

Plate 68: Tunnel complex beneath building H, Corridor H3, blocked tunnel looking north

Plate 69: Tunnel complex beneath building H, Corridor H4, looking southeast

Plate 70: Tunnel complex beneath building H, Corridor H5, looking northeast

Plate 71: Trench 1, looking southeast

Plate 72: Trench 2, overview, looking northwest

Plate 73: Trench 2, glass-cone foundations, looking south

Plate 74: Trench 3, looking south

Plate 75: Trench 4, looking south

Plate 76: Trench 5, looking north

Plate 77: Sieges recovered from Trench 3

Plate 78: Furnace fire blocks recovered from Trench 3

Plate 79: Glass residue, recovered from Trench 4

Plate 80: Glass like residue, recovered from Trench 4