3 GLASS WHARF, TEMPLE QUAY, BRISTOL

Post-excavation Assessment Report

Oxford Archaeology North

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SUMMARY

Salmon Harvester Properties Ltd is in the process of redeveloping land at Glass Wharf, Bristol (centred on ST 5985 7265). The redevelopment area lies within the boundary of an earlier development proposal by Castlemore Securities Ltd, the groundworks for which were progressed in 2007-8. In order to secure archaeological interests, Bristol City Council recommended that a condition was attached to the 2007 planning permission that required an appropriate programme of archaeological excavation to be carried out in advance of development. This work was undertaken in order to record any significant below-ground remains at the site, including those associated with two historically significant glass-works, which had been established in the early eighteenth century and which, following amalgamation, were in operation until the early part of the twentieth century.

Oxford Archaeology North (OA North) was therefore commissioned to undertake an archaeological investigation, which commenced in April 2007. This allowed for the full excavation of the Castlemore Securities Ltd site, coupled with an archaeological watching brief that was maintained during groundworks associated with the development. The excavation exposed considerable below-ground remains associated with the glass-works, and enabled a comprehensive record to be made of these in advance of their ultimate destruction. The physical remains of the eighteenth-century glass furnaces were fragmentary, although well-preserved remains of four regenerative glass furnaces, together with a bank of associated gas producers, a probable annealing house, and ancillary structures, were exposed. Excavation provided some evidence for the application of design improvements to the furnaces, offering a valuable opportunity to elucidate details of the evolution of glass-furnace technology during the later nineteenth century. The record of the physical remains is enhanced considerably by a large assemblage of glass-manufacturing debris, which has some potential to furnish important details of the manufacturing processes carried out at the works. Other remains exposed during the excavation included a nineteenth-century dock and associated railway lines, which had been constructed across the site of earlier stone buildings.

Following the archaeological fieldwork, and during the course of the post-excavation assessment process, Castlemore Securities Ltd went into liquidation and the archaeological analytical process stalled. Therefore, in order to fulfil a condition attached to the current planning permission (ref 14/04758/F), in March 2016, Salmon Harvester Properties Ltd commissioned OA North to finalise the post-excavation assessment relating to the earlier archaeological investigation.

This assessment has examined the results of the 2007 excavations, and assessed the potential for analysis of each category of data with regard to the project's research aims, in accordance with professional guidelines. The results obtained from the assessment have concluded that the dataset has considerable potential for analysis. An updated project design is presented, and an appropriate programme of analysis outlined. Following analysis, a draft publication will be prepared, which will be submitted for publication in the international academic journal, *Post-Medieval Archaeology*.

ACKNOWLEDGEMENTS

Oxford Archaeology North (OA North) is grateful to Matthew Fox, Salmon Harvester Properties Ltd, for commissioning the completion of the post-excavation assessment report, and to Bob Jones, Senior Archaeological Officer, Bristol City Council, for his support and advice during all stages of the project. The 2007 excavation was directed by Vix Hughes and Chris Wild, who were assisted by Christina Robinson, Chris Standish, Peter Cox, Robin Maggs, Elizabeth Verrinder, Martin Greavy, Richard Kerr, Charlotte Haines, Rebecca Griffin, Des O'Leary, Pete Stock, Trevor Jose, Simon McCann, Rowena Tucker, Becky Wegiel, and Annie Hamilton-Gibney. Ian Miller managed this stage of the project.

The post-excavation assessment was managed by Ian Miller, and during the process a special thanks must be expressed to David Dungworth for considerable assistance with technological information and guidance with sampling policies, and for carrying out the assessment of the glass assemblage recovered from the excavation. Thanks are also expressed to Rod Dowling for sharing his considerable knowledge of the development of Bristol's glass industry, and his assistance with the documentary research. Further thanks are due to Reg Jackson, of the Bristol and Region Archaeological Services, for undertaking the assessment of the ceramic and clay tobacco pipe assemblages recovered from the excavation. Other material classes were examined by OA North in-house specialists Andrew Bates (animal bones) and Christine Howard-Davis (ferrous and other metalwork; glass; stone; marine molluscs; organic materials; and modern synthetic and other materials).

The post-excavation assessment report was compiled by Vix Hughes, Chris Wild and Ian Miller, and was subsequently edited by Richard Gregory. The illustrations were prepared by Marie Rowland, Chris Wild, Christina Robinson, and Mark Tidmarsh.

1. INTRODUCTION

1.1 CIRCUMSTANCES OF PROJECT

1.1.1 Salmon Harvester Properties Ltd is in the process of redeveloping land at Temple Quay in Bristol (centred on ST 5985 7265). The redevelopment area lies within the boundary of an earlier development proposal by Castlemore Securities Ltd, which was partially progressed in 2007-8. In relation to this development, the City Archaeologist, who provides archaeological planning advice to Bristol City Council, recommended that an appropriate programme of archaeological excavation was carried out in order to mitigate the ultimate loss of significant buried remains. Acting on this recommendation, Bristol City Council therefore attached an archaeological condition to the planning consent for this proposed development and, in order to satisfy this condition, Oxford Archaeology North (OA North) was commissioned to undertake a major programme of archaeological investigation, which commenced in April 2007. This included an open-area excavation across the main development site to the south of Avon Street (*Section 3*), coupled with an archaeological watching brief that was maintained during groundworks to the north of Avon Street (*Section 4*; Fig 1).

1.1.2 Following the completion of the site investigation works, a programme of post-excavation assessment was implemented, in accordance with professional guidelines (English Heritage 2006). This was intended to produce an updated project design and method statement for the analysis and ultimate publication of the hugely significant dataset recovered from the excavation, in accordance with the archaeological condition attached to planning consent. However, during the course of the post-excavation assessment process, Castlemore Securities Ltd went into liquidation and the archaeological analytical process stalled.

1.1.3 In September 2014, OA North was commissioned by Salmon Harvester Properties Ltd to produce a summary of the archaeological works carried out at Temple Quay in 2007-8, in support of their planning application, and provide a synopsis of the analytical tasks that were required to satisfy the archaeological conditions (OA North 2014). These remaining tasks relate solely to the analysis and publication of the archaeological dataset, and they now form part of a condition attached to the current planning permission (ref 14/04758/F, note 25). More specifically, it is stipulated that post-excavation assessment, specialist analysis, archive production and deposition, and an acceptable publication, need to be completed in order to fulfil this planning condition. This report, therefore, represents the completion of the post-excavation assessment, which has examined the results of the OA North 2007 open-area excavation and watching brief, and assessed the potential for analysis of each category of data with regard to the project's research aims, in accordance with professional guidelines (English Heritage 2006).

1.2 SITE LOCATION, GEOLOGY, AND TOPOGRAPHY

1.2.1 Both the open-area excavation site (centred on ST 5978 7270) and watching brief site (centred on ST 5991 7268) are situated within the historic parish of St Philip's and St Jacob's, in the Temple Quay area of Bristol (Fig 1). This area of the city is a predominantly modern commercial area, but has a rich industrial heritage as a focus for Bristol's former glass-manufacturing industry (Buchanan and Cossons 1969).

1.2.2 The open-area excavation site (designated Areas ND3-ND5) lay to the south of Avon Street, north of the Floating Harbour, and was bordered by a railway viaduct and Trinity Quay, to the east and the west respectively (Plate 1). In contrast, the watching brief site (designated ND9) was bounded to the north by Anvil Street, to the east by Oxford Street, to the south by Avon Street, and to the west by a then vacant plot (Plate 1).

Plate 1: Recent aerial view of the sites prior to development

1.2.3 The solid geology across the excavation and watching brief sites comprises Triassic sedimentary material, consisting of the Redcliffe Sandstone Member, whilst superficial deposits comprise Tidal Flat Deposits derived from both the River Avon and its tributaries over the last 10,000 years (BGS 2004).

1.2.4 Topographically, the Bristol Conurbation as a region is determined by the courses of several rivers, which have created an undulating landscape, although much of the central part of the city is more gently sloping (Countryside Agency 1999, 125). The topography within the environs of the excavation and watching brief sites, however, reflects the valley of the River Avon, which takes a course through the city and on to the Avon Gorge and the Severn Estuary.

2. HISTORICAL AND TECHNOLOGICAL BACKGROUND

2.1 THE DEVELOPMENT OF THE ENGLISH GLASS INDUSTRY

2.1.1 Glass-making was introduced to Britain by the Romans, although the character and scale of glass production during this period is poorly understood. It is unclear whether glass was made from raw materials, or melted from imported pre-manufactured material (Angus-Butterworth 1958). During the Middle Ages, the industry was concentrated in heavily forested areas, as glass-makers required a ready supply of wood to fuel their furnaces, and bracken as a source of potash. The traditional centre of glass-making was the Weald of Sussex and Surrey (Ashmore 1969, 123), although there were smaller local production areas, such as the Forest of Dean, and there is some evidence for glass-making in Bristol and Gloucester during the early fourteenth century (Grimke-Drayton 1915). Glass production during this period was carried out on a fairly small scale, and the glass was of a poor quality, reflecting the simple furnace design of the time, and the impurities within the potash that was used (Dungworth 2003, 2). The quality of glass improved dramatically during the late sixteenth century as a result of the influence of immigrant French glass-workers (Vose 1980, 106-10).

2.1.2 In 1615, James I banned wood as a fuel for glass furnaces, forcing glass-makers to consider redesigning their furnaces to operate on coal. This required a solution to several technical difficulties; coal burns with a shorter flame than wood and therefore requires the heat source to be closer to the glass-melting pots, and the burning of coal also demands much larger volumes of air. These requirements led to the introduction of furnaces with grates and deeper flues (Crossley 1990, 232-5). The use of coal necessitated modifications to furnace superstructures to facilitate the efficient venting of sulphur produced from burning coal, leading to the development of the English glass cone-furnace, designed to remove smoke and soot, and to create a stable atmosphere, in addition to increasing the size of glass furnaces. This structure comprised an open-ended cone around and over the furnace, increasing the draught through the grate, whilst maintaining a steady working temperature around the furnace (Parkin 2000, 8). After its introduction in the late seventeenth century, the cone-furnace became widely recognised as a classic symbol of the English glass-making industry (Plate 2).

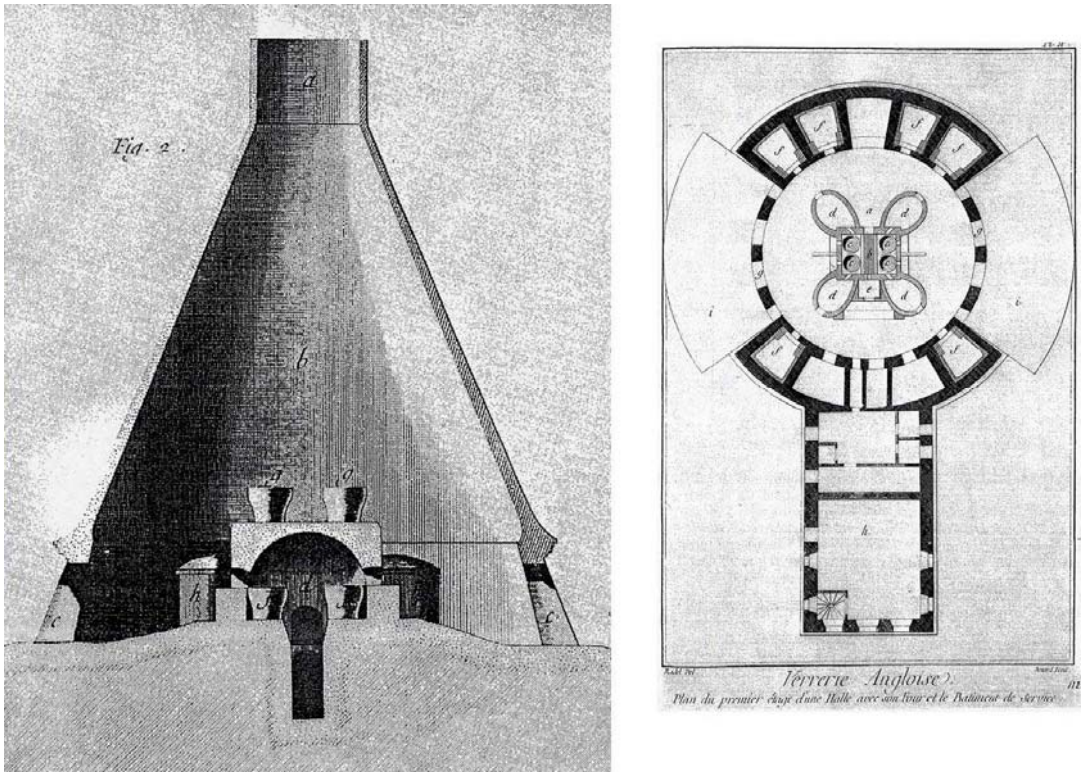


Plate 2: Section and plan of a typical eighteenth-century glass cone (taken from Diderot 1771)

2.1.3 The sudden change of fuel source, from wood to coal, also resulted in a shift in the focus of the industry, from the traditional centres in the south of the country to those with accessible coalfields (Ashmore 1969, 123). Hence, Bristol, Stourbridge, Newcastle upon Tyne, South Lancashire, and South Yorkshire all developed as important glass-making centres during the seventeenth century, although London also boasted a considerable number of glass cones.

2.1.4 Whilst it has been argued that Britain became a net exporter of glass and was in the forefront of European glass-making during the seventeenth century (Charleston 1984), the finest colourless glass was produced by Venetian workers and imported to Britain until the later part of the century. In 1676, however, George Ravenscroft succeeded in producing good-quality colourless glass in England by introducing lead as a flux, in addition to potash. The invention of colourless lead glass, which is also known as lead crystal or flint glass, had a profound impact on glass manufacture (Dungworth 2003, 5). Upon the expiry of Ravencroft's patent in 1681, the production of lead glass was taken up by numerous glass-makers; in a list of 88 glasshouses compiled by John Houghton in 1696, 27 were producing 'flint glass' (Vose 1980, 198-9). Houghton's list also indicates that Bristol had nine glasshouses at this time, with only Stourbridge (17) and Newcastle upon Tyne (11) having more. The development of the glass industry in Bristol was more compatible with Tyneside, having begun earlier than those of other large cities, such as Birmingham, Manchester, and Liverpool, which date from the eighteenth century (Dodsworth 1982).

2.1.5 It is widely thought that covered glass-making crucibles were introduced shortly after Ravenscroft's development of lead glass, although there is no historical or archaeological evidence to support this conjecture (Vose 1980, 147). However, during the mid-seventeenth century, Merrett described open crucibles that were 20 inches wide (508mm) at the rim and narrowed down towards the base (Neri 1662). Crucibles were often referred to as pots, and were either manufactured on site from

imported raw clay, or were imported from the Midlands, where the clays were particularly suitable for producing heat-resistant refractory bricks and crucibles (*ibid*).

2.1.6 Glass was produced in three main types during this period (Wills 1974), the simplest being bottle glass, which used less expensive ingredients and was often dark greens and browns, sometimes referred to as 'black' glass. Ornamental and table glass, usually referred to as 'flint' or 'lead' glass, was pale or colourless, and manufactured using higher-quality, more expensive, ingredients. The third type of the period was window glass, also known as crown glass (Powell 1925, 214). In all cases, the raw materials, referred to as 'batch', were placed into the pots and gradually heated from the furnace. The raw materials could include silica, often in the form of sand; alkali from sources such as potash, kelp ash, and soda ash; lime derived from either limestone or high-lime sand; colouring agents; and often 'cullet', which was reused and reheated. Once the batch was heated and the chemical processes under way, the material became known as 'metal', and it was imperative to keep it free from smoke, grit, or other impurities (Angus-Butterworth 1958). Higher temperatures were required to melt the batch fully, and once this was achieved the metal was allowed to cool slightly so that it was workable. Glass-making operations varied according to the types of glass being made, but all were originally based on glass-blowing (Plate 3), whereby a quantity of molten glass was picked up on the end of a long metal tube, and then blown to the required shape and size (Chaloner and Musson 1969).

Plate 3: Glass-workers at work in the mid-eighteenth century

2.1.7 A major advance in the industry was an improvement in the production of plate glass, whereby molten glass was poured onto a metal casting-table and then flattened into thick plates or sheets by heavy rollers (Plate 4). The glass was finished by grinding and polishing. The first company for the manufacture of English plate glass was established in 1773, and commenced its operations at Ravenhead, near St Helens (Redding 1842, 89). The workmen for this enterprise were brought over from France, but by the mid-nineteenth century 'the great majority of persons employed are Englishmen' (*op cit*, 90). Redding also claimed that English glass of the nineteenth century was superior to that of either the French or Venetian artisans as a direct result of 'the application of chemical and mechanical science to the improvement of several processes', but noted that 'great jealousy is manifested by the proprietors in keeping secret the details of their processes' (*ibid*).

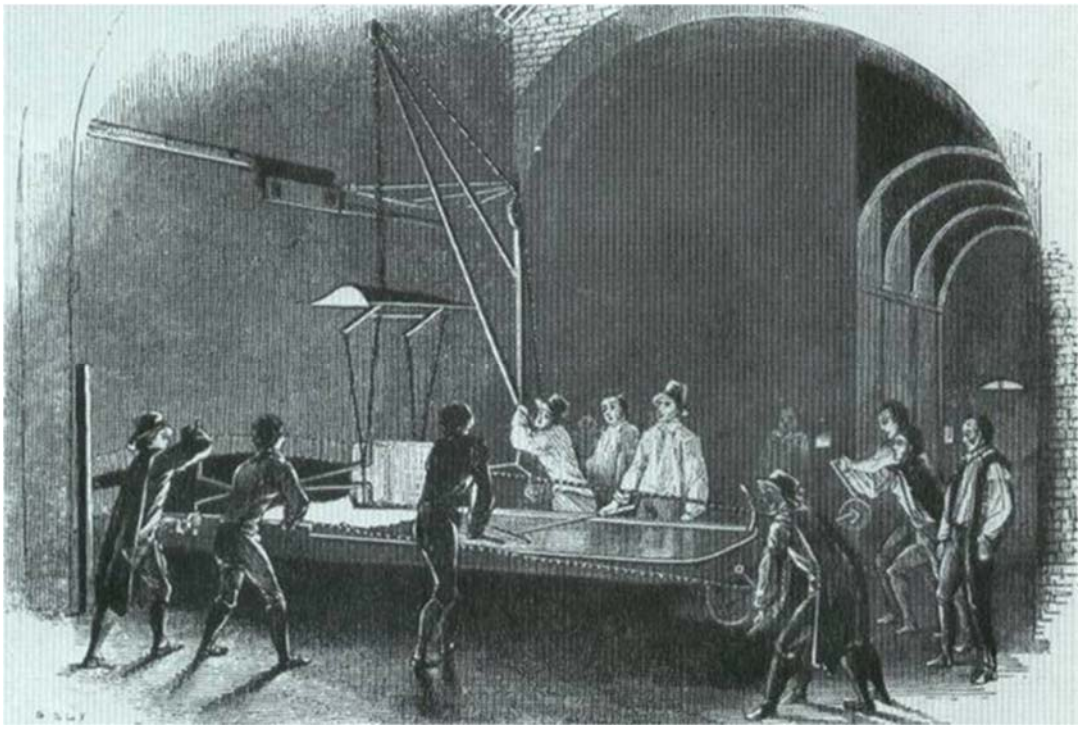


Plate 4: Casting plate glass in St Helens, 1842 (taken from Musson and Robinson 1969)

2.1.8 The round reverberatory furnaces of the early nineteenth century generally contained either two, or four crucibles, with the period 1835-50 seeing enlargements to accommodate eight or ten crucibles, each with a capacity of up to five hundredweight of molten glass (Parkin 2000, 14). The circular nature of the early eighteenth-century furnaces and cones allowed a number of pots/crucibles to be placed around the heat source. However, the pots and central furnace system was not an efficient use of fuel and the melting was problematic.

2.1.9 The concept of a tank and furnace system was proposed as early as 1769 (BP 929), but it was not until 1840 that a more workable system was initiated by Joseph Crossfield (Musson 1965). The demand for a new type of furnace was driven by the window glass sector of the industry, which by the mid-nineteenth century had become monopolised by three large concerns: Chances, in Birmingham; Pilkingtons, in St Helens; and Hartleys, in Sunderland. Each attempted to gain temporary advantage by technological innovation (Parkin 2000).

2.1.10 Following the Salford-based physicist James Joule's discovery, in 1845, that the mechanical equivalent of heat could quantify how heat could be converted into mechanical work, several of his contemporaries saw its potential for application to industry. Among them was Carl Wilhelm Siemens (later Sir (Charles) William Siemens), a German, working in England for his elder brother Ernst's communications technology company (Chaloner and Musson 1969). His first attempt in heat conservation was to construct a regenerative condenser, providing superheated steam to a four horse-power steam engine belonging to John Hick of Bolton in 1847. A modified version was applied to the steam engine of Messrs Fox, Henderson, and Co, of Smethwick, in 1849, and although both had limited success, Siemens was awarded a gold medal by the Society of Arts in 1850 for his endeavour, acknowledging the value of the principle (*ibid*). During the early part of the next decade, he, and younger brother Frederic, changed the focus of their work to furnace design. Working initially with the iron industry, the brothers adapted the principles of their regenerative condenser to create a regenerative furnace. As outlined in the original patent of 1856 (BP 2861), entitled *Improved arrangement of furnaces which improvements are applicable in all cases where great heat is required*, the furnace worked by:

> *arranging smelting and heating furnaces...that the products of combustion on their passage from their place of combustion to the stack or chimney shall pass over an extended surface of brick, metal or other suitable material imparting heat thereto...The result of this arrangement is that the air or other materials of combustion are nearly heated to the degree of temperature of the fire itself, in consequence whereof an almost unlimited accumulation of heat or intensity may be obtained* (*ibid*).

2.1.11 This original furnace design contained two pairs of regenerative chambers beneath the furnace, each packed with bricks in open Flemish bond, *ie* a chequer-pattern of unbonded brick, stacked in such a way that gases could pass through. Hot exhaust gases leaving the furnace flowed downwards through one pair of regenerative chambers, imparting a substantial part of their heat to the brick chequer-work, on their way to the chimney. Once the bricks were sufficiently hot, the direction of gas flow in the system was reversed by a series of valves to allow the hot bricks to heat up the gas and air entering the furnace via the other pair of chambers, whilst the exhaust gases reheated the opposing pair. This preheating of gases gave a considerable reduction in fuel, and William Siemens suggested the figure was as high as 70-80% (BP 1320).

2.1.12 It was this original design that stimulated the interest of Windle Pilkington, who realised that the furnaces for iron smelting and glass production were not dissimilar. In 1857, the Siemens obtained a further patent (BP 1320), entitled *Improvements in Furnaces and in the Application of Heated Currents*', which specifically mentions the potential use of the furnace for 'melting glass'. Such a furnace was installed in a glass-works in Rotherham in 1860 (Krupa and Heawood 2002, 10).

2.1.13 A second breakthrough in the Siemens redesigning of the furnace was the removal of the coal-powered fireplace, and its replacement with a gas supply, located away from the furnace. Both the modifications to the furnace and method of gas supply were patented by the Siemens brothers in 1861 (BP 167), the specification in the patent referring specifically to 'furnaces for melting glass or for other purposes', demonstrating that the technology was now being driven by the glass, rather than iron, industry.

2.1.14 Significantly, the use of producer gas was much more economical, as the gas-producer units could be fuelled with 'slack', the lowest grade of extracted coal, available far more cheaply than the higher grades required previously. This had a benefit not only in the areas of the coalfields, like St Helens and Bristol, where huge quantities of slack could be procured extremely cheaply, but also areas like South Staffordshire, where only the lower grade could be mined in any quantities, reducing the cost of fuel from 12s 6d per ton to 3s or 4s (Siemens 1862, 35). Gas producers also used less fuel, so a furnace smelting steel in Gorton, Manchester, in 1865, which had previously been utilising seven hundredweight of coal, only required four hundredweight, one quarter, five pounds of slack to produce the same quantity of steel (Betts Brown 1866, 142).

2.1.15 The slack, coal, or alternatively even coke dust, lignite, or peat (Siemens 1862, 26) was heated gently on an inclined fire-grate, fed from above with slack, via a hopper onto an inclined brick plane. An arch of firebrick above the grate, and heated by it, imparted heat to the new coal slack as it travelled down the incline, beginning the decomposition process before it reached the grate itself. When mixed with air rising through the grate, these gases formed carbonic acid gas (H_2CO_3), which then rose through the partially decomposed material above, onto which droplets of water were added via a small pipe, the resultant gas comprising carbon monoxide (CO) and hydrogen. This then rose into a flue linked to the regenerative chambers.

2.1.16 Although the use of gas, rather than a solid fuel, produced a great economic saving in fuel costs, it also improved the working of the furnace. By introducing dampers into the air and gas channels, the quantity and quality of the flame within the furnace could be regulated 'to the utmost nicety' (BP 167). A further advantage of using gas instead of solid fuel was that the lack of any solid particles or ash in the working chamber of the furnaces enabled the use of open crucibles. 'We are thus enabled to melt flint and other superior qualities of glass in open pots' (*ibid*). Siemens also claimed that:

> *fewer pot breakages also occur, less repairs are required, and the amount of waste has decreased; moreover, the glass metal is obtained from a cheaper composition than that hitherto used, and proves to be of a far superior quality. The pots last fully double the time, and melt more than three times the quantity of material, whilst the furnace itself stands for three years; that is, it lasts six times as long, and melts more than nine times the quantity of material it did previously to its reconstruction (Siemens 1884, 5).*

2.1.17 The new furnace proved popular and, significantly, was immediately trialled by the Chance Brothers in Birmingham in 1861, under close monitoring by the Siemens brothers. Pilkingtons, based in St Helens, quickly followed suit, installing a similar furnace in 1863 (Krupa and Heawood 2002, 13). Thus, by the end of 1863, England's two largest glass-manufacturing firms were operating Siemens' gas-powered furnaces.

2.1.18 Despite the exceptional economic savings of this early Siemens furnace, it still operated essentially in the same manner as the traditional glass furnace, production being stifled by the limited number of pots (crucibles) that could be heated, and the cycle of heating, working, cooling, and recharging the pots, which took between two and three days for each batch (Krupa and Heawood 2002, 10). It appears to have been the Pilkington family that seized the initiative from the Chances, working at first independently, but then in conjunction with the Siemens brothers, who had been attempting to develop a cistern or tank furnace for several years (Cable 2000). This

was first presented in a patent of 1870 (BP 1513), which was concerned mainly with improvements to gas producers, mentioning improvements to pots, and the introduction of tanks almost as a footnote. This provided the basis for continuous working of the furnace, with the tank divided into three compartments: one receiving raw materials; a central 'clarifying' compartment; and a semi-circular working end. Each compartment was separated by refractory brick walls, with inter-connecting channels, to allow flow through the solid brick tank. Heat was applied at different intensities along the tank, with higher temperatures required to melt the 'batch' (raw materials), than the 'metal', with a further reduced temperature required for the 'gathering' at the working end (Parkin 2000).

2.1.19 The design was perfected by 1872, when a further patent was granted for the continuous tank furnace (BP 3478). The main improvement was the replacement of the three compartments with only two: a melt end; and a working end, separated by a floating bridge (Plate 5). The Siemens had observed that the remnants of imperfectly melted batch floated above molten glass, and thus could be held back from the working end by a floating barrier. This improvement was also facilitated by a change in the heating of the tank; rather than heating the tank to a much greater degree where the batch was added, a hot spot was created approximately two-thirds along the length of the tank with the material essentially flowing towards it, becoming increasingly more refined, and emerging beyond the bridge in a form suitable for gathering (Parkin 2000). This process relied on the varying density of the melting materials to help their movement through the tank, and to aid this, various supplementary elements were tried, such as partition walls, and floating refractory rings, all with the aim of preventing the metal from devitrifying.

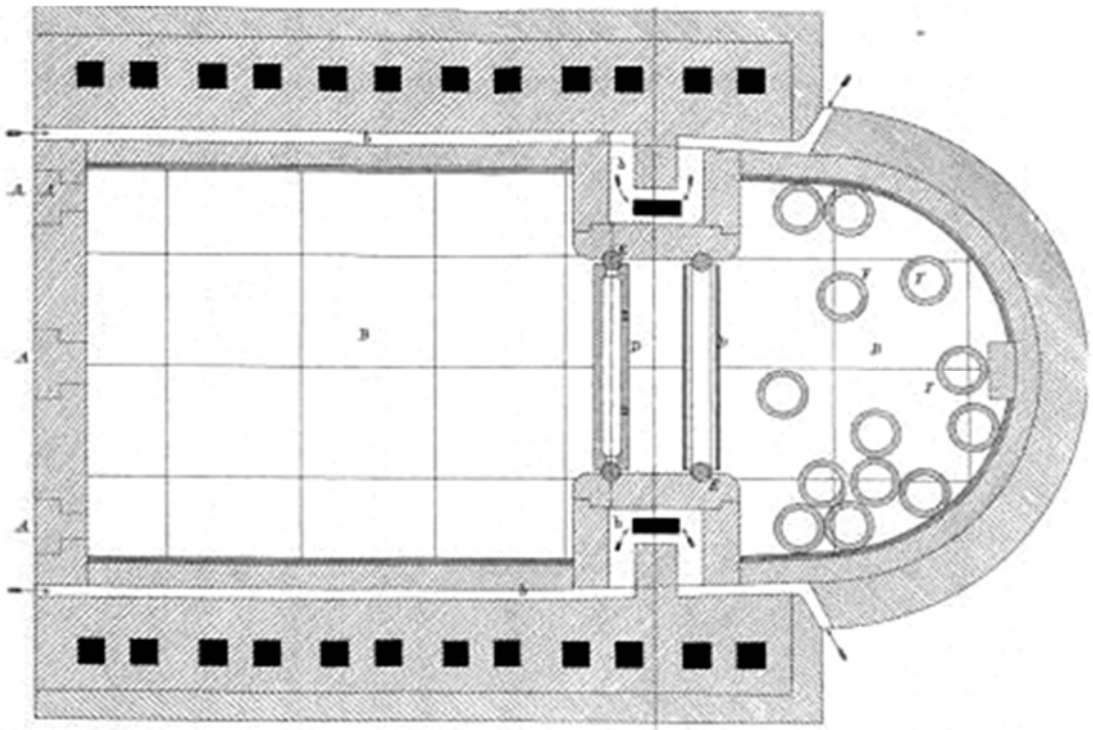


Plate 5: Plan of a continuous tank furnace, from William Siemens' patent of 1872 (BP 3478)

2.1.20 Construction of such a tank was commissioned by Pilkingtons at their St Helens works a week prior to the publication of the patent, demonstrating their close working relationship with Siemens (Barker 1960, 147). The furnace was operational in April of the following year, with an announcement to the Board of Directors three days later that it was 'beating any pot furnace on the ground' (PA Minutes of the

Board 17/4/1873). However, the following day, the tank leaked badly, causing a fire that destroyed the furnace building (Barker 1977, 134). Despite this setback, Pilkingtons rebuilt quickly, and following better success with the replacement tank, they installed 12 tanks within four years (*ibid*).

2.1.21 A further improvement in tank design was prompted by the introduction of the flat-drawn glass process, and comprised a tank of approximately double the size, split by a bridge, as before, into a large 'melt end' tank, and a similarly sized 'working end'. This was, however, superfluous to the needs of the bottling industry, where the semi-circular 'working end' was retained.

2.1.22 ***Bottle-glass manufacturing:*** the dark green, brown, or even black, bottle used for the storage (as opposed to the serving) of wine, beer, and other beverages appears to have been developed around the middle of the seventeenth century in England. Godfrey (1975, 228) recounts appeals made in 1661 against the granting of a patent to John Colnett for the manufacture of 'glass bottles in standard sizes'. The bottle makers who petitioned against the patent complained that the manufacture of such bottles had already been practised 'neer thirty years since' (*op cit*, 229) and had been invented by Kenelm Digby, who had since left the industry. The first well-dated examples, of what soon became known as the English bottle, belong to the 1650s. Wine was still imported in barrels, but the owners quickly took to storing their wine in bottles, and often had their initials and a date added to the bottle. This was achieved by adding a small lump of glass to the outside of the bottle and impressing a brass die engraved with the relevant letters, symbols and/or numbers (Noël Hume 1961; Tyler and Wilmott 2005); the earliest example of a wine bottle dated in this way bears the date 1650 (Van den Bossche 2001, fig 24.1).

2.1.23 Studies of wine bottles have shown that a variety of shapes were made; globular (Plate 6), squat cylinders (Plate 7) and tall cylinder forms (Plates 8-9) were prevalent. In addition, the bottles display a variety of typological variation, including the finishing of the lip, the size, shape and positioning of the string-rim, mould marks, and embossed decoration. The different types have been compared against a variety of dating evidence (date stamps, archaeological context, representations in paintings, *etc*), and it is now relatively straightforward to date English bottles on typological grounds (Noël Hume 1961; Wills 1968; 1974; Fletcher 1976; Morgan 1976; Jones 1986; Van den Bossche 2001).

Plate 6: Early eighteenth-century bottles (Van den Bossche 2001)

Plate 7: Late eighteenth-century bottles (Van den Bossche 2001)

Plate 8: Early nineteenth-century bottles (Van den Bossche 2001)

Plate 9: Late nineteenth-century bottles (Van den Bossche 2001)

2.1.24 The earliest types (globular or onion-shaped; Plate 6) belong to the late seventeenth century and early eighteenth century, and were blown without the aid of a mould of any kind. After the first decade or so of the eighteenth century, the most popular shapes were cylindrical, first squat cylinders and later tall cylinders. The popularity of cylindrical shapes seems, in part at least, to have been related to the use of metal moulds, which helped to form the bodies. It is likely that the metal moulds (both brass and cast iron), referred to in eighteenth-century documents, were simple 'dip' moulds consisting of a single slightly tapering cylinder (the slight tapering allowed the removal of the bottle from the mould); an article in Farley's *Bristol Journal* of August 1752 mentions the theft of a brass bottle-mould, which had a value of 18/-. The glass was still gathered by hand and blown in the mould (made of brass or cast iron), but the shoulder was free-blown and the lip and string-rim continued to be finished by hand. Dip moulds continued in use until the mid-nineteenth century.

2.1.25 Two-piece metal moulds, known as open and shut moulds, were invented by Charles Chubsee in 1802, although the design was not patented and it was soon widely copied (Ellis 2002, 320). This type of mould was hinged at the base to allow the easy release of the finished bottle (Plate 10). Bottles made in open and shut moulds have two vertical seams running up the cylindrical part of the body, and allowed the application of embossed decoration and letters (Jones 1986, 88-9). The embossed lettering usually identified the source of the beverage and, while the earliest example dates to 1750, the practice seems to have been most popular for beverage bottles in the nineteenth century (Van den Bossche 2001).

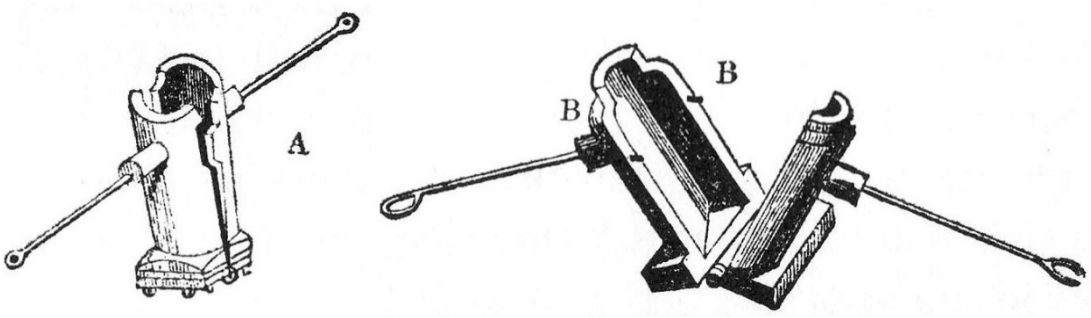


Plate 10: Open and shut moulds for the manufacture of cylindrical (A) and square (B) glass bottles (Pellatt 1849, 103)

2.1.26 In 1821, Henry Ricketts patented a three-part mould for bottles, which consisted of a single (slightly tapered) mould for the body and two further moulds for the shoulder and neck (Plate 11). The tapering of the body of the mould was necessary to allow the finished bottle to be withdrawn. The base of the cylindrical mould and the two halves of the neck mould could be decorated to provide embossed text on the bottle, personalising the bottle to the manufacturer. Early Ricketts's three-part moulded bottles are usually embossed with PATENT on the shoulder (Witt *et al* 1984, plate 40). The use of the three-part mould remained in use in the bottle-manufacturing industry until the early twentieth century.

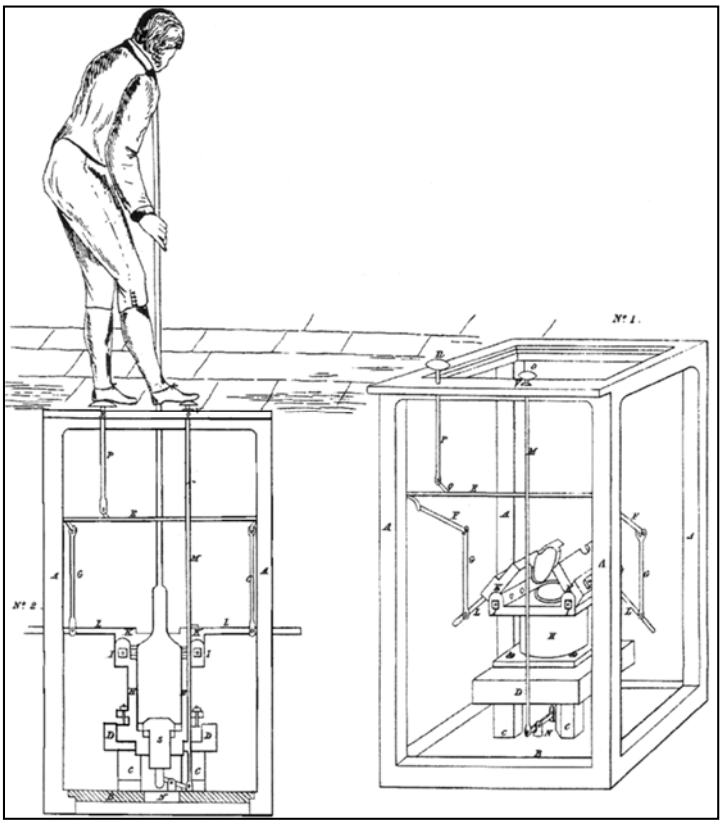


Plate 11: Ricketts' three-part bottle mould, from the 1821 patent (Van den Bossche 2001)

2.1.27 The next major innovation in the glass-bottle making industry was the development of semi-automatic and automatic bottle-forming machines, which had a dramatic impact on the industry as whole. The Ashley semi-automatic bottle-making machine was developed in the 1880s in Yorkshire (Cable 2002, 5) and by 1907, 14 firms, mainly in Yorkshire and Lancashire, had adopted the same or similar machines (Douglas and Frank 1972, 174-9). The semi-automatic machine still required the accurate gathering of the requisite amount of glass by hand, but this was then transformed into a suitable container through the use of moulds and compressed air (Cable 2002, 5-6). A fully automatic machine, which both gathered the glass by suction and then shaped it using compressed air and moulds, was developed by Owens in the United States by 1903 (*op cit*, 8-12; Douglas and Frank 1972, 180-2). The first Owen's machine in Britain was installed in Manchester in 1906, and then was adopted quickly throughout the industry (Turner 1938).

2.1.28 The glass used to make English bottles was initially the high-lime low-alkali glass (HLLA) used for the manufacture of a range of other artefact types. The manufacture of late seventeenth-century bottles is known in some detail from Vauxhall, London (Tyler and Willmott 2005), and Silkstone, Yorkshire (Dungworth and Cromwell 2006). The Pcomposition of late seventeenth-century HLLA glass indicates manufacture from sand and common plant ashes (*cf* Cable 2003). HLLA bottle-glass manufacture in the eighteenth century is known from several sites in Bristol, but less is known about the composition of nineteenth-century bottle glass. The documentary evidence for the manufacture of eighteenth- and nineteenth-century bottle glass frequently stresses that only the cheapest ingredients were used, such as kelp, soaper's waste, clay, brick and slag (Berg and Berg 2001; Pellatt 1849; Cossons 1972; Parkes 1823; Muspratt 1860; Powell *et al* 1883). The use of cheap ingredients was in part forced on bottle manufacturers by the nature of the taxation system which

was not repealed until 1845. The trend through the eighteenth century of the increasing use of cheap (or even free) raw materials can perhaps be seen in the compositional changes of HLLA glass. At the beginning of the eighteenth century, these glasses contained high levels of elements usually associated with plant ashes (especially phosphorus) but by the early nineteenth century this element is virtually absent from bottle glass. The HLLA glass used in the nineteenth century for the manufacture of bottles appears to have contained high levels of aluminium and iron (Cable and Smedley 1987). Nevertheless, HLLA probably continued to be used by most bottle manufacturers until the advent of fully automatic bottle-making machinery at the end of the nineteenth century (Cable 2002).

2.1.29 ***Window-glass manufacture:*** window glass in the eighteenth century and early nineteenth century was made using the crown process. Molten glass was gathered from the crucible and inflated into a bubble, which was then opened out and spun to obtain an almost flat disc of glass. The glass-maker continued to spin the disc until it had solidified sufficiently to be placed in an annealing chamber (Douglas and Frank 1972, 137-9). The crown technique meant that the glass was solid by the time it was handled, and so its surfaces were extremely smooth (fire-finished). The forming process also allowed crown glass to be made extremely thin (some eighteenth-century crown glass is as thin as 1mm), which improved its transparency, although it often retained concentric waves or ripples that could distort a transmitted image. The major limitation of crown glass was the size of the discs (typically 1.2m in diameter; Cossons 1972, 84), and the 'bull's eye' at the centre, which limited the maximum size of panes which could be produced; glaziers' manuals of the nineteenth century indicate that the largest panes that could be made from crown glass were typically 0.6 x 0.4m (Louw 1991, fig 6).

2.1.30 ***Taxation:*** throughout the development of the glass industry, several external factors had impacts on levels of production, profits and investments. The main factors were political instability, mostly in the form of wars, and the second factor was economic policies, namely taxation. This affected the glass industry quite severely; for example, in the 1690s, glass-workers from Newcastle upon Tyne petitioned to have taxes reduced or removed on the raw material, finished products and fuel, and when this was denied it caused all the glass furnaces to close down temporarily in 1698 (Powell 1925, 94). The nineteenth-century tax regulations involved the measurement of every crucible size used for glass manufacture, and the prohibition of mixing production. Thus, bottle glass could not be made in a plate-glass factory, and a common bottle factory had to produce phials of six fluid ounces and greater (Witt *et al* 1984, 155). Taxes on glass production were finally abolished in 1845.

2.2 THE EARLY DEVELOPMENT OF BRISTOL'S GLASS INDUSTRY

2.2.1 The earliest reference to probable glass-makers in Bristol dates to 1313, when Johannes de Galswroughte and Radolphus de Glasworth paid tax (R Dowling *pers comm*). Glaziers are mentioned in apprentice books of the sixteenth century, probably associated with the use of glass windows in churches: '…an ingenious glass-maker, master Edward Dagney, an Italian then living in Bristow…' was called in to assist iron-workers in the Forest of Dean in 1651 (Witt *et al* 1984, 21). The early establishment of the glass industry in Bristol was due to several factors: there were regional coal sources, which were crucial after the 1615 ban on the use of wood as fuel in glass-making; there were sources of sand, limestone and red lead available locally; and Bristol was the largest port outside of London until the mid-eighteenth

century, allowing bulk deliveries of coal, whilst kelp could be easily obtained from Ireland (*ibid*). The port of Bristol also handled large volumes of sugar imported from the West Indies, which was instrumental in the growth of the city's distilling industry, a ready market for any bottles produced. The trade network extended to include the New World, Ireland, Iceland, the Hanseatic League, and the Mediterranean.

2.2.2 In 1696, John Houghton noted that 'in and about Bristol there were five (glasshouses) making bottles, one making bottles and window glass, and three making flint glass and ordinary glass' (Powell 1925, 97; Witt *et al* 1984, 21). In the 1720s, however, when Daniel Defoe visited Bristol, he noted that

> *there are no less than 15 glasshouses in Bristol…they have indeed a very great expense of glass bottles by sending them filled with beer, cyder and wine to the West Indies, much more than goes from London also great numbers of bottle even such as is almost incredible are now used for sending the water of St Vincent's Rock away which are now carried not all over England but we may say all over the world (Defoe 1769, 308).*

A similar description was also given in John Read's *Bristol Calendar* in 1792 (Powell 1925, 217). By 1727, the Avon had been made sufficiently navigable for boats to transport large quantities of goods from Bristol to Bath directly. Since Bath was a market for glass products, such as window glass and tableware, this was a distinct improvement (Witt *et al* 1984, 24). Prior to this, most items were transported by road, which was both more expensive and not suitable for delicate glass items.

2.2.3 During the eighteenth century, glassware for the table, as bottles, and windows were held in some regard; the first will from Bristol to mention a bequest of dinner crockery and glass dates to 1715 (Latimer 1893, 14). A fine dinner was laid on for Queen Anne during her visit to Bristol in September 1702 to celebrate her accession to the throne, and the sum of £6 14s was paid for glasses bought or commissioned especially for the occasion (*op cit*, 45). In 1738, during the processions of The Companies of the City, put on for the visit by the Prince and Princess of Wales, the glass-workers were honoured by being first and were described as being on 'horseback, some with swords, others with crowns and sceptres in their hands made of glass' (*Daily Post*, 14 Nov, 1738).

2.2.4 In the *Freeholders' Journal* of 1722, a quart-sized bottle was priced at 2d, and at least one destination for bottles manufactured was shown by the advertisement for Bristol Water (known as 'Hottwell Water'), for sale in bottles (Wills 1974, 74). In 1728, there was a failed protest by the glass-makers of Bristol, via a petition to Parliament, against the prohibition on importing wine in either bottles or small casks. The aim of the ban was to prevent smuggling, and it was feared that the stoppage of this would severely affect the bottle trade (Latimer 1893, 163). The importance of glass-making equipment in Bristol is demonstrated by an account from 1752, which states that 'on Thursday James Watkins was committed to Newgate for stealing one brass bottle-mould, value 18 shillings, the property of Mr Thomas Warren and Co, from the glasshouse in St Thomas Street in this city. It seems the said Watkins worked at the glasshouse and sold the mould to a brazier of this city at a market price' (Wills 1977, 22).

2.2.5 Angerstein's account of his tour of England includes a detailed description of a visit to a Bristol bottle-glass-works in 1754 (Berg and Berg 2001, 128-30). Unfortunately, Angerstein does not identify which bottle-glass-works he visited, but given the nature of the industry, it is likely that the account reflects practice in most

glasshouses. Angerstein reports that, for glass bottles, the ingredients were sea sand, soap ash (or potash), iron slag, kelp, limestone and old bottles (*op cit*, 129). Angerstein describes how the sand, soap ash and kelp were pre-roasted (fritted) in arches or vaults, and then melted with the iron slag in crucibles. The furnace had four holes for access to the four crucibles, and a team of five worked the glass from each hole. Each team was led by a master glass-blower who was paid 25s per week, the others receiving 18s, 15s, 10s and 4s per week (*op cit*, 130). These four teams would produce 240 dozen bottles in a week, which sold for 20d per dozen (*ie* 400s per week in total). Angerstein also says that coal was consumed at the rate of 1.5–2 tons per day, and that it cost 7d per sack (or three bushels). As raw materials were an almost negligible cost, it is likely that weekly profits would have been around £10 per week (or eight times the wage of the most skilled wage earner in the glasshouse; *ibid*).

2.2.6 In 1775, during the American War of Independence, various agreements were in force concerning non-importation of goods, including glass. It is estimated that between 1775 and 1778 glass production fell by a third and only reached the same levels ten years later, and within this timeframe several Bristol glasshouses and shares in companies were put up for sale (Witt *et al* 1984, 28). Some of the restrictions remained in place, and even when lifted, the heavy taxes and duties were also a depressing factor. However, the American glasshouses in the eighteenth century could not meet the demand and goods had to be imported (*ibid*).

2.2.7 In 1789, a contemporary source noted '…the great demand for glass bottles for the Bristol and the Bath waters…', and for '…the exportation of beer, cider and perry…', as well as '…a great export of plate or window glass, vials and drinking glasses…' (Barrett 1789, 184). There were around 14 glass-works operating in the city by 1797, some of which allowed strangers and sight-seers to view the activities twice a week (Latimer 1893, 484). A trade directory for 1825 lists four glass benders, one glass-blower, five glass cutters, four (black) glass-bottle manufacturers, one patent crown-glass manufacturer, one flint- and cut-glass manufacturer, ten flint-glass dealers, two glass stainers and 49 glaziers operating in Bristol (Mathews 1825, 238-9).

2.3 OPEN-AREA EXCAVATION SITE: HISTORICAL AND ARCHAEOLOGICAL BACKGROUND

2.3.1 ***Historical development:*** the excavation area occupied open land on the eastern fringe of Bristol throughout the medieval and post-medieval periods. During the early eighteenth century, two glass-works (glasshouses) were sited in close proximity within the excavation area, occupying land adjacent to the River Avon. Avon Street was originally a continuation of Cheese Lane, and businesses were listed under either name throughout the eighteenth and nineteenth centuries (*eg* Mathews 1794; 1825; 1875). The first of these glasshouses was built in the western part of the site, and was known as the Soap Boilers' Glasshouse, whilst the second lay to the east, and was known as Hoopers' Glasshouse.

2.3.2 ***Soap Boilers' Glasshouse:*** in 1715, a consortium of soap boilers, fronted by Edmund Mountjoy, built a glasshouse on Cheese Lane (now Avon Street), associated with a single glass cone (Witt *et al* 1984, 50). The others involved in the venture were John Purcell, John Thomas and Elisha Hellier, who were all apparently soap makers. The manufacture of soap used caustic alkali, which was often made by the soap makers themselves, and produced a by-product of calcium carbonate, known as soaper's ash,

which could be reused as the alkali needed in glass-making. The business was sufficiently successful that a second glass cone was built subsequently for the production of crown glass. One of these glass cones lay directly within the excavation area (Plate 12).

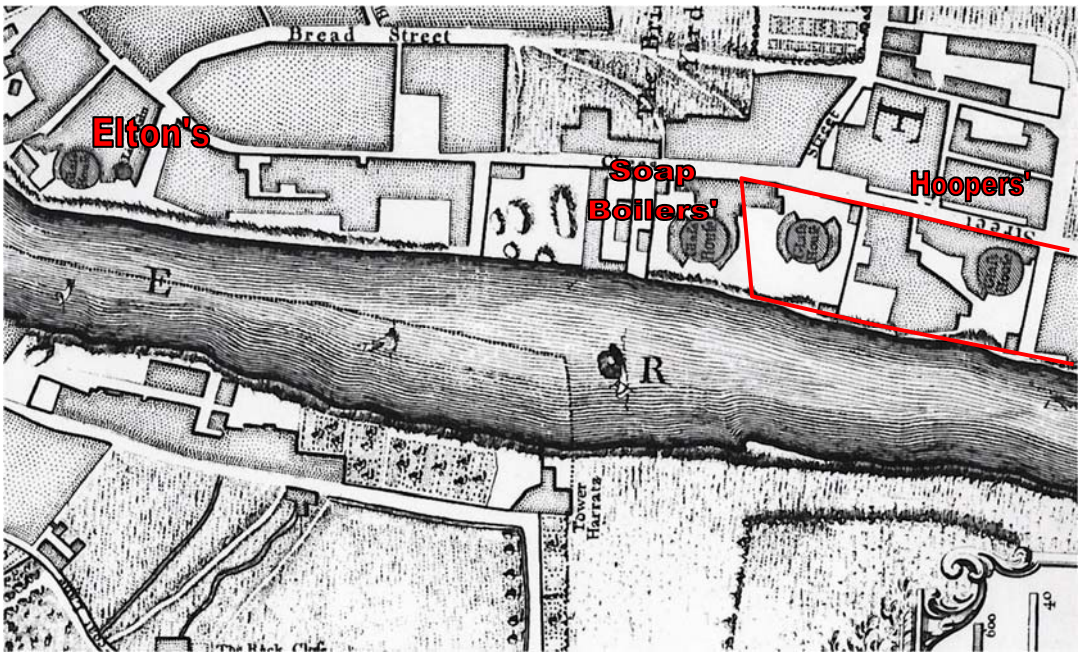


Plate 12: Extract from Roque's plan of 1742, showing glass furnaces on Cheese Lane

2.3.3 In 1751, as evidenced by a notice of sale in the *Bristol Weekly Intelligencer*, the glasshouse was known as 'Mr Tyndall's glasshouse' (Witt *et al* 1984, 50) and a deed of 1753 lists the co-partners in 'the undertaking for making glass, glass bottles and other glass wares' as being Thomas Tyndall, Oesiphorous Tyndall, Corsley Rogers (merchant), Arthur Jepson (wine merchant), William Hall (dry-salter), and William King (glass-maker) (Powell 1925, 243). The business changed various partners, through deaths and withdrawals, and was eventually dissolved in 1766, by then owned by William King and Thomas Harris. An auction sale announcement for the premises in 1766 listed the assets as 'the stock, implements, utensils, kelp, frit, sand, ashes, pots, bricks, clay and a great number of other things commonly used in making crown window glass and glass bottles, belonging to two glasshouses in Cheese Lane within the parish of St Philip and St Jacob…lately occupied by William King and Co', and goes on to include rights or shares in the business and property for the remainder of the lease (Powell 1925, 243). The auction was a result of business disagreements, and the premises were advertised on the same date as available to be leased for 21 years, and that creditors of Harris and King should apply to the business of Tyndall, Pennington and Rogers.

2.3.4 Eventually the business and the glasshouse came under the control of John Coughlan, Samuel Peach, Issac Elton (the younger), William/Philip Miles, and Matthew Cowper; this partnership also owned the glasshouse belonging to Sir Abraham Elton, further west in Cheese Lane. Tax documents show that in 1780-4 they were paying for three glasshouses in St Philip's, one of which was being used as a warehouse, and it has been suggested that the two adjoining ones within the excavation area remained working, while the one further west on Cheese Lane was not in use (Jackson 2005, 98). There were reports of a fire breaking out in 1790 in the pot house (where the crucibles were in use) belonging to Messrs Coughlan and Co in St Philip's (*Bristol Gazette*, 13 May, 1790). By the later 1790s, the glasshouse

was held by Issac Elton, William Miles, Robert Hurst and John Wilcox, the latter two being glass manufacturers (Powell 1925, 244).

2.3.5 In 1810, the glasshouse held by Elton, Miles & Wilcox was sold to John Hillhouse Wilcox (son of John Wilcox) in its entirety (*ibid*). A year later, in 1811, the premises were let for 21 years to Jacob Wilcox-Ricketts, David Evans, John Cave and Henry Ricketts (*op cit*, 245). Again, it seems that the owners had interests in other glasshouses in Bristol at the time, and all the interests were eventually known as the Phoenix Glass-works, although the name may have been transferred from the glass-works in Temple Gate to the two adjoining ones in Avon Street (*op cit*, 237). The glasshouses during this period is depicted on a painting of 1821 (Plate 13).

Plate 13: Painting of Soap Boilers' and Hoopers' glasshouses (Hugh O'Neill 1821)

2.3.6 During his tenure, Henry Ricketts devised and applied for a patent that would mould both the bottle and the neck together. The patent (BP 4623), *'An Improvement in the Art or Method of Making or Manufacturing Glass Bottles such as are used for wine, porter, beer or cyder'*, was granted on 5th December 1821, and enrolled on the 26th January 1822 (*Section 2.1.26*). The mould consisted of hinged cast-iron that was kept open by gravity, which allowed the paraison to be introduced (Wills 1974, 22). The mould was then closed using a lever operated by a foot pedal. This method left the neck plain and, if a string neck was required, this still had to be added. Ricketts died in 1859, and was the last survivor of the firm engaged in flint glass; as such, his stocks of wine were sold on (Latimer 1887, 369).

2.3.7 In 1824, the surveyors involved in the renewal of the lease on the glass-works stated that '…on account of the very dilapidated state of the whole of the premises would advise their being let at £250 per annum…', and that the adjoining glass-works '…in their present state think them worth £60 per annum…' (Witt *et al* 1984). As a result, the crown glasshouse ceased production, although the bottle glasshouse continued in production. From 1851, the works were owned by Richard Rickett, Henry's second son, and in 1853 they were amalgamated with the Hoopers' Glasshouse on the adjacent site, which was then owned by William Powell, William Augustus

Powell and Edward Filer (Powell 1925, 245; *Section 3.3.14 below*). As AC Powell reported later,

> *for a long period there had been fierce competition between the two firms and much unfriendliness to their mutual disadvantage. At last it was decided to unite their forces and the event was celebrated by a feast, the relation of whose mighty proportions was a favourite subject of some of the old men…'* (Witt *et al* 1984, 52).

2.3.8 In 1856, the company became Powell & Ricketts, and AC Powell was taken into the firm by his uncle in 1889, continuing as proprietor until 1919. The gas works on Avon Street was apparently leased to Ricketts & Co, and this may relate to their embracing the use of regenerative furnaces. Their first such furnace was seemingly installed during the 1860s (*op cit*, 50-3).

2.3.9 ***Hoopers' Glasshouse:*** the other early glass-works within the excavation area was built by a separate group in *c* 1720. Robert Hiscox was one of a consortium of 17 people who is known to have invested in the concern, and amongst the others were five hoopers' (now referred to as coopers), hence the name Hoopers' Glasshouse (Powell 1925, 247). Inventories from the Hoopers' Glasshouse show that bottle moulds were in use from 1736 (Jones 1986, 84). An inventory of 1738 (*ibid*) also shows the following bottles in stock:

7940 doz best cast[?] Quarts
10168 doz ditto Seconds
6150 doz unsorted Quarts
3060 doz measured Pints
225 doz unsizable Ditto
284 doz eight sqr, Ditto
46 doz Ditto Quarts
207 doz three Pints
110 doz flatt Pottles
100 doz Single Gallons.

2.3.10 Partnerships in businesses often fluctuated during the eighteenth and nineteenth centuries, as people's interests and fortunes waxed and waned. In 1749, four shares in the Hoopers' Glasshouse (equating to about a sixth of the overall business) were up for sale. In the *Bristol Journal* of 1765, there was an advertisement for the sale of

> *…the Hoopers' Glasshouse, situate in the parish of St Philips, with all the building, outhouses and materials together with large quantities of sand, kelp, clay, glass… this glasshouse is known to be well situated and commodious for this manufactory, has lately had a very thorough repair and lies convenient to the river with a very good wharf. The present lease has 55 years to come and is subject to a ground rent of £12 per annum…' (Witt* et al *1984, 51).*

2.3.11 The majority of the business was eventually sold as a going concern in 1767 to Richard Reynolds, William Cowles, Cornelius Fry and Richard Cannington, who all also held a flint glasshouse in Temple Street (Powell 1925, 248). By 1775, the business was known as Cowles, Dowell, Lawson & Co, changing to Lawson, Fry, Frampton & Co and Fry, Frampton & Co until 1809 (Witt *et al* 1984). The glasshouse was sold to Joseph and Septimus Cookson in 1809, who had family connections in Newcastle upon Tyne (Powell 1925, 248).

2.3.12 Mathews' *Directory* of 1820 lists J & S Cookson & Co, glass-bottle manufacturers, at Hoopers' glass-works on Avon Street, with an additional entry for Issac Jacobs,

flint-glass manufacturer. Other entries for Avon Street in this directory provide a flavour of the industrial nature of the area: JS Riddle & Co, lead merchants; Thomas Cook, coal merchant, and agent for Stourbridge clay and fire bricks; John Dimond, Union coal wharf; John Lewis, lime burner; John and Jacob Smart, lime burners, lighter barge-masters, and freestone dealers; Samuel Sheppard, brownware potter; J Spokes, stoneware potter; William Hopkins of the Sign of Glasshouse public house; and Simon Mizen of the Full Moon public house. The importance of the glass industry in Bristol is shown by the large number of categories listed: Glass Benders, Glass-Blower, Glass Cutters, Glass (Black) Bottle manufacturers, Patent Crown Glass manufacturers, Glass (Flint and Cut) manufacturers, Glass Flint Dealers, Glass Stainers and Glaziers. Of the two firms within the excavation area, J & S Cookson and W & T Powell are listed as Avon Street, whilst H Ricketts & Co is listed as Cheese Lane.

2.3.13 In 1824, the Cooksons went into partnership with William and Thomas Powell, and the glass-works changed its name accordingly from Cooksons to Cooksons & Powells (Powell 1925, 248), although it is annotated as 'Cooksons Bottle Works' on Ashmead and Plumley's map of 1828 (Plate 14).

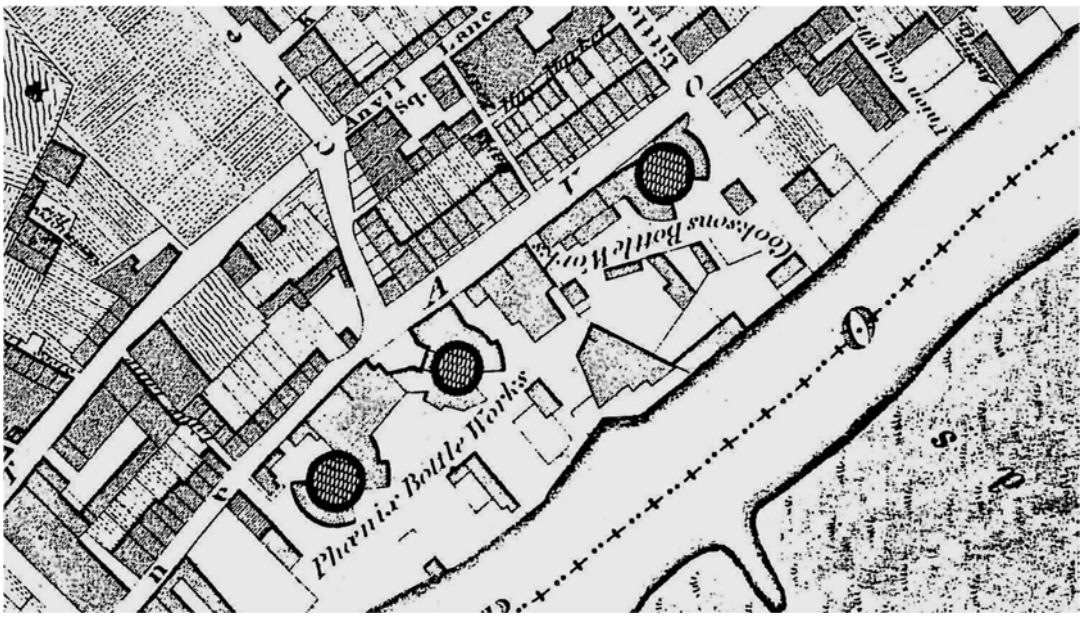


Plate 14: Extract from Ashmead and Plumley's map of 1828

2.3.14 By 1831, the glass-works is listed in trade directories as being held by the Powells only, whilst H Ricketts & Co's premises are listed as being on Avon Street (Plate 15); these two firms are the only manufacturers of glass bottles listed for Bristol in 1851 (Mathews 1851, 185). In 1853, the Soap Boilers' glasshouse was merged with the adjacent Hoopers' glasshouse (Powells) to form the firm of Powells, Ricketts & Filer (*Section 2.3.7*). Edward Flier died in 1856, and the firm then traded as Powell & Ricketts. Richard Ricketts died in 1856, and William Powell continued the business alone, keeping the name of Powell & Ricketts (Powell 1925, 245). William Powell was responsible for the early adoption of a Siemens' regenerator during the 1860s, although,

> *the problem of producing glass on the larger scale required for making bottles was not then solved, and Powell & Ricketts had to pass through a long and costly experience of experiments before success was attained* (*op cit,* 249).

Plate 15: Advertisement for Henry Ricketts & Co in a trade directory (Mathews 1851)

2.3.15 The 1875 edition of Mathews' *Directory* reverts to listing entries by street (Table 1). The trades listed for Avon Street provide an illustration of the change, diversification and increased occupation that had occurred since the 1820 edition. They also clearly demonstrate the new age of the railway, as evidenced by Avonside Engineering Co Ltd, which manufactured railway engines and other items to be exported worldwide.

Name	Nature of business
Avonside Engineering Co Ltd	(Railway engines and other items)
Joshua Bird	Grocer
Bristol United Gas Light Co	Gas company
Mrs Edwards	Full Moon public house
Philip Foxwell	Hope and Anchor public house
James Gibbs	Vitriol works
Matthew Greening	Boot and shoe manufacturer
R Grist & Son	Hauliers
William Grist	Freemasons' Arms public house
Chas Hare & Co	White lead manufacturers
John Harris	Rising Sun public house
CH & J Hewitt	Coal merchants – lower railway wharf
Henry Hickery	Grocer
George Hodge	Gas station
Issac Jeffries	Grocer
John King	Tea and provision dealer, at No 6
Lawson, Phillips and Billings	Soap works
Mrs Maunders	Smith and farrier
William Maynard	Engineer
William Mountain	Gas station
Panther Lead Works Ltd	Lead works
Powell and Ricketts	Patent glass-bottle manufacturers – Phoenix works
S Scrase	Avon mews
Richard Sleep	Haulier
Edwin Smart	Grocer
Smart & Gore	Glass-bottle manufacturers
Thomas Smith	Grocer

Name	Nature of business
JT Spokes	Redware potter
Joseph Stokes	Beer retailer
Offer and Thomas	Wheelwrights
John Thomas	Wheelwright
Charles Trivett	Gas station
John Warren	Shopkeeper
Richard Webb	Coal merchant
Williams and Bird	Union coal and gravel wharf

Table 1: Businesses on Avon Street: occupiers listed in Mathews' Directory for 1875

2.3.16 By the time of the publication of the Ordnance Survey map of 1885 (Plate 16), Powell & Ricketts of the Phoenix Works was the only glass-works operating in Bristol, although their output was reported to equal nearly that of the whole glass manufactories of the eighteenth century (Buchanan and Cossons 1969, 146). Accordingly, the glass-works is shown on the 1885 map to have expanded, infilling much of the open space at the western end of the site, whilst the density of structures to the east had increased. The eastern end of the excavation area appears to have been used for goods transport, with new railway lines and a new dock transforming the character of this end of the site.

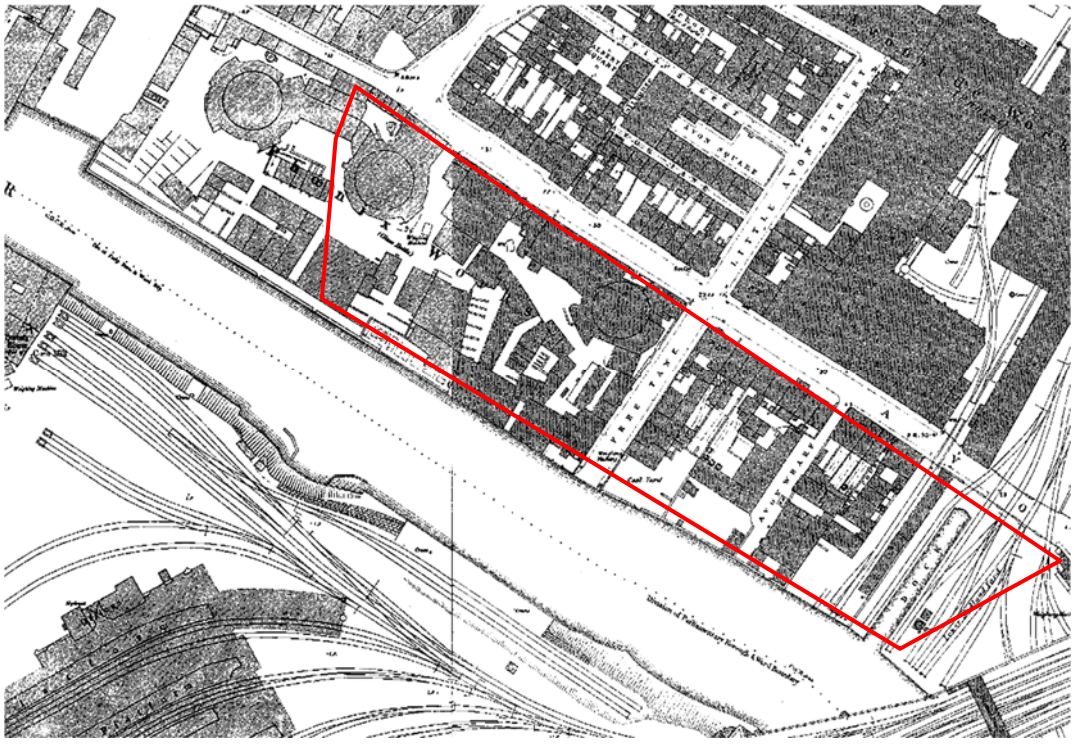


Plate 16: Extract from the 1:500 Ordnance Survey plan of 1885

2.3.17 Despite the adoption of regenerative furnaces for the manufacture of glass bottles, the firm saw the continuation of many old practices, such as the rule that only the sons of bottle-makers could be apprenticed as bottle-makers. In addition, payment was usually given to a team of glass-workers (three men and two boys) rather than individuals, and the payment was for a journey (a set number of bottles) rather than for the length of time worked (Powell 1925, 250). Crucially, the company failed to install the automatic bottle-making machinery that came to dominate the industry in the twentieth century.

2.3.18 In 1889, Arthur Powell (William's nephew) joined the partnership and continued to run the business until 1919, when he

> *…sold the factory and the business to a limited company, who used the old name. Unfortunately, the circumstances of the trade, coupled with unfair foreign competition, (which was an old danger), compelled the factory to be closed two or three years later' (op cit, 245).*

2.3.19 The liquidation of Powell & Ricketts in 1923 was mostly as a result of the post-war depression, and the large investments that were necessary for the manufacturing to become automated. Kelly's *Directory* of 1925 confirms the closure, and sale of the land, listing the site as the Avonside goods sheds of the London, Midland and Scottish Railway Co. Following the closure of the Powell & Ricketts glass-works, a yeast factory was established in the excavation area, which was in operation during the mid-twentieth century (Plate 17).

Plate 17: View of the open-area excavation site in c *1950, showing the yeast factory*

2.3.20 ***Other potential industries:*** various documents suggest that, in the early and mid-eighteenth century, Benjamin Lund, a brass founder and stay maker, occupied part of the strip of land between the Soap Boilers' and Hoopers' glasshouses. He is named (probably as an agent rather than the intellectual instigator) in a patent of 1728 for manufacturing copper (Powell 1925, 251). It has also been suggested that he had a porcelain factory, possibly situated within one of the glass cones (Jones 2007; (Pountney 1920, 191-2).

2.3.21 ***Previous archaeological interventions:*** the archaeological significance of the open-area excavation site had been highlighted by the results obtained from several previous archaeological studies carried out between 1988 and 2003, including three intrusive investigations:

- ***BaRAS 1988:*** an excavation of the western end of the site was undertaken by the Bristol and Region Archaeological Service (BaRAS) in 1988 (HER: 481M). This comprised five trenches, within and beyond the present site boundary (Fig 2). Excavation was focused on the easternmost and central of the three eighteenth-century glasshouses, and exposed the remains of two furnaces, several adjoining annealing houses and ovens, an annealing arch and other related features. The dataset generated from this excavation is awaiting detailed analysis;
- ***BaRAS 1995:*** in 1995, BaRAS carried out an evaluation of land to the east of the present scheme area (Fig 2). The work comprised the excavation of three trenches, which provided evidence for the development of the site from the early eighteenth century. Nineteenth-century activity was represented by the rebuilding of Cuckold's Pill as a formal dock, and further structural remodelling, in both stone and brick (BaRAS 1995);

- ***AOC 2002:*** a further evaluation consisted of five trenches, which were placed between Free Tank and Valentine Bridge (Fig 2). Three phases of activity were established, the earliest of which represented reclamation of land on the edge of the River Avon, seen as a sequence of industrial waste dumps. The second phase comprised the remains of a late nineteenth- to early twentieth-century glasshouse, which were uncovered in three of the five trenches. The final phase comprised later twentieth-century structures (AOC 2002).

2.4 WATCHING BRIEF AREA: HISTORICAL AND ARCHAEOLOGICAL BACKGROUND

2.4.1 ***Historical development:*** the cartographic evidence indicates that the watching brief site was open land during the early post-medieval period and that it was traversed by the Wain Brook. This watercourse flowed through the site from north-east to south-west, entering the River Avon at Cukold's Pill. By the early eighteenth century, as evidenced by Roque's map of 1742, the site fell within 'The Brick Fields', which refer to the extraction of clay across this area, for the manufacture of bricks. At this date, the watching brief site is depicted as open land, though more substantial industrial works existed to the south of the site, between Avon Street and the River Avon, whilst Cuckold's Pill is depicted as a short inlet between the River Avon and Avon Street. Small buildings also stood at the eastern, western, and northern boundaries of the site, and these, perhaps, had an industrial function, whilst to the north-east of the site, adjacent to the former course of the Wain Brook, a large pool was present, known as 'Brick Yard Pool', which provides a further link with brick making in this area.

2.4.2 During the early nineteenth century, as seen on Ashmead and Plumley's map of 1828, the watching brief site was still mostly open, and possibly marshy, with the surrounding area laid out as fields. However, by 1828, a curving boundary had been established, which extended across the site in a north-east/south-west direction and that seemingly followed the former course of the Wain Brook. It is possible that this wall had been constructed in order to reclaim an area of marshland, which lay to its west, extending as far as Little Avon Street.

2.4.3 Several small buildings, fronting Avon Street, are also depicted on the 1828 map, which stood at the far south-eastern corner of the site. These were within a larger rectangular plot, which was bounded on its western side by the curving boundary (*Section 2.4.2*), on its northern side by another boundary wall, and to the east by 'Kilboar Street'.

2.4.4 By the time of the 1847 tithe map, a railway had been constructed, by the Midland Railway, across the centre of the site in a north/south direction, terminating to the south, adjacent to Cuckold's Pill (Hicks 1847). In addition, immediately adjacent to the railway, the Avonside Iron-works had been established, which contained several buildings. Of these, a linear range partly covered the western half of the site, whilst the eastern end of another of the ironwork's buildings, fronting Avon Street, was also within the site. In contrast, to the east, and associated with the railway, a yard had been constructed, which was to the north-west of the early nineteenth-century properties that fronted Avon Street and that lay within a rectangular plot (*Section 2.4.3*). It also appears that by this date some additional buildings had been constructed within this latter plot.

2.4.5 Ashmead's 1855 map of the area indicates that by this date the iron-works had been slightly expanded in size, which, within the watching brief site, involved the

extension of the original linear range (*Section 2.4.4*) southwards to the Avon Street frontage. On Ashmead's map, the railway yard is also now marked as a 'coal yard'.

2.4.6 The late nineteenth- and early twentieth-century form of the site can be discerned through reference to Ordnance Survey (OS) mapping. These indicate that, by the late nineteenth century, the Midland Railway line still ran through the centre of the site and that the iron-works, referenced as 'Avonside Works (engine)', had been slightly expanded and also provided with its own small railway, running to the River Avon. Within the watching brief site, this expansion specifically involved extending the ironwork's building that fronted Avon Street (*Section 2.4.4*). By the late nineteenth century, several additional buildings had also been constructed within the rectangular plot, at the south-eastern corner of the site, which had been established in the early nineteenth century (*Section 2.4.3*).

2.4.7 By the early twentieth century, although the Midland railway and associated coal yard had been largely unaltered, the iron-works had been substantially modified. Within the watching brief site, this involved the demolition of the linear range (*Section 2.4.4*), and also a larger building to the north, which it originally adjoined. By this date, historical mapping indicates that the main body of the iron-works had been converted into a paper mill, whilst one of its buildings fronting Avon Street had been converted into the Midland Railway Company's goods warehouse. In addition, some of the nineteenth-century buildings that were within the bounded rectangular plot at the south-eastern corner of the site (*Section 2.4.3*) had been demolished immediately prior to the construction of Oxford Street.

2.4.8 ***Previous archaeological inventions:*** in 2003, a scheme of archaeological evaluation was undertaken across an area of land to the north of Avon Street (AOC 2004). This evaluation entailed the excavation of ten trial trenches, two of which (Trenches 4 and 6) lay within the watching brief site (Fig 2; OA North 2016). One of these trenches (Trench 4) uncovered evidence for a boundary wall of eighteenth- or early nineteenth-century date (*Section 2.4.2*) and an associated culvert, channelling the Wain Brook towards the River Avon, as well as evidence for the reclamation of marshland. The other (Trench 6) exposed the remains of a nineteenth-century building associated with an iron-works (*Section 2.4.5*).

3. OPEN-AREA EXCAVATION

3.1 INTRODUCTION

3.1.1 The open-area excavation commenced in April 2007, to the south of Avon Street, and covered 2800m^2 of the former glass-works site. The work conducted was consistent with the relevant standards and procedures of the then Institute of Archaeologists (IfA), and generally accepted best practice (IfA 2001a).

3.2 OBJECTIVES

3.2.1 The general objectives of the archaeological excavation were:

- to record the nature of the main stratigraphic units encountered in terms of their physical composition (stone, sand, gravel, organic materials *etc*), and their archaeological formation (primary deposits, secondary deposits *etc*);
- to establish the date of the earliest activity on the site, and characterise the nature of occupation;
- to identify any remains of medieval date and examine their relationship with the riverside environment, as well as any exploitation of the inlet at Cuckold's wharf;
- to identify evidence for continuity or change in the use of the riverside between the medieval and post-medieval periods, and define the post-medieval uses of this area before the establishment of glass-making and other industries;
- to establish the nature, and where possible date, of the riverside reclamation sequences;
- to complete a detailed mitigation record of the glasshouses, which should determine their form, character and dimensions, and elucidate any differences in their construction and operation;
- to recover sufficient fragments of glass to allow a greater understanding of the range of products manufactured, working practices, and the development of glass technology from the eighteenth century onwards;
- to establish whether the manufacture of porcelain was ever undertaken on the site;
- to identify any earlier industrial activity that may have occurred on the site, such as brass- and copper manufacturing;
- to identify any evidence for residential occupation of the site, and establish its date.

3.2.1 Specific objectives for the excavation of Cookson's and Soap Boilers' glass-works included:

- to define the extent of the remaining two glasshouses recorded on historical maps and identified in previous excavations;
- to identify surviving furnaces, flues or evidence for any that have previously been removed, including truncated features;
- to obtain a complete record of both glass furnaces by determining their form, character and dimensions, and elucidate any differences in their construction and operation;

- to characterise the arrangement of the glass-making structures for comparison with other recorded sites;
- to define the period during which glass-making was conducted;
- to determine the nature and extent of any working areas adjacent to the furnaces;
- to determine the form, character, and purpose of any ancillary buildings, and provide an understanding of the functional relationship between these structures and the furnaces;
- to obtain a record of the flues associated with each furnace, and elucidate an understanding of their operation;
- to identify any evidence for the glass-making process, including fuels, raw and semi-processed materials (such as frit), tools (such as crucibles, blow pipes, pontil irons), or processes (such as pot-arching);
- to identify and characterise any wasters and/or finished products, and provide typologies related to historically recorded products where possible;
- to identify any links to features associated with shipping finished products, such as dockside structures or rail infrastructure.

3.2.2 Specific objectives for the excavation of Benjamin Lund's potential porcelain works:

- to define its extent and layout, including identification of the uses of any rooms identified and changes in layout and use over time, as well as the duration of ceramic manufacturing;
- to identify whether the structures recorded conform to known examples of porcelain kilns, particularly in their size and form;
- to identify any evidence for porcelain-manufacturing methods and techniques;
- to identify any dumps of wasters or finished products and create a type series for ceramic forms and decoration;
- to identify, if possible, any variation between the outputs of different kilns and the relationship between ceramic forms and kiln furniture.

3.3 FIELDWORK METHODOLOGY

3.3.1 ***Stripping and excavation:*** the precise location of each excavation area was plotted prior to excavation using a Leica differential Global Positioning System (dGPS). A mechanical excavator, operating under close and permanent archaeological supervision, was then used to remove the modern surfacing and overburden of each site. The machining continued to the level of the first significant archaeological deposits. Thereafter, selective manual cleaning was carried out in areas where it was necessary to define structures and features. The precise location of the trenches, and the position of all archaeological structures encountered, was surveyed by Electronic Distance Meter (EDM) tacheometry, using a total station linked to a pen computer datalogger. This process generated scaled plans and sections within AutoCAD, which were then subject to manual survey enhancement. The drawings were generated at an accuracy appropriate for 1:20 scale, and all information was tied in to Ordnance Datum.

3.3.2 ***Recording:*** a comprehensive written, drawn and photographic record was compiled in accordance with the Institute of Field Archaeologist's (IFA) *Standard and*

Guidance for Archaeological Excavation (2001a). All information identified in the course of the site works was recorded stratigraphically, using a system adapted from that used by the former Centre for Archaeology of English Heritage. A continuous unique numbering system was operated. Results of all field investigations were recorded on *pro-forma* sheets, comprising factual data and interpretative elements. A Harris matrix was compiled during the course of the excavation.

3.3.3 The site archive includes both a photographic record and accurate large-scale plans and sections at an appropriate scale. The photographic record consists of black and white, colour (35mm transparency) and digital formats, illustrating in both detail and general context the principal features and finds discovered. It also includes working shots to illustrate more generally the nature of the archaeological work. A register of plans and sections from all the excavations was kept, and all sections were tied into the Ordnance Datum.

3.3.4 ***Artefactual procedures:*** all finds recovered during the excavations were lifted, cleaned, conserved, bagged and boxed in accordance with the United Kingdom Institute for Conservation (UKIC) *First aid for finds* (1998), and following discussions with the recipient museum (Bristol City Museum and Art Gallery). Recovery and sampling programmes were in accordance with best practice and subject to expert advice. Initial artefact dating has been integrated into the site matrix.

3.4 RESULTS

3.4.1 In total, an area equivalent to approximately 10,436m^2 was subject to detailed archaeological excavation. The excavation comprised three areas (Areas ND3-5), all located on the southern side of Avon Street. Summary results of the investigations are presented for each area.

3.4.2 Broad phasing has been ascribed to the deposits and structures encountered during the investigation, and the results are presented below in chronological order for each of the areas (ND3, ND4, and ND5). The four broad phases of activity determined by the excavations are as follows:

- ***Phase 1:*** Pre-glass-works activity; post-medieval to early eighteenth century
- ***Phase 2:*** Early industrial activity; early eighteenth century to mid-nineteenth century (1715-1853)
- ***Phase 3:*** Later industrial activity; late nineteenth to early twentieth century (1853-1925)
- ***Phase 4:*** Post-glass-works activity; 1925 to present

3.4.3 ***Area ND3:*** this area was situated at the north-western end of the scheme area, incorporating the site of the glass-works (Fig 3), and formed the main focus of the archaeological excavation. The excavated area comprised 4782m², with a maximum length along the Avon Street frontage of 124m, and was 58m wide to the bank of the River Avon, which formed the south-western boundary of the site. Despite only two furnaces having been identified previously within this part of the site, the excavation revealed the remains of four regenerative furnaces, a bank of associated gas producers, and two possible annealing houses.

3.4.4 ***Natural deposits:*** the natural geology comprised mid-brownish orange plastic clay, identical to that seen in other parts of the site. The fine texture and consistency of

the material was indicative of it being an alluvial deposit, accumulating gradually over time. In several areas, the nature of the natural clay had been altered by subsequent activity, most notably where it was discoloured and more brittle, as a result of being exposed to an intense heat source. For example, deposits ***3123*** and ***3365*** were discernibly darker beneath the area of Furnace A.

3.4.5 ***Phase 1:*** this primary phase of occupation represents activity pre-dating the glass-works, with which the site had been associated since the early eighteenth century (*Section 2.3.2*). The deposits of this phase included layers of dark-brown clay containing a wide range of finds, and all appear to relate to layers of spread and trampled debris from nearby occupation, accumulating gradually prior to the construction of the glasshouses (Phase 2).

3.4.6 ***Phase 2:*** this phase comprises the construction of the glasshouses, and their use up to 1853, when the two glass-works amalgamated. The remains of two Phase 2 furnaces were identified with one (Furnace A) forming part of the Soap Boilers' glasshouse, whilst the other (Furnace B) was an element of the Hoopers' glasshouse (Fig 4).

3.4.7 Little survived from this initial phase of activity, although several features were identified, including the vestiges of stone-built structures. These tended to be of sandstone construction, bonded in lime mortar, augmented, or replaced later within this phase, by structures utilising handmade brick.

3.4.8 *Furnace A (Soap Boilers'):* elements of the southern wall of the original glasshouse (***3152***=***3297***) survived in the north-western part of Area ND3 (Fig 5). This stone-built wall was 0.54m wide, 12.25m long, aligned east/west, and had a northwards return at its western end (***3302***). This wider wall (0.66m) was cut by a later drain (***3362***), but continued as wall ***3352***, which returned in an easterly direction, presumably to connect with a similar wall (***3353***), which formed the eastern wall of the glasshouse (Plate 18); walls ***3352*** and ***3353*** were not, however, linked physically, as the central part of the projected wall had been destroyed by subsequent activity. All walls comprised roughly dressed and randomly coursed sandstone, bonded in a hard, mid-grey lime mortar, containing charcoal and lime inclusions.

Plate 18: Wall **3353***, representing the vestiges of the original glass furnace*

3.4.9 Locally, eighteenth-century glass cones were generally of sandstone construction, formed of two concentric walls. The exposed remains, however, appeared to represent a rectangular structure, although it remains unclear whether they formed part of an original, early eighteenth-century furnace, or a later modification or rebuild. Unfortunately, the damage caused by the construction of the later yeast factory (***3002***; Phase 4) meant that many of the walls survived to only a single course in height, precluding any reliable stratigraphical or typological analysis.

3.4.10 Several sandstone walls also extended along the northern limit of excavation. Although truncated by the later yeast factory, sufficient fabric survived *in-situ* to permit their identification as probable elements of the earliest phase of the glass cone. The position of the walls corresponded to structures shown on Ashmead and Plumley's map of 1828, but they are not shown on Roque's map of 1742, indicating a late eighteenth- or early nineteenth-century date for the construction. Two such walls (***3083*** and ***3088***) were probably part of a building situated between the two Soap Boilers' cones, and demonstrate phasing within the fabric, as wall ***3088*** butted the northern face of L-shaped wall ***3083***. This was 0.5m wide and over 0.7m deep, and formed the north-east corner of the building, within which evidence of make-up layers and internal brick flooring (***3084***) were observed. The wall butting its northern face (***3088***) appeared to have formed the eastern end of a narrow structure, fronting the road; stratigraphic evidence indicated it to have been added to the structure to the south.

3.4.11 Three parallel sandstone walls (***3097***, ***3098*** and ***3099***), all aligned perpendicular to Avon Street, each survived to approximately 2m long and were each 0.7m wide, with a maximum height of 1.2m. These formed part of a building attached to the north-eastern side of the Soap Boilers' glass cone, again on the Avon Street frontage. The areas between the walls retained vestiges of flagstone floors (***3100*** and ***3101***), which appeared to be contemporary. The walls and floors were all constructed on a make-up layer that included glass waste, demonstrating that this was also a secondary structure within the phase.

3.4.12 *Furnace B (Hoopers'):* this furnace retained more of the original cone, with several sandstone walls relating to the circular glass cone (Plate 19). Along the northern side were two short arcs of walling (***3579*** and ***3564***/***3565***; Fig 6), each measuring no more than 3.4m long, 0.75m high and over 0.6m wide at their bases. Both had been truncated by service trenches and activity associated with the yeast factory (Phase 4). Wall ***3564***/***3565*** appeared to represent two different episodes of construction, implying that a repair, modification or rebuild had been necessary. Nothing survived of the southern part of the cone, but these two sections of wall allow the diameter of the cone to be extrapolated as approximately 24m. Two further sandstone walls (***3528*** and ***3530***), on the western side of the furnace, also appeared to be part of the earliest phase of construction; the position of wall ***3528*** lay within a building shown on Roque's plan of 1742, but outside the structure on Ashmead and Plumley's map of 1828. The wall was dog-legged in plan, and measured 5.7m long, 0.58m wide, and survived to a height of 0.3m.

Plate 19: General view of Furnace B, with the Phase 2 sandstone walls visible, looking west

3.4.13 A flagstone floor at the level of the wall top was seemingly exposed during the 1988 excavation, presumably forming the floor to an associated structure shown on historical mapping around the south-western side of the cone. Wall ***3530***, to the north-west, was aligned north-west/south-east and survived for a length of 7.15m, butting sandstone wall ***3575*** at its north-western end. It appeared to have formed the southern wall of a structure that was divided internally by a perpendicular wall, which was part of the original construction of wall ***3530***. The area within this structure, to the west of the dividing wall, contained the remains of a flagstone floor (***3507***).

3.4.14 Wall ***3575*** was constructed of roughly squared, and randomly coursed, sandstone blocks, bonded in a pale-yellowish sandy lime mortar, and appeared to have formed the southern corner of a separate structure. It was 0.7m wide, and was aligned parallel to Avon Street, surviving for a length of 8.7m. At its south-eastern end, where it was abutted by wall ***3530***, it returned north-eastwards, perpendicular to the street. The structure was probably that depicted on Roque's map of 1742, and possibly represented the south-east corner of an annealing house. To the west of wall ***3575***, but within the same structure, were two short stretches of perpendicular wall (***3010*** and ***3011***; Fig 7), which presumably represented the remains of internal divisions within the larger structure. Both were of similar sandstone construction to wall ***3575***, and were set 4.35m apart. The walls extended for approximately 2.1m from the northern limit of excavation, and survived to a maximum height of 0.95m.

3.4.15 Another sandstone wall (***3390***; Plate 20), surviving for a length of 17m to the west of Furnace B, formed the east external wall of a further building shown on Roque's plan of 1742. A concentration of brass slag blocks (***3394***) to the west, within the structure, may be related to the conjectured copper and brass works of Benjamin Lund, thought to be in this location by about 1738 (Jones 2007; *Section 2.3.20*). Two later, and poorly constructed, brick walls (***3388*** and ***3389***), butted the external, eastern face of wall ***3390***, and are depicted on the 1885 Ordnance Survey map, suggesting that they dated from the latter part of Phase 2.

Plate 20: Southern part of Area ND3, showing sandstone wall **3390***, looking south*

3.4.16 Remains of a separate building between the two glass cones, shown on Ashmead and Plumley's map of 1828, were also exposed during the excavation. Two sections

of a sandstone wall (***3188*** and ***3189***; Fig 7), aligned parallel to Avon Street, were of a similar character to others of this phase seen across the site. Both sections of the wall survived to a height of 0.97m, and were separated by a doorway, 0.92m wide, and apparently original to the construction of the wall, although blocked subsequently (***3190***). The north-western section of the wall returned in a north-easterly direction, forming the south-west corner of the building. An additional skin of bricks had been added to the northern, internal side of the south-eastern portion of wall (***3188***), presumably carried out to reface the interior. A short, 2.15m, section of wall (***3192***), located to the west, was also of sandstone construction and formed a similar corner to that of ***3189***. It was associated with a brick floor (***3191***) to the west, and formed part of a separate structure, which appeared to be later than ***3188***/***3189***, probably forming an extension to the original building.

3.4.17 Several walls dating to this phase of activity in the southern part of the site had been damaged severely by the construction of Furnace D (Phase 3): the south-west side of a Phase 3 access passage (***3526***) into the furnace comprised stone wall ***3525***/***3596***, built of rough-hewn sandstone blocks, bonded with a lime-rich mortar (Fig 8). It survived for a length of 11.26m, on a north-west/south-east alignment, and was 0.30m wide. The placement of this later passage was clearly dependent on the earlier wall, which is shown on the 1742 map as an oblique building/structure.

3.4.18 Two walls forming a 4.3m-long passage were both constructed of sandstone at their lowest level, and were capped subsequently with red brick, in order to create a Phase 3 switch room (***3506***; *Section 3.4.46*; Fig 8). Their position is likely to relate to a structure opposite the Hoopers' glass cone, which functioned as an entrance prior to incorporation into the Phase 3 Furnace D. Another wall (***3817***), incorporated into the later furnace building, was of stone and brick construction, and survived to a height of 1.22m. It was aligned north-east/south-west, and was butted by a later chamber (***3684***) to the south-east. At its south-western end, a later flue ***3680*** was keyed into the wall. Wall ***3817*** was parallel to two further sandstone walls, ***3677*** and ***3670***. Wall ***3677*** was double-faced, with roughly squared blocks, with a rubble core bonded with grey ash-rich lime mortar. It was 0.61m wide and survived for a length of 2.88m. Wall ***3677*** was cut by flue ***3652*** (Phase 3) to the north-east and south-west, and was also butted by later brick floors ***3679*** and ***3678*** on its eastern side.

3.4.19 Several walls pre-dating Furnaces C and D were revealed in the south-east corner of Area ND3. A 7.25m length of sandstone wall (***3509***), aligned north-west/south-east, and returning southwards at its east end, formed the corner of a building (Fig 8). The wall was built of roughly hewn sandstone blocks, randomly coursed and bonded with a grey ash-rich lime mortar. The interior of the structure it formed retained a segmented brick floor (***3514***, ***3516***, and ***3517***), which was probably a Phase 3 addition. An associated continuation of an internal floor (***3661***) comprised both bricks and flagstones, suggesting that the latter may have formed the original floor throughout. The remains correspond to a building depicted on Ashmead and Plumley's map of 1828, and might possibly be earlier, as the area is shown within a structure depicted on Roque's plan of 1742.

3.4.20 The vestiges of several other structures in the vicinity may also date to this phase. The component walls were all of rough-hewn sandstone blocks, in a random coursing, and bonded with ash-rich lime mortar. The remains all correspond to walls depicted on the Ordnance Survey map of 1885, although they all appeared to pre-date the Phase 3 Furnaces, C and D. These walls included ***3741***, ***3749***, ***3757***, ***3774***, and ***3812*** (Fig 8), and presumably were elements of structures forming part of the

Hoopers' bottle works, being adapted subsequently when the Phase 3 Furnace C was constructed.

3.4.21 Wall ***3741***, to the east of Furnace C, was orientated north-east/south-west and survived to a length of 2.54m, with a short 0.85m stretch further south. The substantial width of the wall (0.85m) may have been a result of Phase 3 refacing, although there was no physical evidence to demonstrate that this was not the original width. Wall ***3774*** was the largest surviving section of wall (5.54m), located to the west of Furnace C, and south of Furnace D. It was aligned north-west/south-east, parallel to the Floating Harbour wall, which was positioned 11m to the south (*Section 1.2.2*). The wall had been destroyed by the later furnace at its south-eastern end, and by associated Phase 3 features at its other end. This wall appears to represent an episode of structural infilling of the site after 1828. Ashmead and Plumley's map of that date shows two buildings adjacent to this position, suggesting that wall ***3774*** was constructed as part of a later building inserted into the open space. Parallel to this were short remnants of sandstone walls (***3749***, ***3757***, and ***3767***), all cut by Furnace C (Phase 3). Within the same area, two north-east/south-west-aligned walls were revealed beneath the later structures. Wall ***3812*** lay to the west, with wall ***3813*** positioned 3m to the east, both corresponding to a wall visible on the Ordnance Survey map of 1885, suggesting that they formed part of the same building.

3.4.22 To the south-west of Furnace D (Phase 3), and north-west of Phase 3 Furnace C, were the remnants of several walls. One of the largest was wall ***3775***, which was 0.97m wide, of similar sandstone construction to those seen elsewhere, and bonded with an ash-rich lime mortar. At its north-western end, the wall returned to form a recess, over which was constructed a red-brick arch. The wall had been partially destroyed by the construction of Furnace C, and a modern concrete wall at its south-eastern end. Another wall (***3758***), which appeared to relate to a structure depicted on the Ordnance Survey map of 1885, was 0.4m wide, and was incorporated into features associated with the Phase 3 furnace.

3.4.23 A circular red brick-built feature (***3745***), almost certainly a well, was revealed underneath the foundations of Furnace D. It was bonded with a dark-grey ash mortar, and an occasional squared stone was incorporated within the brick walls. The shaft was 3 feet (0.91m) in diameter, with the structure measuring 1.37m in its external diameter. An extension with a 0.46m wide channel, also of brick construction, ran into the well on the western side.

3.4.24 Several other fragmentary sandstone walls (***3196***, ***3199***, ***3238,*** and ***3263***; Fig 7) were observed within Area ND3. All almost certainly date from this phase, but remain of uncertain function.

3.4.25 ***Phase 3:*** during the following phase, the original glass cones underwent major modifications to accommodate new technologies and changes in the glass-manufacturing industry, namely the introduction of Siemens'-type regenerative furnaces (*Section 2.1 above*). The glass-works also appear to have undergone a significant expansion following their amalgamation in 1853, with the construction of two additional furnaces. There is some suggestion that the new furnaces may have been used for the experimentation of glass and bottle production (*Section 2.3.14*). These Phase 3 structures, and alterations elsewhere within the complex, were made of machine-made bricks, using various mortars, including hard, grey, lime mortars, and latterly dark-grey ash mortar and cements. Refractory brick (firebrick) was used extensively during this phase, and stamps identified on many bricks suggest that the

majority were imported from the West Midlands, from specialist suppliers such as Rufford & Co (Plate 21), Hickman & Co, and Harper & Moore. The specialist suppliers of refractory brick were based in Stourbridge, where clay of refractory character was exploited on a large scale (Bartholomew 1887). Rufford & Co was one of the largest brick firms in Stourbridge, and was established in the early part of the nineteenth century (Cockeram 1998).

Plate 21: Sample of a refractory brick manufactured by Rufford & Co of Stourbridge

3.4.26 *Furnace A – Phase 3a:* the earlier (Phase 2) elements of Furnace A incorporated a rectangular sandstone feature, and several associated walls along its northern side. During Phase 3, however, the earlier furnace was removed and replaced with a Siemens'-type regenerative furnace (***3370***; Plate 22; Fig 5). This furnace had been heavily disturbed by a later Phase 3 rebuild, and by the yeast factory (Phase 4), with many of the walls within the furnace surviving only as either mortar scars, or as a discolouration of the natural subsoil.

*Plate 22: Furnace A (**3370**), Phase 3a, looking west*

3.4.27 Furnace ***3370*** had a rectangular plan, aligned approximately north/south, and comprised four regenerative chambers (***3366-9***; Fig 5). The plan of regenerative chambers was discernible from lighter-coloured linear patches, where the walls had been bonded to the underlying floor, forming the base of the furnace. The outer chambers were narrower than those on the inner side, representing those supplying gas to the furnace, as shown in the Siemens' patent drawings. The base of the furnace was observed as darker, more heat-affected brick surfaces (***3355***, ***3356***, and ***3357***), each surviving to a depth of only one brick (Plate 22).

3.4.28 A red-brick flue (***3274***), 0.64m wide, extended from the northern end of the furnace, snaking towards a chimney (***3093***), which was situated 9.4m to the north of the furnace. A small rectangular 'pit', ***3276***, situated within the flue, and extending 0.35m below its brick floor, ***3272***, was on a similar alignment to the flue, suggesting that it was contemporary with its use, although it appears to have remained in use into Phase 4. This late use was demonstrated by a timber edging around the top of the pit, forming a boundary to the later concrete. The function of the 'pit' is not immediately obvious, although it may have related to the 'switch room' of the furnace, where the flow of gas and air was regulated. The fill (***3277***; not illustrated) contained pottery and glass waste. The brick chimney, ***3093*** (Plate 23), was 8 feet square (2.45m), and survived to a height of 24 courses (6 feet 4 inches (1.93m)), constructed of English bond. Internally, the lowest courses raked inwards, giving an internal area of 6 feet square (1.82m). Glass waste, within the fill (***3096***; not illustrated) of the feature, demonstrates the extensive dispersal of waste material following the levelling of the site prior to the erection of the Phase 4 structures.

Plate 23: Furnace A, the Phase 3a chimney, **3093***, looking north*

3.4.29 *Furnace A – Phase 3b:* two phases of regenerative furnace construction within Furnace A were identified during the excavation. The later furnace (***3385***) was rebuilt on a slightly different alignment to that of earlier furnace ***3370***, oriented slightly to the east (Plate 24; Fig 5). The construction of furnace ***3385*** must have involved the dismantling of much of the earlier structure, but may have incorporated elements still extant. It would appear that concrete was poured to form a new base for the furnace. Observed as features ***3283***, and ***3288***, this construction technique probably caused the preservation of the earlier remains below. The walls of the later furnace were constructed on this concrete base, and were almost indiscernible, with only small sections uncovered in the islands of surviving archaeology. This phase of construction used a higher proportion of refractory brick to red bricks, all bonded with a darker sooty mortar. On the northern side of the structure, a later exhaust flue (***3271***) was constructed of two parallel walls, set 0.98m apart, which curved sharply towards the north-west. The angle of this flue was on a different alignment to that of the earlier flue, and sealed it. The base of the flue, and the area within the confines of the furnace walls (***3283***), were of concrete construction and contained brick fragments, suggesting a relatively early type of concrete, possibly used in preference to a brick base to reduce construction costs. There were no remains of a chimney associated with this flue.

*Plate 24: Furnace A (**3385**), Phase 3b, looking south-west*

3.4.30 The installation of stanchions associated with the later yeast factory (Phase 4) within this area removed any physical evidence for the internal layout of furnace ***3385***, but the overall plan and variation in alignment to the earlier furnace (***3370***) were established. This wholesale re-alignment of the later furnace is somewhat difficult to reconcile; it is probable that it represents a complete rebuild, either by design, or as the result of an accident. It may be significant that there were several furnaces within the glass-works during this phase, allowing large-scale rebuilds to take place with minimal interruption to overall glass production.

3.4.31 *Furnace B:* the second furnace (***3502***; Fig 6) had been excavated partially in 1988 (*Section 2.3.21*), and the present excavation provided very similar results, demonstrating that there had been relatively little degradation of the *in-situ* remains. The furnace survived relatively well in plan, but only to a maximum height of 1m. It lay within the area that would have been situated below the Phase 2 glass cone, visible as walls ***3564***/***3565*** and ***3579*** (*Section 3.4.12*). The construction of the yeast-factory buildings (Phase 4) had, however, destroyed much of the remains, as it had been built on concrete beams (***3584***), inserted through the furnace structure.

3.4.32 In plan, the remains had the distinctive four-chambered Siemens'-type regenerative furnace layout. The overall plan demonstrated that furnace ***3502*** had straight edges along the north, east and south sides, but that the western side was effectively curved, following the lines of the flues (Plate 25). Within the outline of the main walls, there were partitions sub-dividing the furnace into four regenerative gas and air chambers, with an additional parallel passageway along the north side, forming the access passage, or 'cave'. All were aligned approximately east/west, and were between 8m and 8.6m long, with the outer, narrower chambers transporting producer gas, which appeared to have been delivered from a bank of gas producers (***3709***) associated with Furnace D (Fig 8). The outer chambers were notably blackened along the interior faces, with the discolouration becoming more diffuse away from the wall faces. This was a common problem with the early furnaces, although the layout suggests that the furnace heated a glass tank, rather than crucibles, a process not patented until

1872, by which time the major problems of soot accumulation had also received much attention (Krupa and Heawood 2002, 13). This rather suggests that this furnace was operating with a slight fault, possibly having not been built exactly to the Siemens' specifications.

Plate 25: General view of Furnace B, looking north

3.4.33 The furnace walls appeared to show a single episode of construction, their fabric comprising yellow refractory bricks, many of which were discoloured, either red or black, by the intense heat of the furnace. The bricks were of a similar standard size to those seen elsewhere on the site, being 225 x 115 x 65mm (9 x 2½ x 4½ inches) Within the centre of each longitudinal wall, within the bonding, were interlinked metal rods, each with hooks at each end to join them. These served as tensioning bars, to control the expansion and contraction of the brickwork with the variation in temperature caused by the switching of gas flow within each chamber (Plate 26). The rods were attached to upright metal posts beyond the end of each wall, and braced against the end of the wall itself by rectangular iron plates. Three of the four end plates and rod systems were visible, but the southernmost set was obscured and damaged by later activity. Originally, these vertical bars would have extended to the full height of the furnace and tank, and would have supported tensioning bars at a higher level within the regenerative chambers, and also at tank level. The stirruped-base of two such bars, located within the north wall of the north regenerative chamber, would have supported iron bars providing tranverse support across the tank above.

Plate 26: Furnace B, tension bars within the furnace walls, looking south

3.4.34 At the east end of each chamber, the gaps between the main walls had been blocked by refractory bricks. These blockings were poorly built, and represented temporary blocking of the regenerative chambers. Only the northern two chambers were fully exposed, as the southern two were obscured by the concrete beams. These temporary blocking walls would be removed to allow access to the regenerators to replace the chequer-work of bricks within each chamber, the intense heat of the furnace, and constant change in temperature, requiring this to be done on a regular basis.

3.4.35 The perimeter wall to the north and east of the regenerative chambers may represent a later rebuild, as the mortar appeared to contain a much higher ash content, although this was difficult to confirm due to the effects of heating on the mortar of the inner walls. The wall was also generally of red brick rather than refractory brick. This wall delineated a passageway that provided access to the north and east sides of the furnace, around the regenerative chambers. The layout of furnace ***3502*** was different from that of Furnaces C (***3776***) and D (***3665***; Fig 8), where the access cave was situated at one end of the furnace, opposite the 'switch room', where the flow of gas and air through the regenerative chambers was regulated.

3.4.36 At the western end of the Furnace ***3502*** were two parallel walls, set approximately 0.9m apart and curving sharply northwards (Fig 6). These walls formed the two sides of a flue and, judging from the relative position, this would have been the exhaust flue. This was built of the same brickwork as the furnace and the two were joined by a channel, about half the width of the flue, leading out from the western end of the furnace. The flue had a well-laid brick floor, the component bricks being in a layer of stretchers, with their long axes perpendicular to the walls. Only a 4.85m section of the flue survived, and there was little evidence of an associated chimney. The floor of the flue sloped gently, and rose upwards towards the north. Evidence of the brick roof of the flue, situated approximately 1m above its floor, was revealed in the

excavation carried out in 1988 (*Section 2.3.21*). All the brickwork of the flue showed discolouration due to the prolonged exposure to the proximity of heated gases.

3.4.37 The switch room for the furnace appeared to have been at the western end, although only two of the below-floor-level flues into the base of the regenerative chambers survived *in-situ*. The partial survival of the chimney flue provided the most conclusive evidence for the switch room being positioned at this end of the furnace. This survived for a length of approximately 5m, and its alignment almost certainly demonstrated that it was attached to the chimney on the eastern side of the bank of gas producers associated with Furnace D. This strongly suggests that Furnace B represented the last of the three regenerative furnaces to be constructed at the eastern end of Area ND3.

3.4.38 *Furnace C*: located in the extreme south-east corner of Area ND3 (Fig 4), this furnace (***3776***) was the first to be purpose-built away from the glass cones (Plate 27). The layout of the furnace demonstrated an overall similarity to Furnaces A (***3370*** and ***3385***; *Sections 3.4.27* and *3.4.29*) and B (***3502***; *Section 3.4.31*). The Ordnance Survey map of 1885 shows the outlines of buildings that correspond to the size and shape of Furnace C (***3776***), and the gas-producer complex (***3709***; Fig 8) to the north, suggesting that they were in place by that date. It would thus appear that Furnace C dates from the earlier part of Phase 3, and, presumably following its success, Furnace D was subsequently constructed. The remains of the furnace were well preserved, with the crowns of the regenerative chambers surviving *in-situ*. Other surviving elements included the four chambers of the regenerative furnace (***3777-80***), the exhaust flue (***3715***), chimney (***3713***), switch room (***3821***) and associated gas producers (***3709***) to the north, and the 'cave' (***3822***) to the south. The main building material used in the construction of the furnace was yellow refractory brick. The bricks were identical in size to those used in Furnace B, with numerous examples stamped with similar makers' marks, including 'Thistle', 'Rufford Stourbridge', 'Hickman & Co Stourbridge', 'Jones, Darras, Risca', and 'Harper & Moore, Stourbridge' (*Section 3.4.33*).

Plate 27: General view of Furnace C, looking south

3.4.39 The four regenerative chambers (***3777-80***) followed the main orientation of this furnace, and were aligned approximately north-east/south-west. As with the other regenerative furnaces, the chambers were of two sizes, the narrower gas chambers measuring 0.91m (3 feet) and the wider air chambers, 1.82m (6 feet; Plate 28). Again, as with the other furnaces on this site, there was no central passage below the furnace, as shown in the Siemens' patent drawings, although they were often not included, particularly in the smaller bottle furnaces (Krupa and Heawood 2002, 11). Unlike Furnaces A and B, the gas-regenerative chambers were positioned inside those supplying air, demonstrating that no definitive arrangement had been established by this time.

Plate 28: Furnace C: regenerative furnace chambers, looking north. The wider chamber carried air and the narrower carried gas

3.4.40 Of the four chambers, the two outer air regenerators, ***3777*** (west) and ***3780*** (east), had partially intact crowns at their northern ends; chamber ***3777*** had a further section of arched roof that survived at the south-west end. Air regenerators ***3777*** and ***3780*** had an intact maximum height of 1.56m, measured from the crown to the floor of the switch room. The crowns of the air regenerators were designed with a segmental arch, comprising two courses, and a packing of brick, below a single course of voussoir and standard bricks. A single course of voussoir bricks was all that survived on top of the gas-regenerative chamber walls. The chambers also retained evidence of upcast flues, which would have allowed the gas and air to be passed up into the furnace or drawn down from the furnace to heat the stacked bricks. Chamber ***3777*** had two approximately square voids, each measuring 0.36 x 0.38m, located along the western edge, in the positions of the upcast flues. A further upcast flue was marked by an identically sized void on the eastern side of chamber ***3780***. The sides of all of the upcast flues were heavily vitrified.

3.4.41 Within each regenerative chamber was a single-skin projecting ledge, constructed to a height of 18 inches (0.46m) above floor level, with a single-skin longitudinal wall built down the centre of each chamber, in places surviving to a height of 2 feet (0.61m). These would have supported the checkerwork arrangement of bricks positioned above the lowest level of the chamber where the gas/air was allowed to flow more freely. At the south-west end of the regenerator chambers, the gaps between the main walls and the smaller 'spine' walls were blocked by refractory brick walls. These were poorly constructed, representing temporary blocking of the regenerators, which could be unblocked to remove or restack bricks in the regenerators as necessary, and afforded access from the cave (***3822***). The temporary wall at the end of chamber ***3779*** was not observed, as it remained unexcavated.

3.4.42 The tensioning bars observed within the main walls of Furnaces B and D were not visible within Furnace C. Whilst it is possible that they may have been so corroded that they were not preserved, this is unlikely. Vertical furnace straps, identical to those seen in Furnaces B and D, were visible in the switch room (***3821***), on the north-east face, and additional support was provided by three I-section rails built into the outer furnace walls at the north-east end. However, it is probable that these were installed to act as tensioning supports solely for the tank, rather than for the regenerative chambers, suggesting that the system was modified prior to the construction of Furnaces B and D.

3.4.43 The switch room (***3821***) was situated at the northern end of the furnace, and survived to its floor level, which housed access into the flues from the switch gear, as well as several inspection and access hatches. A significant amount of flooring survived on the eastern side of the room, in front of the air regenerator (***3780***), providing a good example of what the original flooring was probably like in the other furnaces (Plate 29). This refractory brick floor was 0.91m (3 feet) above the regenerative chamber floors and contained 11 apertures, eight of which descended to the floor level of the chambers, the remaining four being inspection hatches into the air and gas flues into the regenerative chambers. These hatches, which would all have been covered with cast-iron sheets originally, were connected to the chambers with a butt joint and a two-course shallow segmental arch, the crowns of which were 0.38m below the floor of the switch room, and 0.51m above the chamber floor. The two hatches for the air chambers were connected to a further two hatches to the north-east, separated only by an I-section horizontal beam at switch room floor level. These would have been attached to the switching gear, to control the flow of air within each chamber. The two apertures for the gas regenerators were connected to a further pair, situated 0.38m to the north-east. These were connected by a single-skin of edge-set bricks, with a voussoired keystone, to the switching gear, to control the flow of gas. The switching gear would probably also have been attached to a circular-topped flue placed centrally between the two outer hatches of the air regenerator. Below its circular capping, it comprised a rectangular flue, connected to two access hatches to the north-east, each with edge-set brick arches, and into the exhaust flue (***3715***). The base of this flue sloped downwards to the north-east, to provide a better flow for the exhaust gases.

Plate 29: Elevations of flues in Furnace C, looking south

3.4.44 This flue was 0.55m wide, and had a brick floor that sloped upwards from beneath the floor of the switch room, and led towards a truncated square structure (***3713***), situated 5.2m away, which represented the remains of a brick-built chimney. These two structures had partially destroyed an earlier rectangular structure (***3737***), which measured 4.15 x 3.2m.

3.4.45 To the west of Furnace ***3776*** was a second probable flue (***3781***), which was aligned north-east/south-west before turning further north-eastwards at its northern end (Fig 8). This suggested that it was aligned into chimney ***3713***, but insufficient remains survived to confirm this. The structure was at a higher level than flue ***3715*** and, as flue ***3715*** was apparently venting the air from the regenerators to chimney ***3713***, it is not clear at this stage how it might have functioned, although it is possible that flue ***3781*** was a later alteration.

3.4.46 *Furnace D*: Furnace D (***3665***) comprised four chambers (***3684-7***), with a similar layout to the other Phase 3 furnaces, and was constructed on the same north-east/south-west alignment to Furnace C (Plate 30). The switch room, ***3506***, was situated to the north-east of the four chambers, and it incorporated two earlier walls in its design (*Section 3.4.18*), whilst the exhaust flue extended around the north-west side of the furnace to a chimney base (***3742***). To the south-west of the furnace was an access passage, or 'cave' (***3682***), which afforded access to the four chambers. The main body of the furnace was built of refractory bricks, similar in size to those observed in the other furnaces, with stamps of 'Thistle' and 'Rufford Stourbridge' observed. The main chambers were built in English bond, with alternate rows of headers and stretchers, whilst the remainder of the structures had less regular brickwork, all being bonded in a pale lime mortar, with the exception of parts of the regenerator crowns, which appear to have been bonded in puddled clay.

Plate 30: General view of Furnace D, looking west

3.4.47 As seen in the other three furnaces (A-C), there were two sizes of chambers, the narrower measuring 0.9m and the wider ones were between 1.29m and 1.37m. These chambers were paired, with the narrower gas chambers positioned outside the wider air chambers. This appears to be adaptation from Furnace C, where the air regenerators were positioned on the outside.

3.4.48 Chamber ***3684*** was the only one that survived almost intact and chamber ***3685*** had good though partial survival. The chambers that survived to full height showed that they varied from 1.8m, measuring from the crown, for the gas regenerators and 2.1m for the air regenerators. The roof of chamber ***3684*** comprised a double segmental arch, of tapered voussoir bricks, whereas only a single segmental arch of voussoir bricks survived on chamber ***3685***. The arches then changed construction from voussoir bricks to standard-size bricks (Harley 1974), with fillets on the upper skin of the arch. The front arch was a separate, but contemporary, build to the rest of the chamber. The upper skin of the arch formed a series of raised transverse arches separated by three gaps that penetrated to the lower level. Each gap was 0.48m wide and capped with fillets. Within the raised transverse arches were two preserved upcast flues, set through the highest part of the crown. Both of the flues were splayed with the angle of the tunnel crown and directed the gas in to heat the glass melt-tank and then vent out on the opposing side of the furnace, through the 'off' regenerator. The internal faces of the upcast flues were covered with large amounts of vitreous deposits and burning, resulting from spillage of the glass melt/batch.

3.4.49 The four chambers, ***3684-7***, were built with two tensioning bars running through the main north-east/south-west walls of the chambers. These bars were positioned 0.3m and 1.6m above the chamber floor except for the most westerly wall of chamber ***3684***, where the upper bar was placed at 1.8m above the chamber floor. These were held in place with furnace straps at both ends, consisting of 'I'-section rails set

vertically with rebated cast-iron plates. The 'I'-section rail for the western wall of chamber ***3684*** was slightly bent, but the purpose of this was unclear. The tension bars were in place to help with the expansion and retraction of the heating and cooling of the furnace. Further support was given in the form of two solid rectangular-section iron bars on the western side of the furnace.

3.4.50 Within the chambers was a ledge lower down in the main walls, with evidence of a single-skin longitudinal wall of similar height, parallel to the main walls, only in the centre of chambers ***3685*** and ***3686***, although all four chambers would have had them. These features supported the checkerwork stack of bricks that absorbed the heat of the expelled air. No stacks of bricks were found within the chambers but stacks of regenerator bricks were found within switch room ***3506*** and on other parts of site. These bricks were smaller than regular bricks.

3.4.51 At both ends of the air regenerators, a narrowing wall had been built abutting the chamber walls. At the north-east end, these walls were set back from the chamber face, but at the south-west end they were set flush with the ends of the chamber walls. All of the narrowing walls were separate builds to the chamber walls, but at the north-east end they were contemporary with the construction of the switch room floor, ***3690***. At the south-east end, the chambers were all blocked with short, less well-built brick walls, at right-angles to the main walls. These would have been temporary, to allow access so that the checkerwork stacks of bricks could be maintained as necessary.

3.4.52 The cave (***3682***) allowing access to the furnace was entered from the north-west end, where there was a flight of at least seven brick and stone steps. The steps varied in size and had been cut by a modern concrete pipe. The south-east end led to another passageway (***3708***) at right-angles, and through an arch to the south was the ante-room for gas producer ***3818***. The main walls of the cave were built of red bricks, with a varying bond of English and English Garden Wall. The floor was also constructed of red brick, with a stack bond as the main panel and a one-brick lengthways chamber down either side. At the south-east end, a set of bricks on end separated the cave flooring from passageway ***3708***. The cave was 16.2m long by 1.3m wide.

3.4.53 The south-east wall of cave ***3682*** comprised two main parts, and in one section of the wall was a hatch, situated 1.05m from the floor of the cave. This hatch appeared to be connected to flue ***3748***, which may have been part of the probable annealing house (*Section 3.4.77*). Towards the south-east end of the wall was a vertical iron bracket mounted on the south-west face of the wall. The wall at the north-west end of the cave contained a segmented archway and a pair of drainage pipes set into the top of the wall. The south-west wall had a return at the north-west end towards the south-west and may have continued as wall ***3760*** and possibly walls ***3758*** and ***3759***.

3.4.54 The switch room, ***3506***, was a sub-rectangular structure on the north-east side of the main chambers. It was a separate build to the main chambers but had a butt joint, demonstrating that their use was contemporary. The entranceway into the switch room was via a sloping passageway (***3506***) to the north-east and was flanked by a double-faced, 0.45m wide, stone wall (***3505***). This passageway was connected to another passage (***3526***). Later blocking (***3590***) was seen at the north-east end of passage ***3506***.

3.4.55 The refractory brick floor was 0.88m above the regenerator chamber floor and had 11 apertures that would have originally been bridged with cast-iron covers (Plate

31). Eight of the apertures accessed the floor level of the regenerator chambers and, of these, the four nearest the chambers were inspection hatches to the flues that carried the air and gas into the regenerator chambers. All of the hatches were connected to the chambers with a butting joint and shallow segmental arches. The crowns of these arches were 0.38m from the floor of the switch room and 0.5m above the chamber floor.

*Plate 31: Furnace D, arrangement of access pits in switch room **3506**, looking west*

3.4.56 The two hatches for the air chambers were connected to another two hatches to the north-east, and were only separated by an 'I'-section horizontal bar; the latter two hatches would have been attached to the switching gear to control the flow of air. The two hatches for the gas regenerators were connected to another two hatches further north-east of the air hatches, which were attached to the switch gear. These would also have been attached to the switching gear to control the flow of gas.

3.4.57 The main switching gear would probably have been attached to the circular-topped flue that was located centrally between the two outer hatches of the air regenerator. This was a rectangular flue connected to another two hatches to the north-east, which was given access into the exhaust flue by two brick arches. The base of the flue sloped downwards to the north-east to provide a better flow of the exhaust fumes.

3.4.58 The walls on the north-west and south-east side were bonded with a grey ash/lime mortar, and had several phases of rebuild. The latest rebuild provided a curving entrance, that presumably made an easier working space around the switch gear. On the south-eastern wall of the switch room was a cast-iron door, which measured 0.45 x 0.45m, and afforded access to flue ***3702*** (Fig 8).

3.4.59 The exhaust flue (***3652***) was connected to the switch room through the hatches, and curved round the north-west side of the furnace, terminating at chimney ***3742***. The floor sloped upwards towards the south-west from the level of the chamber floor. The walls of the flue were parallel and its internal dimensions were 0.58m wide by

1.07m high from the crown of the double-row segmental arch to the floor. The last 0.45m length of flue ***3652*** was a separate build from the rest, and comprised red brick rather than refractory bricks.

3.4.60 The base of chimney ***3742*** comprised a single-skin red brick floor, bonded with black ash mortar. The floor was bonded to a 0.12m-thick concrete base, which overlay another layer of concreted clinker and bricks. This overlay a single skin of handmade/mould-thrown bricks, bonded with a mid-brown sandy-lime mortar with charcoal inclusions. Below this were two courses of rough-hewn stone and brick, which probably represented an earlier phase of chimney. The only surviving wall of the chimney was on the west side, and was 0.6m thick. This had been rebuilt several times for the insertion of modern drains (Phase 4).

3.4.61 *Gas Producers*: nestled between Furnaces C and D were four structures (***3709***, ***3729***, ***3632***/***3638*** and ***3818***) that clearly represented the remains of gas producers, which may have developed sequentially (Fig 8). In terms of size, ***3729*** and ***3818*** were similar, with ***3632***/***3638*** being slightly larger, and the remaining gas producer (***3709***) effectively being a bank of five or possibly six producers. Producers ***3729*** and ***3818*** were located at opposing corners of the furnaces, in close proximity to each other. Producer ***3729*** was connected to Furnace D by a series of brick flues, but there were no surviving remains linking ***3818*** to Furnace C.

3.4.62 Gas producer ***3729*** was located to the south-east of the main body of Furnace D. It was built of refractory bricks, rectangular in shape (1.2 x 0.9m), with a rough brick floor. The upper portions of the south-east and north-west sides of the structure tapered slightly at an angle of 9°, and reached a plinth/ledge before becoming vertically sided towards the base. On all sides was a band of heavy burning or accretion, which was seen 0.75m from the top and was 0.75m wide. An iron bar was visible at the level where the half-brick plinth projected on the north-west side. The lower part of the south-east wall contained evidence for later blocking, but this was respected by the wall of passageway ***3708***. It is possible that this producer would have originally supplied furnace ***3776***. The entire structure was abutted by the back of the north-east wall of cave ***3682***.

3.4.63 Leading out of the top of gas producer ***3729*** was flue ***3710***, which would have carried the gas to the switch room, ***3506***, and from there it would have been directed into either of the gas regenerators, ***3684*** or ***3687***. Flue ***3710*** was constructed of refractory bricks, and measured 4.9m long, with an internal width of 0.45m, surviving to a height of 0.6m. The flue was situated at the north-west corner of gas producer ***3729***, and followed a general north-easterly direction. At the north-east end it would have originally joined flue/chamber ***3702***, but it had been blocked when producers ***3632*** and ***3638*** were built, indicating that gas producer ***3729*** may have become obsolete, although it was still likely to have been in use when passageway ***3708*** was constructed, since an aperture was maintained for the producer.

3.4.64 Flue/chamber ***3702*** was an irregularly shaped structure, aligned north-west/south-east, and built of refractory bricks that had been heavily blackened on all faces. The structure was constructed of walls two-bricks wide, and with a single-brick segmental arch at the south-east end. The arch was 0.61m long, 0.74m wide, and measured 0.81m in height to the crown. At the north-west end was the cast-iron door that led into the switch room (***3506***). At this end, the chamber was 0.74m wide and widened to 1.32m at the south-east end. It was 2.74m long, with the floor rising sharply 1.5m from the north-west end.

3.4.65 Gas producer ***3818*** (Plate 32) was situated north-west of Furnace C (***3776***) and south-east of Furnace D (***3665***). The gas producer was reached through a small ante-room to the north-west which connected to the passageway (***3708***) and the cave (***3682***) for Furnace D, indicating that it remained in contemporary use with Furnace D (***3665***), and gas producer ***3709***. The feature was not fully preserved, but the iron fixtures, presumably for the grate, were easily visible. There was a brick floor beneath the void of the producer and this continued outwards to become the floor of the ante-room. Above the floor, the lower brick walls of the gas producer were vertical, on top of which were several horizontal iron bars spanning the walls, and an additional bar set perpendicular to and on top of them. Over the front iron bar, a brick wall had been constructed carefully so that it became gradually arched towards the top. This presumably would eventually have formed the roof of the chamber, through which the raw fuel could then have been loaded. The interior faces of the brick walls, above the level of the iron bars, displayed the effects of intense heat.

*Plate 32: Gas producer **3818** viewed from above, looking west*

3.4.66 The complex structure to the north of Furnace C (***3776***) and gas producer ***3818*** was interpreted as another gas producer (***3709***; Plate 33). A building of this size and shape is depicted on the Ordnance Survey map of 1885 and suggests that this structure may have been present on the site by this date. It is also possible that gas producer ***3709*** was inserted into the earlier structure, or was rebuilt completely within the space occupied by the building.

*Plate 33: Gas producer **3709**, towards the bottom of the picture, with passageway **3708** above, looking west*

3.4.67 In plan, the overall structure (***3709***) was rectangular, orientated north-east/south-west and had dimensions of approximately 13 x 4.3m, with an additional passageway, ***3708***, to the west, which was 2.15m wide. The northern end was better preserved than the southern, surviving to a greater height, and retained iron fixtures and fittings. The layout of the gas producer had five to six compartments, the fourth compartment from the north being either slightly different or completely destroyed. The northern three compartments all had short curved parallel walls leading out of the top of the compartments, the brickwork of which showed discolouration and were blackened. The curved features joined a linear, parallel-walled structure, which may have been a flue that effectively funnelled the air, drawn up through the producers, outwards. There is evidence indicating that this producer was supplying at least Furnaces B and C.

3.4.68 Within each compartment, the base was constructed of brick walls with a concrete lining, forming the base where the ashes would have emerged, thus allowing them to be raked out. The lining sloped front and back, with a flat base, while the sides remained vertical, ensuring the raking out could be done efficiently and easily. The concrete bases were set 0.6m above the floor of passageway ***3708***, from which the gas producers were reached. There were possible foot holes within the base of the front wall to assist those cleaning out, allowing closer access.

3.4.69 Above the rake-out bases were the chambers for the gas production. These were apparently set into frames of iron bars constructed within the upright walls of the chambers, similar to the arrangement in ***3818***. The front wall of the producer was set back from the front of the rake-out pit. There was a 0.62m aperture surmounted by an arch built of a double row of bricks (Plate 34). This aperture corresponded to the position of the intact faceplate in the iron fixtures. The iron housing had two central openings, the upper arched one blocked at the rear by brickwork, and the lower one was circular (within a hexagonal case), with a 0.15m wide opening for the gas pipe. On either side of these were two rectangular openings, which on the northernmost chamber had thick iron covers over. Their intended function was unclear, although they may have been related to subsidiary pipework or overflow release systems.

*Plate 34: Detail of gas producer **3709**, face-plate elevation*

3.4.70 Behind the iron faceplate, the gas-producer pipework was uncovered as the furnace was excavated. This complex piece of equipment was cast in one, which presumably made it inherently stronger and more resistant to breakages. The walls of the upright chambers all appeared to have been subjected to high temperatures, since the brickwork was both discoloured and modified.

3.4.71 The passageway, ***3708***, to the west of gas producer ***3709*** was formed by a long brick wall on its western side, and by the front of the gas producers on the eastern side.

The passageway was contiguous with 'cave' ***3682***, which ran perpendicular to it to the north-west, and also with a short stretch of passageway leading obliquely north-west at the northern end. The passageway gave access to the gas producer complexes, ***3709***, ***3729***, ***3632***/***3638*** and ***3818***, indicating that all three producers may have operated at the same time. Gas producer ***3729*** was later blocked, as it had clearly gone out of use. There were two surviving arches at the northern end of the passageway (***3682***), spaced 1.8m apart, which presumably maintained the structural integrity of the complex and could have allowed a floor to be spanned over the top of it. Originally, there would have been two further arches associated with the passageway, as demonstrated by the scars of their springers on the western wall.

3.4.72 Just north of the gas producer were two linear features, ***3654*** and ***3655***, which appeared to be the remains of the bases of flues. Their position suggests that there may have been some inter-connectivity between the furnaces, as these features were definitely on alignments that led towards Furnace B.

3.4.73 To the north-west of gas producer ***3709*** was a set of two other gas producers, ***3632*** and ***3638***. These gas producers appeared to have been accessed from the north-east side from a continuation of passageway ***3708***.

3.4.74 *Annealing Houses:* the annealing houses would have required a controllable source of heating to facilitate the gradual cooling of molten glass-products, as rapid cooling caused breakages. Assessment of the dataset has highlighted two areas within ND3 that may have been the positions of annealing houses (Fig 4).

3.4.75 An area of internal flooring to the west of Furnace B varied in composition from flagstones (***3013***; Fig 6) and bricks (***3028*** and ***3030***), to a combination (***3022***) of materials (Plate 35). Although partially destroyed by later services and walls (***3034***), this area seemed to be part of a single structure. There were five openings in the floors, four of which were rectangular and were paired to the east of a circular opening (***3072***). Circular opening ***3072*** was constructed of both standard and firebricks and consisted of a 1.8m-diameter circular brick structure, that had a north-west/south-east-aligned rectangular opening out from the eastern side (Plate 36). The rectangular opening was 0.96m deep and 1.15m long by 0.68m wide, narrowing to 0.46m within the circular base. Iron bars were positioned horizontally along each long side and there was an iron plate in the narrower western end, that bowed downwards.

Plate 35: Area of the possible annealing house on the north side of the site, looking west

Plate 36: Circular brick structure **3072***, looking north*

3.4.76 Of the four rectangular openings/recesses, only two survived intact (***3068*** and ***3071***), the other two (***3074*** and ***3076***) having been damaged by later services. The openings were aligned north-east/south-west, and measured 1.55 x 0.75m by 0.45m deep. Each opening had brick edging, and ***3068*** and ***3071*** had steps built on the northern side, indicating pedestrian access into the feature (Plate 37). Metal plates were

present at the southern ends of each of the northern openings. The plates appeared to act as flaps, as they seemed to rotate around two metal pins lodged in the side walls, and there were visible scar marks on the side walls where the metal flaps had obviously rubbed. The purpose of these features is not clear, but it is conjectured that they may have been related to ventilation or managing air movement, and could thus be associated with the operation of an annealing house. In addition, a building in this location was the only one shown on historical mapping (*eg* Roque's plan of 1742; Plate 12) to have been attached to the original glass cone, and would therefore have contained the annealing house. There were other extensions of the flooring and additional features revealed to the immediate south-west of this area, all probably representing later modifications, although their precise chronology will require further analysis.

Plate 37: Rectangular opening **3608***, looking south*

3.4.77 To the south of Furnace D (***3665***) and west of Furnace C (***3776***) was an area of brick floors (***3772***, ***3790*** and ***3802***) and flues (***3747*** and ***3748***; Fig 8). Floor ***3802*** was at a higher level than ***3772***, and they clearly formed distinct rooms, whilst floor ***3790*** overlay ***3772***, and may have represented an episode of later reflooring. Several flues, including ***3747***, ***3748,*** and ***3766***, were situated on the south-west side of the 'cave' of Furnace D. All were constructed of refractory bricks, bonded with a lime mortar, and were all covered in soot. Flues ***3748*** and ***3747*** were both built in unequal sections that could be seen on the tops of the arches and in the walls. The arches of both flues were constructed of brick, with voussoir bricks for the keystones. It is unclear at this stage what the purpose of the flues was in this part of the site; they may have vented hot gases and air into a building in this position, which would suggest a possible annealing house. Furnaces C and D had clearly associated exhaust flues, and the exact relationship of these flues with cave ***3682*** remains to be resolved.

3.4.78 ***Phase 4:*** the latest phase essentially comprised the activity on the site after the closure of the glass-works in the early 1920s. This was represented by layers of demolition debris and modern make-up. In addition, all structures pertaining to a yeast factory built on the site fall into this phase. Most of the features and remains dating to this phase were removed mechanically.

3.4.79 The foundations of the yeast factory extended across the entire area of ND3, covering an area 67.15 x 28.15m (Fig 7), represented by a complex of deep foundations. These were part of the fermenting plant, adjacent to the clarifying plant and hot water tanks, shown on the Goad Insurance plan of 1939. On the southern side of the site were several deep, squared-pile foundations that had been associated with the molasses tanks.

3.4.80 Over the northern part of Area ND3 were deep deposits of demolition and backfill around the foundations. These contained large amounts of brick rubble and glass waste; the rubble was derived from the demolition of the yeast factory in the late twentieth century. The actual foundations comprised a form of poured concrete, and there was evidence of wooden shuttering at the bases. The foundations varied in shape, although all essentially comprised pyramidal bases (square base and four sloping sides) with upright pillars of reinforced steel.

3.4.81 A series of brick structures with concrete floors were exposed towards the north-eastern corner of Area ND3; these had formed part of the yeast factory, and probably correspond to the cold stores. They were filled with building rubble and debris. Other modern walls were exposed along the northern side of the site, and probably related to the yeast factory.

3.4.82 Numerous services crossed the site, all of which were clearly of a twentieth-century date (not illustrated). These were almost certainly associated with the yeast factory, and were of little archaeological interest.

3.4.83 Railway tracks (***3117***; not illustrated) were exposed in the south-western part of Area ND3. The tracks were aligned north-west/south-east, and are likely to have extended from the network of lines seen crossing Area ND5 (***1007*** and ***1049***; *Section 3.4.136*), but were of a later date.

3.4.84 ***Area ND4:*** this part of the site was situated to the west of Area ND5 and to the east of Area ND3, and measured 56 x 44m (Fig 3). It was bordered by the old access route (Free Tank), which separated ND3 from ND4. The major phase of activity represented in this area comprised the construction of stone-built buildings.

3.4.85 ***Natural deposits:*** the earliest identified deposit was a mid-brownish-orange, plastic clay (***4023***; not illustrated). This had clearly been deposited prior to the occupation of the site, and almost certainly represented the natural drift geology.

3.4.86 ***Phase 1:*** no features pre-dating the glass-works were encountered within this part of the site.

3.4.87 ***Phase 2:*** several sandstone walls exposed in Area ND4 can be ascribed to Phase 2. These were all aligned north-east/south-west and north-west/south-east, and respected each other spatially (Fig 9). Along the western side of the site were two main walls, ***4002*** to the north, and ***4044*** to the south.

3.4.88 Wall ***4044*** had a visible return at its northern end, demonstrating that the two walls were not part of the same building although they were probably originally laid out at the same time. At the southern end of wall ***4044*** was another stretch of wall (***4043***),

perpendicular to it and continuing in a westerly direction. Wall ***4043*** almost certainly represented the southern extent of a building. It is possible that it would have joined wall ***4045***, which was parallel to and 14.5m east of ***4044***.

3.4.89 Several other sandstone walls were exposed in the north-western corner of Area ND4 (Plate 38). Contemporary with wall ***4002*** was a north-west/south-east-aligned wall (***4003***), which was parallel to the main alignment of Avon Street, and had a distinct return northwards part way along its length. The walls all continued north beyond the limit of excavation, and would presumably have had a northern wall somewhere under the edge of Avon Street, forming the old street frontage. This layout was seen elsewhere in Areas ND3 and ND5.

Plate 38: Phase 2 sandstone walls in Area ND4, including **4002***, looking north-east*

3.4.90 To the south of wall ***4003*** were the vestiges of walls ***4006***, ***4007***, ***4008*** and ***4011***. These were again of sandstone construction, and there was evidence of them having been cut by nineteenth-century service trenches. These walls seemingly represented smaller structures, probably contemporary with the main ***4044***/***4043*** and ***4002***/***4003*** phase of building.

3.4.91 Along the eastern side of the site was a length of sandstone wall (***4052***) that was parallel with walls ***4045*** and ***4044***. The similarity of construction and alignment were suggestive of a contemporary date, although no direct stratigraphic link survived.

3.4.92 Although Area ND4 was in close proximity to the glasshouses, the boundary of Free Tank would appear, from the cartographic evidence, to be the limit of the glass-works (Fig 3). However, the presence of glass-working waste in several of the deposits suggests that they were likely to have been formed during the phase of glass-works activity. The deposits in question were all part of a sequence in the vicinity of walls ***4008*** and ***4011***. The deposits, including ***4017***, ***4018*** and ***4022*** (not illustrated), appeared to post-date the walls, perhaps being used as make-up material to help establish floor levels, after the foundations and walls had been constructed.

There was also a small area of burnt natural clay, which may have been modified due to the dumping of hot material, such as glass waste.

3.4.93 ***Phase 3:*** later structural activity was visible in several places where later brick structures had been added to the earlier stone structures. There was a definitely later phase of activity along the southern side of ***4043***, where the truncated remains of a brick structure were exposed. At the eastern extent of wall ***4003*** was a possible foundation for a brick wall (***4015***), which may have sub-divided the premises. There was also a short stretch of brickwork (***4004***) within wall ***4003***, towards the west and although very little of it remained, making it difficult to interpret, the remains could have been those of a stairway, as similar features were seen more clearly in Area ND5 (*Section 3.4.126*).

3.4.94 ***Phase 4:*** there was only one feature attributed to the latest phase of activity, a modern, brick structure at the north end of the site. It was an enclosed basement area constructed of machine-made bricks beneath the modern make-up layer and poured concrete.

3.4.95 ***Not closely phased:*** at present, there are several features that are not closely phased, as they cannot be associated directly with other features. These include well ***4030***, which was of sandstone construction, and situated in the north-east part of the site, and also well ***4054***, which lay beneath tiled floor ***4051***.

3.4.96 In addition to the two wells, there were also four features interpreted as culverts: ***4024***, ***4026***, ***4046*** and ***4050***. Three of these were constructed of sandstone and brick, while one (***4026***) appeared to be exclusively of sandstone. The easternmost two (***4050*** and ***4046***) were parallel to each other and probably contemporary. It is difficult to ascertain at this stage whether these culverts/drains were indeed all contemporary, but if so they may represent a wholesale scheme of drainage at some stage. Again, it is not possible to identify if the drainage was undertaken prior to the construction of the original buildings on the site, during the transition from open land to occupied land, or whether they were later inserted as a necessity to mitigate groundwater issues.

3.4.97 ***Area ND5:*** this area lay at the eastern end of the site, bordered by Area ND4 along the eastern edge, and measured 56 x 45m. Area ND5 was essentially open land until the nineteenth century. There is some cartographic evidence, such as that provided by Roque's map of 1742, to indicate small encroachments of buildings onto the land, in a similar fashion to that of Area ND9, which at the time was called The Brick Fields. The name refers to the use of the land for clay extraction, presumably for the manufacture of bricks. The area was depicted as possibly marsh, with the surrounding area laid out as fields. Evidence was found at the lowest levels of excavation for regular pits dug into the natural alluvial clay, and these were interpreted as being clay-extraction pits.

3.4.98 The small inlet known at the time as Cuckold's Pill probably flowed through the area to the east of Area ND5, as no evidence was uncovered for it within Area ND5. The inlet allowed the importation and exporting of goods, albeit on a small scale.

3.4.99 By the time of Ashmead and Plumley's map of 1828, 70 years later, there had been significant change, with the area becoming occupied by buildings, although some parts remained open. It would seem that, prior to and during this period, land was being reclaimed along the edge of the River Avon using any available material, and this incorporated some pottery-waste dumps. These may have originated from

redware producers known to have been located along Avon Street in the eighteenth century (*Section 5.7.27*).

3.4.100 ***Natural deposits:*** the earliest identified deposit was the mid-brownish orange, stiff clay, ***1025=1185*** (not illustrated), which was established as the natural alluvial clay, water-lain prior to the occupation of the site. The deposit was seen to extend across the entire northern half of the site but was not reached across the southern half, where man-made deposits were encountered. In the northern half, all identified layers were seen to overlie this natural deposit and several features were cut into it.

3.4.101 ***Phase 2:*** three main feature types may be attributed to this phase, each suggestive of a different sub-phase. These are identified as layers, pits, and structures.

3.4.102 There were numerous tip layers that seemingly formed deliberate land reclamation and levelling in the area. The majority of these layers were seen within the southern half of the site and several sequences of layers were excavated in a variety of locations. In the south-east corner of the site, east of the dock, 11 thin layers were seen to overlie the natural clay (Plate 39). These layers (***1014-24***; not illustrated) varied in composition and colour, indicating several origins for the material, but all were deposited at the same angle, which would suggest that they were laid down in a relatively short period of time. Two layers (***1018*** and ***1019***; not illustrated) contained fragments of waste glass, indicating that some of the material was being derived from the glass-works. Above this sequence of layers was a long, substantial sandstone wall (***1001***; Fig 10), which represented later activity in this phase. The deposits were seen to overlie the natural geology (***1025***) at their northern limit, where the natural clay gently rose upwards.

Plate 39: Sandstone wall **1001**, *with tip layers* **1014-24** *below, looking north-west*

3.4.103 Along the southernmost limit of the excavation, towards the western side of the site, was another series of deposits (***1008***, ***1009***, and ***1010***; not illustrated), although these were different in nature from the eastern sequence. In particular, these deposits were

generally thicker, less consistent in their tip angles, and all of similar composition. The layers were rich in clay, and contained abundant fragments of redware pottery. They may have been deposited as part of a deliberate attempt to reclaim, extend and organise the river edge. The base of these layers was not reached, and the level of the natural geology could not be established in this area.

3.4.104 Further west, the excavation explored the sequences of deposits to a greater depth, but not as close to the river edge. Layers ***1102-4*** (not illustrated) were again typically quite clay-rich and contained large proportions of redware ceramics. Two layers, ***1105*** and ***1106*** (not illustrated), were distinct from this pattern in being almost exclusively glass waste, which demonstrates that waste materials from elsewhere, probably the glasshouses to the west, were being transported this short distance and being dumped. Whether this was a deliberate reuse of material to help reclaim the land or whether it was simply an open area in which to discard the waste is not yet clear.

3.4.105 A sequence of deposits, ***1262-7*** (not illustrated), was seen below wall ***1123*** (*Section 3.4.115*) in this area, illustrating similar circumstances to that of the deposits below wall ***1001***. These layers were relatively varied and also demonstrated tiplines, but interestingly they tipped downwards at a moderately steep angle from west to east, which suggests that this area may have been subject to two periods of tipping, or at least multi-directional tipping was taking place. This could be indicative of large-scale activity.

3.4.106 Associated with these layers was a further sequence of ten tipped deposits, ***1166-75*** (not illustrated), which showed a consistency of angle, from north to south, but a variety in nature. The majority of the layers had a high clay content, and five of them contained significant amounts of pottery (***1167***, ***1169***, ***1171***, ***1172***, and ***1174***), mostly redware ceramics. These layers were identified in a sondage excavated south of wall ***1221*** (*Section 3.4.107*); the sondage was excavated to a depth of 1m below the permitted level of works and there was no evidence of natural deposits at the base. This sequence again suggests the material was being dumped over a short timespan.

3.4.107 Some of these layers appeared to post-date a deep sandstone wall, ***1221***, which was aligned north-west/south-east. Although it was not possible to excavate the wall fully, since it was mostly below the level to which excavation was permitted, it is possible that this wall may have been an early retaining boundary, or of a building, beyond which the area remained open until the deposits were tipped.

3.4.108 Numerous pits were also revealed, mostly semi-regular in plan and generally located in the north-western part of the site (Plate 40). They were particularly distinct once the level of the natural geology had been reached, as it was evident that they had been cut into this. Stratigraphically, all other features and deposits sealed or cut through the upper fills of the pits. In total, eight pits (***1140***, ***1162=1233***, ***1232***, ***1218***, ***1220***, ***1254***, ***1255***, and ***1256***) were identified, ranging in size from 11.65 x 4.4m (pit ***1218***) to 2 x 1.7m pit (***1254***). The best examples, such as ***1255***, had numerous layers tipped in, and several fills contained large proportions of redware ceramics; in particular, pit ***1255*** had nine fills (***1068***, ***1114***, ***1115***, ***1191***, ***1192***, ***1193***, ***1238***, ***1239*** and ***1245***; not illustrated), each with large volumes of ceramics. The ceramics had all been deposited with fresh breaks and there was some evidence of over-firing and warping noted. A number of other fills in the sequence appeared to be almost sterile clay (***1244***, ***1246***, and ***1194***; not illustrated), very similar to the surrounding natural deposits, but evidently redeposited. A few fills, such as ***1243*** (not illustrated), were

ash-rich and possibly related to fuel waste. The overall nature of pit ***1255*** suggested that perhaps it had been dug to extract clay for use in ceramic production. The pit had then been backfilled with wasters and unused raw materials once operations ceased.

Plate 40: Clay-extraction pits in Area ND5, looking north-west

3.4.109 The fills of three pits (***1218***, ***1220*** and ***1256***) contained large proportions of glass waste; others contained glass objects, such as pit ***1140***, although pit ***1255*** had no glass waste or objects. The glass-waste-rich pit fills (***1217***, ***1219*** and ***1065***; not illustrated) demonstrate the same principle of industrial waste disposal as seen in the sequences of tipped layers elsewhere on the site, and suggest that, although the origin of the pits may have been for clay extraction, they found a secondary use as rubbish pits. This shows that the pits were going out of use by at least the early eighteenth century, when the glasshouses had begun production on the adjacent site. Intriguingly, Roque's map of 1742 shows apparent pits to the west of the most westerly glasshouse, but none in the vicinity of the pits identified archaeologically.

3.4.110 The most easterly pit, ***1140***, was smaller, and contained four fills, of which three (***1126***, ***1127*** and ***1128***; not illustrated) yielded a mixed assemblage of finds, including pottery, metal, clay pipe, bone and ceramic building material. It is likely that this pit, given its size, was originally for rubbish, rather than for clay extraction. Another smaller pit (***1253***) had been disturbed by later activity, but its shallow nature again suggested that this was unlikely to have been originally for clay extraction. The fills (***1145***, ***1146***, ***1147***, and ***1202***; not illustrated) again contained a variety of finds more suggestive of rubbish.

3.4.111 Apparently later than both the probable clay-extraction pits, and at least one of the sequences of tip layers, was the third type of feature attributed to this phase. The sandstone walls and wall foundations were seen mostly in the northern half of Area ND5, but there was some survival of walls in the south-western corner as well. The

walls were all of a broadly similar nature, being constructed of roughly squared mid-grey sandstone, built in a random, coursed manner using lime-rich mortar of moderate hardness. The overall layout of the walls demonstrated a general consistency, with walls trending either north-east/south-west or north-west/south-east. The walls were in three main clusters: one in the north-west; one in the south-west; and the last in the east of the site.

3.4.112 In the north-west, there was a main north-east/south-west wall, ***1155***, which had two short lengths of wall abutting it to the west, ***1156*** and ***1157***, which had been cut by a modern brick structure. Wall ***1155*** was over 8.2m in length, with the two abutting walls set 4.25m apart. The southern end of ***1155*** had been destroyed and the terminus could not be defined, but it was seen to continue north beyond the limit of excavation. All three walls were between 0.4m and 0.5m wide, and survived to a maximum height of four courses, 0.45m, and formed part of the same structure. There may have also been an association with a north-west/south-east wall, ***1160***, located to the east, but any stratigraphical relationship had been removed by modern services.

3.4.113 Along the northern limit of the site were three sides of a building's basement area (Plate 41). The main walls consisted of ***1149***, aligned north-west/south-east, with a return north at the east end (***1148***). At the west end, the walls had been disturbed, but the northern return was identified as wall ***1224***. The walls survived to a maximum height of 1.20m and were approximately 0.42m wide. They were built of randomly coursed, roughly squared sandstone, and the resulting building had dimensions of approximately 8.5m north-west/south-east and over 3m north-east/south-west. This corresponds well to a building in the position on the 1828 map fronting on to Avon Street, and with a small alley along the western side. This structure was interpreted as the basement/ground floor for the building.

Plate 41: Wall **1149** *in the north-western corner of ND5, with later brick steps, looking north-west*

3.4.114 A small semi-circular feature, ***1261***, was seen to the immediate south of wall ***1149***. Whilst its phasing is difficult, the feature appeared to be contemporary with the use of the wall, although constructed after it. The dimensions were slightly smaller than the sandstone wells seen elsewhere in Areas ND5 and ND3 (*Sections 3.4.95* and

3.4.124). The feature may therefore have been acting as a sump or drainage for building ***1149***. The fill (***1151***; not illustrated) contained a range of finds, including some fragments of fine glass. A similar feature (***1213***) was seen 1.35m to the south, but it had no surviving relationship with any of the walls; this may have been a stone-lined pit or well.

3.4.115 In the south-western part of Area ND5 were walls ***1123***, ***1117***, and ***1137***. Wall ***1123*** was aligned north-west/south-east, and survived to a height of 0.66m over a distance of 3.37m. Built of roughly squared, randomly coursed sandstone, it was rendered on the northern side and had an offset foundation course on the same side. The wall was constructed on a sequence of deposits (***1262-7***; not illustrated), and probably had a relationship with wall ***1117*** to the east, but this had been destroyed by the later insertion of a modern crane base and a manhole. The two walls were of an identical build, and bonded with similar mortar, suggesting that they were contemporary. Wall ***1117*** survived to a height of 1.05m, but only for a distance of 0.85m, and was rendered on the east side.

3.4.116 In addition to these two walls, wall ***1137***, slightly to the north, was of similar construction and used the same materials, again suggestive of a contemporary date. This wall survived to a height of 1.55m over a distance of 7.7m. It incorporated an offset foundation course similar to that for wall ***1123***, but on the opposite, southern side. This suggests that the walls, although probably contemporary, were not part of the same structure. There was an apparent, 1.25m wide by 0.65m high, opening in wall ***1137***, approximately 1m from the west end. This may have been a window or threshold, but since only the lower part was preserved, it was impossible to determine.

3.4.117 A substantial, north-east/south-west-aligned sandstone wall (***1001***) was exposed in the east of the site (Plate 39); excavation revealed that a separate element of this wall (***1268***) continued to the north. Wall ***1001*** survived to a maximum height of 1.3m, and was over 16m long, although it had been destroyed at the southern end by modern foundations. The wall comprised roughly squared blocks of pale yellowish-grey and red sandstone, laid in random courses and bonded with a hard, mid-yellow mortar. The wall was constructed on top of a sequence of probable reclamation layers (***1014-24***; not illustrated).

3.4.118 The northern part (***1268***) of wall ***1001*** was over 11.3m long, and had a complex of basements surviving to the north-west (Plate 42). In the central part, there was evidence of a recent large disturbance, which may have been one of the test trenches dug for geotechnical purposes. Along most of the length of the western face, an additional skin of sandstone (***1070***) had been added to the wall. This was distinct in having a paler grey mortar bonding, and the western elevation of each exposed section had a skim of plaster applied, which had traces of discoloured lime/whitewash on it. Abutting ***1070*** on the western side were three well-defined basements (***1071***, ***1073*** and ***1074***). All were built of yellowish-grey sandstone, with occasional reddish blocks. The walls were bonded with a pale mid-grey hard mortar, rich with charcoal inclusions. Each basement showed evidence of later modifications and, intriguingly, these alterations and rebuilds were again remarkably similar in nature, indicating a contemporary phase of rebuild.

Plate 42: Wall **1268** *with adjacent cellars, looking south*

3.4.119 The southern cellar (***1071***) had internal dimensions of 2.4 x 2.2m, and survived to a maximum height of 0.73m. All three walls of this cellar could be seen, and the structure was built against ***1070***, using it as the fourth wall. Much of the height of the west wall had been destroyed by the later construction of a dock (*Section 3.4.133*). The original northern wall of the basement was visible behind later stonework. The floor of the basement was of irregularly laid sandstone flags, and had been at least partly relaid when the steps into the basement, located in the north-east corner, were rebuilt and the northern wall expanded. The steps. Of the three steps that survived, the lower two comprised stone-built risers with sandstone slabs, while the top step contained handmade bricks within the risers. The steps were between 0.22m and 0.24m in height. The cellar had been infilled with building rubble.

3.4.120 The middle cellar (***1073***) had internal dimensions of 3 x 2.4m, and survived to a maximum height of 0.70m. Originally, this cellar would have shared a wall with cellar ***1071***, although a later wall of handmade bricks had been built on the northern side of ***1071***, and this formed part of ***1073***. It would appear that this activity was contemporary with the modifications to the steps. Access to the cellar was from the south-east corner, via a flight of three steps (***1072***), which had been built in the reverse direction of those for cellar ***1071***. The steps were again composed of stone risers and flags for the lower two steps, with risers completely of brick for the upper step. The flagged floor was more regularly laid and respected the steps, but only survived along the southern side of the cellar. The fill of the cellar (***1078***) again only survived in the southern part of the structure.

3.4.121 The northern basement, ***1074***, had internal dimensions of 2.45m by over 1.9m, and survived to a maximum height of 0.88m. Of the original walls, only two north-west/south-east-aligned parallel walls survived, delimiting the northern and southern

perimeter of the cellar. Originally, the internal area would have been larger, as much as 3.1m north-east/south-west, but the addition of a later section of walling, ***1248***, reduced the internal area. With no surviving western wall, the overall north-west/south-east dimensions remain uncertain. The walls were of an identical build to those of cellars ***1071*** and ***1073***, to the south, and the southern wall of ***1074*** was possibly the northern wall of ***1073***, but a modern disturbance had destroyed any evidence. The plaster and lime/whitewash on the internal western face of wall ***1070*** survived best in this basement. The cellar was accessed by five steps, ***1093***, in the south-eastern corner, which were of similar construction to those seen in cellars ***1071*** and ***1073***. The floor was again flagged, although the irregularity and the fact that it respected a later brick wall, ***1248***, shows that it was probably relaid. Wall ***1248*** was quite heavily obscured by mid-grey mortar, but was composed of both brick and sandstone and built of regular courses, a distinct variation to the earlier walls. The fill of this cellar, ***1079***, was a similar mixture of building debris and soil, as were those in the other two cellars.

3.4.122 The fills of each cellar (***1078***, ***1079*** and ***1092***) were reasonably similar and none contained large amounts of finds. This rather suggests that the cellars were deliberately cleared, so that whatever goods or items were present had been collected and moved. The most obvious reason for this, from the archaeological evidence, is that the structures were abandoned in advance of the construction of a later dock (*Section 3.4.133*). Since the western walls were either entirely destroyed or highly disturbed, it is clear that the dock and the basements were not in contemporary use.

3.4.123 There were also several more isolated features in the eastern part of the site, including ***1054***, ***1055***, ***1056***. These highly disturbed remains of walls are unlikely to be contemporary, since the building techniques were dissimilar. All were located east of main wall ***1001***. The most substantial of the three was ***1056***, which was a north-west/south-east-aligned sandstone wall over 2.25m in length, 0.73m wide and 0.2m in height. This wall may have corresponded to the large building shown on the 1828 map, but so little survived that it is difficult to interpret fully. To the south-west were the remains of a possible corner of irregular sandstone construction, ***1055***, and within this corner was a clinker-rich material. To the south-east of this was a second partial corner, structure ***1054***, but this was built of brick and stone. The south-eastern side formed the interior of the feature. As a general interpretation, it would seem that these features are likely to have been small storage buildings, possibly below ground level, perhaps for storing coal or goods.

3.4.124 An isolated well was revealed in ND5, whose construction technique suggests a Phase 2 origin. This well (***1097***) was located in the south-eastern corner of the site, at a lower level than the possible storage buildings, ***1054-6***. It had a diameter of 1.45m and was excavated to a depth of 0.2m, but continued below the level of permitted works. It was constructed using the characteristic mid-yellowish grey sandstone, in roughly hewn blocks.

3.4.125 ***Phase 2b:*** there is evidence of a later element comprising alterations, in a number of parts of the site, particularly relating to the walls. Several bricks or further courses had been bonded along the top of wall ***1123*** in the west, and the aperture in ***1137*** to the east was blocked using a combination of bricks and stone. There were also two later walls added to the northern side of ***1137***. These two structures only partially survived, having been disturbed by a crane base and manhole. At the eastern end of wall ***1137*** was a three-sided stone and brick feature, ***1139***, which was reminiscent of the stair foundations seen elsewhere (*eg* ***1072***, ***1093***, ***1186*** and ***1187***; *Sections*

3.4.121 and *3.4.128*). Towards the western end was a stone abutment/base, ***1138***, with outwardly sloping sides and a small brick wall surmounting it. The feature may have been part of support work for flooring, although so little remained it was difficult to prove.

3.4.126 The steps, ***1072*** and ***1093***, seen in the complex of three basements in the east of the site, may also belong in this slightly later period. The modifications associated with this, such as brick wall ***1248*** in ***1074***, the wall in cellar ***1073***, and the additional stonework attached to cellar ***1071*** (*Section 3.4.119*), all could be included in this later activity.

3.4.127 To the south-west of wall ***1123*** in the west were two walls, ***1121*** and ***1122***, which probably date to this general phase, but would appear to be slightly later than ***1123***. The main north-east/south-west-aligned wall, ***1121***, had been cut by a modern manhole, leaving two surviving sections on either side, one 5m in length and one 2.75m long, both with a maximum height of 1.02m. The wall was an irregular mixture of roughly squared sandstone blocks of variable sizes and unfrogged, handmade bricks. It abutted the southern end wall ***1122***, which extended 1.6m to the west, where it survived to the same height, and clearly continued beyond the limit of excavation. To its east there were only trace amounts of stone and brickwork and it could not be determined whether the wall continued, or if this was just an area of rubble. Walls ***1121*** and ***1122*** used the same type of mortar but ***1122*** had a higher proportion of stone to brick within it. The two walls were obviously part of a structure, probably post-dating 1828, since there are no corresponding buildings in this position on Ashmead and Plumley's map. The area to the north-west of the two walls appeared to be internal, as layers such as ***1141*** could be seen tipping into the area from north to south, and the finish of the wall appeared better and more even. On the external, east, side of structure ***1121***, deposit ***1106*** was a glass-rich layer, which appeared to be earlier than the building.

3.4.128 There was an apparent later modification to structure ***1148=1149=1224*** in the north-west of the site, when the basement area was divided into two parts. This was achieved by the construction of north-west/south-east stone wall ***1183*** and adjoining north-east/south-west brick wall ***1184***. These provided the support for two stone and brick stairways, ***1186*** and ***1187***. The flagged floor was probably relaid or altered at the same time, as it abutted central wall ***1183***.

3.4.129 Structure ***1062*** was a brick-lined feature in the central part of the site, with the surrounding natural clay, ***1185***, being discoloured and brittle as a result of proximity to a heat source. It would seem that the feature may have been a chimney, flue or fireplace base, but so little survived that a full interpretation is difficult to establish. The feature was overlain by parallel structure ***1057***/***1058***. To the west was a second feature, ***1060***/***1061***, with no evidence of heating. It was difficult to phase, since wall ***1061*** was stone-built and floor ***1060*** was of brick construction and, again, the feature was earlier than parallel structure ***1057***/***1058***. It is possible that both these features were the remains of basements below buildings, since buildings are clearly shown in these positions by 1828 (Ashmead and Plumley 1828).

3.4.130 Feature ***1057***/***1058*** consisted of two parallel brick walls set 1.15m apart and aligned north-east/south-west, continuing north beyond the limit of excavation. The walls had been highly disturbed and a full interpretation is difficult to make; however, their position corresponds to the alignment of buildings shown on the 1828 map. Between

the area defined by the walls, a dark layer, ***1059*** (not illustrated), was rich in fuel waste, which may have been a deliberate make-up layer rather than debris.

3.4.131 Structure ***1158=1159*** in the north-west of the site was a later addition to the south of wall ***1160***. This structure was built of sandstone and then rendered on the inside. The walls only survived to a height of 0.5m and the feature measured 3 x 2.8m, with the walls being approximately 0.45m thick. It had a flagstone floor, and the fill appeared to contain decayed organic remains. The overall nature of the feature suggested some form of tank, with the surrounding natural clay forming a water-tight seal.

3.4.132 ***Phase 3:*** several important structures were built during the second half of the nineteenth century. In particular, a dock was constructed in the eastern part of the site, which was served by a railway line.

3.4.133 Dock ***1003*** was aligned north-east/south-west, and measured over 41 x 7.65m, with an internal width of 6.2m (Plate 43). It comprised two parallel sides and a gently curved back wall at the north end, with the southern end being originally open to the River Avon. The blocking of the entrance can be seen from the river. It was constructed of unfrogged, machine-made bricks, cement-bonded in an English Garden Wall bond, to a depth of over 22 courses, or 1.75m. The walls were approximately 0.7m wide at the top and stepped out approximately 0.05m every five courses in a symmetrical manner.

Plate 43: The north end of dock **1003***, with railway tracks adjacent, looking south*

3.4.134 On the inside face of the dock, a long length of linked chain was seen to be looped through iron rings attached to the wall face. This was probably used to help moor and guide the boats in the narrow confines. Two iron mooring pins were seen at the surface on either side of the dock walls at the southern end. These are consistent with the findings of the BaRAS evaluation (BaRAS 1995).

3.4.135 The construction of this dock required the excavation of a large area, and the cut for this (***1006***; not illustrated) resulted in the truncation of numerous layers and features on either side, including the earlier basements, ***1071***, ***1073*** and ***1074***. The construction backfill, ***1005*** (not illustrated), contained mixed materials that had been derived from the original deposits. This included significant amounts of glass waste and some pottery.

3.4.136 Associated with the dock, but just post-dating it, is evidence for a railway. The dock allowed the loading and unloading of goods and raw materials and the presence of rail lines laid parallel to it, along the western side, shows that the goods were being immediately loaded onto rail-freight wagons. Two sections of iron lines were seen, ***1007*** and ***1049***, probably part of the same track system. The southern set, ***1007***, were 0.87m apart, but the northern set, ***1049***, were 1.58m apart, and the wooden sleepers were clearly visible beneath this set.

3.4.137 In contrast to ND3 and ND4 there were only two identified drain/culvert features in ND5, which were not contemporary with each other. One, ***1129***, in the eastern part of the site, was aligned north-west/south-east and had been cut by a timber structure. It was constructed entirely of sandstone, and was 0.75m wide and 0.68m high.

3.4.138 The second, ***1044***, to the west of the dock, was aligned north-east/south-west and extended across the width of the excavated site. Its sides were built of brick with sandstone capping stones and it sloped gently downwards towards the river. The feature cut Phase 2 clay extraction pit ***1253*** and early tip layers ***1008-10***.

3.4.139 ***Phase 4:*** on the eastern side of the dock, there were no surviving rail lines, but an intriguing late feature may have been related to the railway. The large feature consisted of a cut, ***1089***, that extended beyond the northern excavation limits. The feature cut into deposits ***1051*** and ***1252*** (not illustrated), thought to be earlier make-up/levelling layers in the area, laid down before the sandstone buildings were constructed. At the base of the cut were several lenses of clinker-rich material alternating with clay deposits, laid in horizontal bands. Above these was a series of north-west/south-east-aligned timbers spaced at 2m intervals, with timber uprights holding them in place. Fixed on to these, using large iron nails, was essentially a raft of contiguous timbers, aligned north-east/south-west (***1090***; Plate 44). The wood appeared to have all been affected and discoloured by a diesel-like substance. The function of the feature is not clear; if it was the bedding for the railway lines shown on the 1850 Ordnance Survey map, then the levels are inconsistent, as the timbers were much lower than the rails on the western side. It is possible that ground conditions were less satisfactory on the eastern side, since this was in the vicinity of the natural inlet, Cuckold's Pill, and the ground may have been prone to flooding or waterlogging. Thus the timbers might have been inserted to provide a more stable ground for the area. Above timber feature ***1090*** were several later deposits that were sealed at the top by a thin skim of tarmac.

Plate 44: Later timber structure **1090***, looking south*

3.4.140 Feature ***1090*** may, alternatively, relate to a later structure shown on the Ordnance Survey mapping as a shed, covering the northern end of the dock and extending some way to the east. The relatively recent date of the features is corroborated from the three concrete pads uncovered beneath timber raft ***1090***, which relate to a further three seen at the northern end of the dock. These may be elements of the shed's foundation.

3.4.141 Dock ***1003*** was in use until the early twentieth century, when the size of boats and increasing use of other forms of transport meant that the dock was no longer viable. It was filled in after 1918 (when it was last depicted on an Ordnance Survey map) with a dark gritty deposit that contained a large proportion of general detritus, such as metalwork, bricks, stone and refuse, probably all deliberately dumped within a short space of time.

3.4.142 By 1918, the area to the west of the dock had been cleared of all buildings and the rail lines were extended through to Avon Wharf. The remains of five circular brick features were uncovered across ND5; three were only half exposed along the northern excavation limit, ***1081***, ***1227*** and ***1249***, and two others, ***1108*** and ***1110***, were found to the south-west (Plate 45). They were all identical, with an annular brick wall enclosing a square brick pillar, both built on a circular base, with a diameter of approximately 4.20m. These features were bases for rotational super-structures, which could be either turntables for railway wagons and engines, or for loading cranes. Several circular features are shown on the 1918 Ordnance Survey map.

Plate 45: Late circular brick structures, looking north-east

3.4.143 There appeared to be a pattern of probable manholes associated with the turntables / crane bases, but it was difficult to determine whether they had been constructed at the same time or afterwards. They were all linked by ceramic pipework.

3.4.144 Several modern features were not recorded as part of the excavation, including the cinder-block foundations seen aligned south-west/north-east on the southern side of the excavation, west of the dock, which corresponded to twentieth-century buildings. A large steel tank, probably for fuel storage, had been dug into the modern make-up deposits below the building.

3.4.145 These more modern layers, which consisted of both imported material and disturbed earlier deposits, covered an extensive area west of the dock. These layers were probably formed during the clearance of the area for the extension of the rail lines and subsequent buildings.

3.4.146 In the extreme north-western corner of ND5 were the remains of a twentieth-century brick building, which were part of the concrete works on the site. A quantity of paperwork relating to orders was recovered from the works, dating to 1964-5 and still legible 40 years later.

4. WATCHING BRIEF SITE: SUMMARY

4.1 INTRODUCTION

4.1.1 As part of the programme of archaeological investigation at Glass Wharf, OA North undertook an archaeological watching brief, which monitored earth-moving activities across an area to the north of Avon Street (designated ND9) and recorded any exposed below-ground remains. The work conducted was consistent with the relevant standards and procedures of the then Institute of Archaeologists (IfA), and generally accepted best practice (IfA 2001b). A separate report has been compiled for this phase of the project, which provides full details of this work (OA North 2016), and, given this, this section presents a summary of the watching brief results.

4.2 RESULTS

4.2.1 The most significant remains uncovered were a sandstone wall (***2024***; Fig 11). This was the same wall identified during an earlier archaeological evaluation (in Trench 6; *Section 2.4.8*; AOC 2004), which probably formed the eastern external wall of a linear building range, part of the mid-nineteenth-century iron-works (Plate 46; *Section 2.4.5*). The wall was over 1.5m deep, 0.8m wide and had been originally dug into the natural mid-brown alluvial clay. It showed two later phases, with an additional stone skin being added on the north-eastern side, and a brick skin, added to the south-western side. The top of the northern part of the wall had been destroyed by later activity. To the west of this was a culvert (***2028***) that may have been a contemporary feature, also uncovered during the earlier evaluation (*Section 2.4.8*).

Plate 46: Sandstone wall **2024***, Area ND9, looking south-west*

4.2.2 Several other structures and deposits were also identified during the watching brief. The structures consisted of brick walls, variously aligned, but, given the nature of the works, their full extent could not be defined. Towards the north-east these included walls ***2001*** and ***2017***, and culvert ***2002***. The corner of a structure, ***2009***, was identified at the eastern limit of the site. This wall was aligned approximately north/south and was seen to return at its northern end. It was evidently the remains of a building, with distinct deposits both within it (***2008***) and outside it, and its position equates with a building range plotted on the 1885 Ordnance Survey map (Fig 11).

4.2.3 Other structures identified by the watching brief included an area of multi-phased brickwork ***2016***. This appears to have formed elements of a brick-built culvert, channelling the Wain Brook towards the River Avon, which had been identified during the earlier evaluation (in Trench 4; *Section 2.4.8*; AOC 2004) and that also abutted an eighteenth-/early nineteenth-century boundary wall (Fig 12; *Section 2.4.2*).

4.2.4 Several deposits (***2015***, ***2019***, and ***2022***) contained glass objects and waste, which suggests that they may have derived from the nearby glass-works. This demonstrates that the debris from glass production was finding its way into the ND9 site, perhaps being deliberately dumped across this area, or being used in other industrial processes. Another deposit (***2023***) contained brown salt-glazed stoneware waste, which may have been ultimately derived from local brown stoneware potteries operating in Bristol during the early nineteenth century (Jackson 2003). Perhaps, again, during this period this material was being deliberately dumped onto the site.

5. POST-EXCAVATION ASSESSMENT

5.1 AIMS AND OBJECTIVES

5.1.1 The principal aim of the post-excavation assessment was to evaluate all classes of archaeological data generated by the excavation, in order to formulate an updated project design for an appropriate programme of analysis. A statement of the significance of the results from each element of the project archive is given below, based on the assessment work undertaken.

5.1.2 The objectives of the assessment were:

- to assess the quantity, provenance and condition of all classes of stratigraphic, artefactual and environmental data;
- to comment on the range and variety of the material;
- to assess the potential of the material to address new research questions raised by the assessment;
- to formulate any further questions arising from the assessment of the excavated data.

5.1.3 This assessment presents:

- a summary of the quantities and potential for analysis of the information recovered for each category of site, finds, dating and environmental data;
- a list of the project aims as revised in the light of the results of fieldwork and post-excavation assessment;
- a list of the methods which will be used to achieve the research aims;
- a list of the personnel involved, indicating their qualifications for the tasks undertaken.

5.1.4 ***Stratigraphic assessment:*** the stratigraphic archive has been examined alongside the artefactual archive and a good level of stratigraphic analysis has been achieved, which has allowed the excavated remains to be placed into several phases.

5.1.5 ***Artefactual Assessment:*** all artefacts have been assessed and a basic record has been compiled. Summaries of the results of the basic assessment quantifications of the artefacts are provided in *Section 5.6*. Detailed assessment reports by the specialists are provided for each category of finds, in which the potential is also considered.

5.2 MATERIAL ASSESSED

5.2.1 The entire paper and material archive was examined for the purposes of this assessment. Quantifications are incorporated within the individual assessments. The method of assessment used varied with the class of information examined, although in each case it was undertaken in accordance with guidance provided by English Heritage (now Historic England) in *Management of Archaeological Projects* (English Heritage 1991a). All classes of finds were examined in full, with observations supplemented by the records generated during the course of the fieldwork; full details of all the finds recovered reside within the project archive. An overview of the paper and digital archive, which forms the primary archive generated on site, is presented in Table 2.

Item	Description	Open-area excavation site			Watching brief site	
		ND3	**ND4**	**ND5**	**ND9**	**Totals**
Contexts	Cuts	83	10	35	0	**128**
	Fills	117	4	41	1	**163**
	Layers	214	12	108	15	**349**
	Structures	355	29	73	11	**468**
	Groups	11	0	1	0	**12**
	Other	36	2	1	0	**39**
	Totals	***816***	***57***	**259**	***28***	***1160***
Plans	Hand-enhanced EDM plots	68	0	1	1	**70**
Sections		26	0	9	2	**37**
	Totals	***94***	***0***	***10***	***3***	***107***
Films	Black and white films	33	1	8	1	**43**
	Exposures on other films	288	115	108	29	**540**
	Total black and white photographs	***1476***	***151***	***396***	***65***	**2088**
	Colour slide films	33	1	8	1	**43**
	Photographs on other films	288	115	108	29	**540**
	Total slide photographs	***1476***	***151***	***396***	***65***	**2088**
	Total number of photographs	***2952***	***302***	***792***	***130***	***4176***
	Digital photographs					***2320***
Folders						**8**

Table 2: Paper archive generated by the excavations

5.3 STRATIGRAPHIC DATA

5.3.1 ***Quantification:*** the site archive contains a total of 1160 contexts. The majority of these originate from the excavations at the open-area excavation site (Areas ND3, ND4, and ND5), with a significant proportion assigned to Areas ND3 and ND5, and relatively few from the other areas. There was a multitude of different types of contextual information, the vast majority of it well-stratified and spatially located.

5.3.2 ***Assessment:*** provisional phasing and chronological development of the key structures has been achieved, and analysis should allow this to be refined further. The large area over which the remains were spread will also mean that the stratigraphy and phasing will need to be compiled on a site-wide basis. The spatial nature of the site, its location, the variety of feature types, and the relatively narrow timeframe for the urban changes, mean that the site is significant not only to the development of Bristol, but to the general development of British cities. The phases as they stand are simplified, and the complex nature of the stratigraphy over a large area, both spatially and temporally, will require sub-divisions and refinement. In particular, further work will be required to refine the phasing of the furnaces and their internal details and alterations, which occupy relatively tight timeframes.

5.3.3 Seven broad phases of activity have been distinguished, both on a temporal and activity-related basis, which means that they are not always temporally exclusive. These are as follows:

- *Phase 1* Pre-glass-works activity up to early eighteenth century
- *Phase 2* Early glass-works early eighteenth century to *c* 1853
- *Phase 3* Amalgamated glass-works *c* 1853 to 1925
- *Phase 4* Post-glass-works activity 1925 to 2005.

5.3.4 The stratigraphic and structural data will provide the framework within which all other analyses will take place. The excavation has allowed a detailed record to be compiled of the archaeological remains across the site to mitigate their ultimate loss during the development. The remains of the amalgamated glass-works are best represented, with the discovery of numerous unusual and significant features, although later features, such as the dock, are of significance. The key to understanding the chronology of these different types of activity, and the development of the urban and commercial landscape, resides within the stratigraphy and the spatial organisation of the site, which can be interpreted through a study of the artefactual and phased stratigraphic records.

5.4 PHOTOGRAPHIC DATA

5.4.1 ***Quantification:*** there are 58 black and white films and 58 colour slide films, forming an archive of 2088 black and white and 2088 colour photographs (Table 2). These cover all of the four excavation areas, although the majority originate from the excavation of Area ND3. There are also approximately 2320 digital photographs (see *Section 5.5*).

5.4.2 ***Assessment:*** the photographs include images of archaeological features and finds, and record how the site was excavated. They will undoubtedly aid the stratigraphic analysis. The photographs could also be integrated with the site database to provide a visual element, which is helpful when dealing with a large corpus of information.

5.5 DIGITAL DATA

5.5.1 ***Quantification:*** the digital archive includes all the raw survey data, and the digital photographic archive (Table 3). There was a total of 43 layers of CAD survey data, which have been assembled on to one main CAD drawing. There is a further layer of data digitised from hand-drawn plans into CAD. These digitised drawings exist in four formats: the initial drawing, which is regarded as part of the paper archive; the raster image produced after scanning the image, which may be in several parts due to the size of the initial drawing; the stand-alone digitised data of the specific plan, which should be a complete representation of the original hand drawing; and the digitised data incorporated into the overall main drawing. The 82 scanned images vary in size from 1700KB to 3870KB.

Item	No files	Size of files (MB)
CAD - *cad*	1	1.8
- *digitised drawings*	N/A	N/A
- *survey*	43	1.9
Database	1	1.4
Image - *photography*	2320	4645
- *scans*	82	164
Spreadsheets	3	0.2

Table 3: Quantification of digital data

5.5.2 In addition, there are also approximately 2320 digital photographs, taken both during the fieldwork, and as part of the post-excavation assessment. These are organised by the date they were downloaded, which was usually once a week, and by the camera set used.

5.5.3 As well as the site photographs, there are also digital photographs taken of finds. These fall into three categories: those taken of large finds that were recorded on site and not retained; those taken of large finds that were recorded on site and were retained; and photographs taken of finds as part of the post-excavation assessment. There is also a fourth category of images, which consists of finds that were scanned directly and are therefore also in .jpg format.

5.5.4 ***Assessment:*** the dataset provides a flexible and adaptable record and resource. It provides part of the baseline data for the recording of the site, in particular the plan of features, and its scrutiny will form an essential component of the analysis.

5.6 INTRODUCTION TO THE ARTEFACTS

5.6.1 The artefactual assemblage recovered during the course of the investigation comprised finds from various material categories, including glass vessels, industrial residues (glass-production waste and cullet), glass-melting crucibles, post-medieval pottery, clay tobacco pipes, metalwork (the majority iron but some copper alloy and lead), animal bone, and leather. The overall assemblage was substantial in size and varied in composition. This material was derived from a variety of excavated contexts, which are listed in *Appendix 1*. An assessment of each class of artefact and environmental evidence is provided in the following sections.

5.7 POST-MEDIEVAL POTTERY

5.7.1 The pottery assemblage from the excavation at Glass Wharf has been examined to assess its potential for further work. The pottery was quantified by sherd count and weight, and the material was scanned to identify the major fabric types present. The fabrics were visually examined using a hand lens (x10) and identified by comparison with the Bristol Pottery Type series held in the Department of Archaeology at the Bristol City Museum. The Bristol Pottery Type series reference number is given where appropriate (*eg* English tin-glazed ware (BPT99)).

5.7.2 Due to the presence of large quantities of kiln waste, there is a considerable bias in the quantification of the assemblage in favour of English tin-glazed ware, English brown salt-glazed stoneware, red ware, and stoneware with the improved glaze patented by Powell in 1835 (*Section 5.7.13*; Wood 2014, 12). In order to provide a more accurate analysis of the pottery assemblage, the kiln-waste material is quantified and discussed separately.

5.7.3 ***Quantification:*** the site produced a total of 6304 sherds of pottery, weighing 436.619kg, from 181 contexts (*Appendix 2*). Excluding kiln waste, there are 1169 sherds of pottery and roof tile.

5.7.4 ***Assessment (excluding kiln waste):*** the excavation produced only one medieval sherd, which was recovered from layer ***3233*** (Phase 2) in Area ND3. This comprised a very abraded fragment from the rim of a Bristol/Redcliffe-ware jug (BPT72).

5.7.5 The earliest post-medieval pottery in the assemblage are two sherds of Cistercian-ware cups (BPT93), from layers ***3227*** (Phase 2; Area ND3) and ***3536*** (Phase 1; Area ND3), possibly from the kiln site at Falfield in south Gloucestershire (Jackson *et al* 1982). These date from the sixteenth to the early seventeenth century. Wares from the South Somerset kilns, especially those at Donyatt (BPT96), began to appear in Bristol during the second half of the sixteenth century and continued well into the seventeenth century (*ibid*). There are 23 sherds of South Somerset ware, including some with white-trailed slip decoration, from 14 contexts (three each from layer ***3005*** (Phase 2; Area ND3), layer ***3212*** (Phase 2; Area ND3), and floor ***3487*** (Phase 3; Area ND3)).

5.7.6 During the seventeenth century, several new wares, including North Devon wares, English tin-glazed ware, Bristol/Staffordshire yellow slip and mottled wares and Staffordshire red ware, were introduced to the region (*ibid*). These all occur in the Glass Wharf assemblage.

5.7.7 In total, 65 sherds of gravel-tempered utilitarian wares and sgraffito decorated plates and dishes made in North Devon (BPT112 and BP108) represent 5.6% of the assemblage. Four or more sherds came from layers ***1041*** (Phase 2; Area ND5), ***3212*** (Phase 2; Area ND3), ***3401*** (Phase 2; Area ND3), ***3407*** (not closely dated; Area ND3), and ***3487*** (Phase 1; Area ND3), and fill ***3245*** (Phase 2; Area ND3).

5.7.8 English tin-glazed wares started to be produced in Brislington, to the north-east of Bristol, and later in the city itself, during the 1640s and 1650s, and production continued into the middle of the eighteenth century (BPT99; 105 sherds; 8.8% of the assemblage; Jackson *et al* 1991). Also produced in Bristol from the middle of the seventeenth century were yellow slipwares (BPT100; 160 sherds; 13.7%) and, towards the end of the seventeenth century, mottled glazed wares (BPT211; six sherds; Jackson *et al* 1982). Both these types of ware were also made in Staffordshire and it is difficult to distinguish between vessels made in Bristol or Staffordshire,

(*ibid*). Typical BPT100 forms are cups decorated with trailed and combed yellow slip, and press-moulded dishes and plates, some with moulded decoration, again decorated with trailed and combed slip, although 'jewelled' slip decoration occasionally occurs. Mottled wares take the form of tankards with a characteristic iron-streaked and speckled brown glaze, usually with lathe-turning just above the base and below the rim. The contexts producing over five sherds of Bristol/Staffordshire yellow slipware were layer ***1041*** (Phase 2; Area ND5), backfill ***1098*** (Phase 2; Area ND5), layer ***3005*** (Phase 2; Area ND3), layer ***3149*** (Phase 1; Area ND3), layer ***3212*** (Phase 2; Area ND3), room ***3386*** (Phase 3; Area ND3), layer ***3487*** (Phase 1; Area ND3), and layer ***3495*** (Phase 3; Area ND3). The assemblage contains five sherds of Staffordshire red ware (BPT109), also known as Metropolitan-type slipware (Barker 1993), all of which are parts of plates or dishes decorated with white-trailed slip on a red ground (layer ***3401*** (Phase 2; Area ND3), fill ***3460*** (Phase 2; Area ND3), and layer ***3607*** (Phase 3; Area ND3)).

5.7.9 The only imported ware in the Glass Wharf assemblage is Westerwald stoneware from the German Rhineland (BPT95; 12 sherds; 1%). The sherds are parts of tankards with cobalt blue- and manganese-painted decoration.

5.7.10 English brown salt-glazed stoneware started to appear on Bristol sites at the end of the seventeenth century and continued into the nineteenth century (BPT277; 40 sherds; 3.4%; Jackson 2003). Some of these wares, which generally comprise bottles and mugs, came from London, but production of salt-glazed stoneware had begun in Bristol by the last decade of the seventeenth century (*ibid*). Five or more sherds of salt-glazed stoneware came from layers ***1000*** (Phase 4; Area ND5), ***2000*** (Phase 4; Area ND9), and ***2015*** (Phase 3; Area ND9). Two sherds appear to be a type of lustrous brown stoneware that was made in Nottingham (BPT212).

5.7.11 Wares that make their appearance in eighteenth-century sites are Staffordshire white salt-glazed stoneware, from about 1700 (BPT179; nine sherds; Sempill 1904); English porcelain, also from about 1700 (BPT203; ten sherds; *ibid*); black basalt ware, from about 1740 (BPT311; one sherd; Jackson *et al* 1982); cream ware, from about 1760 (BPT326; 24 sherds; *ibid*); and pearl ware, from about 1770 (BPT349; three sherds; *ibid*). Cream ware and pearl ware were produced across the river from the Glass Wharf site at the Water Lane Pottery in Temple Back, while black basalt ware was made by the White family, initially at their pottery in Redcross Street, Old Market, and then at Baptist Mills (*ibid*; Pountney 1920).

5.7.12 ***Early Modern Material:*** the end of the eighteenth century saw the introduction of transfer-printed ware (BPT278; 46 sherds; 4%) and other varieties of hand-painted and moulded white china wares (BPT202; 140 sherds; 11.5%). White china wares of all types were made in the Water Lane Pottery (Jackson *et al* 1982), although some of those from Glass Wharf may have come from Staffordshire or other centres of production (Barker 2010). Contexts producing in excess of five sherds of transfer-printed ware or other white china were layers ***1050*** (Phase 4; Area ND5), ***1059*** (Phase 2; Area ND5), and ***3140*** (Phase 3; Area ND3), and wall ***3767*** (Phase 2; Area ND3).

5.7.13 In 1835 the Bristol potter, William Powell, patented an improved stoneware glaze which came to be used universally in the industry (Askey 1981). The assemblage included 134 sherds of this type of ware, which comprise bottles, flagons, jars, barrels and hand- and foot warmers, together with telegraph/electrical insulators (BPT277; 11.5%).

5.7.14 Utilitarian red wares occur throughout the post-medieval and early modern contexts and were the most common wares in the assemblage (BPT201; 186 sherds; 16.9%). They were probably all made in potteries close to the site.

5.7.15 ***Roof tile:*** the excavation produced 150 sherds of red earthenware roof tile, probably mostly made locally from the seventeenth to the nineteenth centuries. The majority show evidence of weathering and an accumulation of dirt deposits, suggesting that they come from demolished buildings. They all conform to Bristol Roof Tile fabric type 13 (type series held in the Department of Archaeology, Bristol City Museum).

5.7.16 ***Miscellaneous:*** in total, 47 sherds either could not be identified to fabric due to their very burnt state or because they were parts of modern, industrially produced, wall tiles.

5.7.17 ***The Kiln Waste:*** the excavation produced 5135 sherds of pottery kiln waste and kiln furniture. The kiln furniture, comprising saggars, kiln bars, separators and kiln bricks, amounted to 327 sherds/fragments. Four types of ware are represented in this kiln material: tin-glazed ware; salt-glazed stoneware; red ware; and stoneware with the improved (post-1835) glaze. By far the most common kiln waste was red ware at 4272 sherds (83% of the kiln assemblage).

5.7.18 ***Tin-glazed Ware:*** there are 145 sherds of waste tin-glazed ware (BPT99) from layers ***1012*** (Phase 2; Area ND5), ***1013*** (Phase 2; Area ND5), ***1021*** (Phase 2; Area ND5), ***1023*** (Phase 2; Area ND5), ***1027*** (Phase 2; Area ND5), ***1028*** (Phase 2; Area ND5), ***1032*** (Phase 2; Area ND5), and ***3140*** (Phase 3; Area ND3), and fills ***1096*** (not closely dated; ND5), ***1126*** (Phase 2; Area ND5), ***1128*** (Phase 2; Area ND5), and ***3001*** (Phase 4; Area ND3). Layer ***1012*** in Area ND5 (Phase 2) produced 118 sherds of waste and was the main kiln dump. It contained solely biscuit ware, vessels once fired but not decorated or glazed. The sherds are all quite small, but fragments of plates, dishes, bowls, tea bowls and drug jars could be identified. There are no fragments of saggars. It is difficult to date this kiln material accurately, as the vessel forms present occur throughout the period of tin-glazed production, from the mid-seventeenth to the mid-eighteenth century.

5.7.19 There were no known tin-glazed earthenware potteries in the vicinity of Glass Wharf or, indeed, anywhere on the north bank of the River Avon. The documented potteries producing this type of ware in Bristol were located in Limekiln Lane, Redcliff Back and Water Lane (Jackson *et al* 1982). The kiln waste must have been taken to the Glass Wharf to be dumped, perhaps from the Water Lane Pottery, which was close by on the opposite bank of the Avon. It is not unusual in Bristol to find waste pottery dumped on low-lying land close to the river, where it seems to have been used, along with other industrial and domestic waste, to stabilise marshy ground prior to development (*ibid*).

5.7.20 ***Brown Salt-glazed Stoneware:*** there are 164 sherds of waste brown salt-glazed stoneware (BPT277), mainly from wall ***1001*** (Phase 2; Area ND5; ten sherds), layers ***1013*** (Phase 2; Area ND5; 36 sherds), ***1053*** (Phase 3; Area ND5; 26 sherds), and ***2023*** (Phase 4; Area ND9; 26 sherds), and fill ***1096*** (not closely dated; Area ND5; 35 sherds). These exhibit faults in production, including blistering of surfaces, fragments of other vessels or pieces of clay adhering to glazed surfaces, and glaze runs over broken edges. Kiln furniture included fragments of bars or girders from wall ***1001*** (Phase 2; Area ND5), layer ***1053*** (Phase 3; Area ND5), and fill ***1096*** **(**not closely dated; Area ND5), and a possible separator from layer ***1038*** (Phase 2; Area ND5).

5.7.21 The vessel forms are flagons or bottles, with a dark brown glaze to the upper part of the body and with a grey or light brown glaze below. Two of the flagons have impressed marks giving the names of the spirit merchants who were the intended customers, although the marks are too fragmentary to identify them (layer ***1013*** (Phase 2; Area ND5) and fill ***1096*** (not closely dated; Area ND5)). The use of impressed lettering would suggest a date no earlier than the later eighteenth century for their manufacture (Noël Hume 1969).

5.7.22 There were several brown stoneware potteries operating in Bristol during this period but one in Cheese Lane/Avon Street, described in 1819 in Felix Farley's *Bristol Journal*, utilised a glasshouse, within which were two large kilns, along with turning and drying rooms (Pountney 1920). This pottery was located next to Ricketts & Co glass-works (*Section 2.3.5*), suggesting that it was either on or immediately adjacent to Glass Wharf. The pottery operated from at least 1815 until 1836 under the proprietors Colston and Pearce, George Cox and Edward Melsom and Company (*ibid*), and it seems likely that this was the origin of the salt-glazed stoneware waste.

5.7.23 ***Red Ware:*** there are 4272 sherds of waste red ware (BPT201) from numerous contexts, the majority coming from layers ***1008*** (Phase 4; Area ND5; 229 sherds), ***1010*** (Phase 2; Area ND5; 90 sherds), ***1011*** (Phase 2; Area ND5; 153 sherds), ***1050*** (Phase 4; Area ND5; 71 sherds), and ***1191*** (Phase 2; Area ND5; 173 sherds); fills ***1068*** (Phase 2; Area ND5; 283 sherds), ***1126*** (Phase 2; Area ND5; 210 sherds), ***1127*** (Phase 2; Area ND5; 296 sherds), ***1128*** (Phase 2; Area ND5; 1113 sherds), and ***1145*** (Phase 2; Area ND5; 252 sherds); backfill ***1098*** (Phase 2; Area ND5; 161 sherds); and deposits ***1102*** (Phase 2; Area ND5; 136 sherds), ***1103*** (Phase 2; Area ND5; 158 sherds), and ***1105*** (Phase 2; Area ND5; 106 sherds). Many sherds show signs of damage in the kiln, mainly caused by over-firing, which led to warping and splitting of the vessels, blistering and bubbling of the glaze, glaze runs over the broken edges of sherds, and the alteration of the usual red fabric to dark grey or black. There is no evidence of saggars having been used in the kiln but this was apparently not unusual in red-ware kilns, where vessels were stacked on top of each other and larger vessels were inverted over smaller ones to provide protection (McGarva 2000, 98). However, there are many fragments of roof tile which had been used as separators or shelves in the kiln, as many have glaze runs on their surfaces and scars showing where vessels had adhered to them during firing.

5.7.24 A wide range of utilitarian vessels were produced, including pancheons, pans, bowls, bread crocks, skillets, dishes, plates, jugs, jars, colanders and lids, all with a glaze ranging in colour from green to brown. Vessels with at least one projecting ridge running internally around their circumference occur throughout the kiln waste and clearly had a specialised use. A similar internal ridge was noted on a vessel from the Donyatt kilns, but its purpose could not be determined (Coleman-Smith and Pearson 1988, fig 132, no 14/45). There are also sugar moulds and other sugar-refining vessels, characterised by a thin internal wash of white slip. Flowerpots, garden urns and seed pans are common. Some of the flowerpots have a central drainage hole in the base but several have at least one hole in the side above the base. Curry (1993, 238) suggests that the transition from holes in the sides of flowerpots to a central hole in the base occurred in the eighteenth century.

5.7.25 Although the red-ware waste came from several different archaeological contexts, the results of the assessment suggest that most, if not all, is from the same production source and has a fairly narrow date range. For example, sherds from the type of

vessel with the unusual internal ridge occur throughout the contexts containing the red-ware waste.

5.7.26 Two red-ware potteries are known to have been operating in the St Philip's area of Bristol during the later eighteenth century and through the early nineteenth century. One of these, established by Joseph Hill in Avon Street by 1770, produced sugar moulds, garden and chimney pots (Jackson *et al* 1982). This continued after 1797 in the ownership of Henry Yabbicom until 1840, when production moved to Temple Back, although the type of pottery produced changed to brown stoneware after 1812 (Pountney 1920). Another red-ware pottery in Avon Street was that owned by Samuel Sheppard, who produced red-glazed ware, chimney and garden pots from *c* 1801 until 1829, when the concern was taken over by Jonathon Flood until its closure in 1834 (*ibid*).

5.7.27 The occasional sherds of tin-glazed ware amongst the red-ware waste, cream ware, and Staffordshire white salt-glazed stoneware would suggest that it was deposited during the eighteenth century, and probably after about 1760. As sugar moulds, other sugar-refining vessels and flowerpots occur in the waste group, it seems likely that the waste came from the Joseph Hill/Henry Yabbicom pottery in Avon Street (*ibid*).

5.7.28 ***Stoneware with Powell's Improved Glaze:*** there are 227 sherds of stoneware kiln waste with the improved glaze which was patented by Powell in 1835 (*Section 5.7.13*). These come mainly from backfill ***3001*** (Phase 4; Area ND3; 53 sherds), demolition material ***3130***/***3131*** (Phase 4; Area ND3; 101 sherds), and layer ***3140*** (Phase 3; Area ND3; 66 sherds). There are several fragments of stoneware saggars, with holes cut in their sides and covered in a thick grey glaze, from backfill ***3001*** (Phase 4; Area ND3) and layer ***3140*** (Phase 3; Area ND3).

5.7.29 The vessel forms are mainly mineral-water/ginger-beer bottles, blacking bottles, barrels, flagons, jars and hot-water bottles. The oval impressed mark 'PRICE BRISTOL' occurs frequently, especially on the bottles, and transfer-printed or rubber-stamped marks refer to the firms Price was supplying: for example Brooke and Prudencio in Bristol; the Standard Soda Water Company in Yarmouth, Nova Scotia; J & RJ Alabaster, London; L Carter, Abergavenny; Albio…, Johannesburg; G & W Buswell, Ironmonger, Torquay; and 'Schwep..' (presumably Schweppes founded in 1783; Orangina Schweppes International nd).

5.7.30 The frequently occurring 'Price' mark shows that this stoneware waste was manufactured in the pottery owned by the Price family which had operated in St Thomas Street and Temple Street in Bristol from the late eighteenth century, and continued in production until the 1940s (Pountney 1920). The type of vessels produced, the use of transfer-printed or rubber-stamped marks (especially that of Brooke and Prudencio, who were not established in Bristol until 1890; Jackson *et al* 1982) and the occurrence in layer ***3140*** (Phase 3; Area ND3) of a sherd stamped 'Lovatt & Lovatt Ltd', who opened a pottery in Nottinghamshire in 1895 (Grace's Guide Ltd 2013), all suggest a very late nineteenth- or early twentieth-century date for the deposition of this waste.

5.7.31 The types of ware and the vessel forms present are typical of those from post-medieval and early modern assemblages found in the city. More complete examples of the vessels present in the assemblage have already been published, for example in Jackson 2006. However, the red-ware kiln waste assemblage from Area ND5 (*Section 5.7.23*) is large and there are many different types of vessel forms represented, including some that are unusual, and these provide a good cross-section

of the wares produced by a late eighteenth-century red-ware pottery. Although there were several red-ware potteries operating in Bristol during the eighteenth and nineteenth centuries, the only group of kiln waste so far published contained a limited number of forms and was late nineteenth century in date (Jackson 2000a). The waste from the present excavation was produced in the late eighteenth century, and almost certainly by the pottery run by Hill and Yabbicom, which is well documented from contemporary sources (Jackson *et al* 1982). The assemblage is therefore considered to be of regional interest and to have some research potential.

5.8 CLAY TOBACCO PIPE

5.8.1 The clay tobacco pipe assemblage was examined to assess its archaeological potential. In considering this, due regard was given to the needs of site interpretation and dating, and to similar material already studied and published locally and nationally.

5.8.2 ***Methodology:*** where possible, the pipes have been dated by the use of the general bowl typology developed by Oswald (1975), which has been refined by further research into pipe production in Bristol (Jackson and Price 1974). A relatively close date for the manufacture of a particular pipe can be achieved by this method. However, where a large part of the bowl is missing or its typology cannot be determined, then only a wide date range, or perhaps no date at all, can be given.

5.8.3 The position, type and style of a pipe-maker's mark are often indicative of a likely date and place of manufacture. It is then possible to assign the initials or full name on the mark to a particular pipe maker whose working dates have been determined by documentary research. Most of the pipes found at Glass Wharf were made in Bristol and the pipe makers working in the city have been extensively researched (Jackson and Price 1974).

5.8.4 No attempt has been made to date the pipes using the stem-bore diameter formula developed by Harrington and Binford (*cf* Binford 1978). That dating method requires a very large assemblage of pipes and it has also been demonstrated to be inaccurate, especially for pipes made during the seventeenth and nineteenth centuries (Noël Hume 1982, 121-2).

5.8.5 ***Quantification:*** there are 1046 fragments of clay pipe from 105 contexts, 112 of which are pipe bowls or bowl fragments, although 50 bowl fragments are too small to be dated. The remaining 934 fragments are pipe stems and none of these are marked or decorated. The pipe fragments are quantified, described, dated and listed by context in *Appendix 3*.

5.8.6 The clay pipes span the period from the mid-seventeenth century to the late nineteenth, or possibly even the early twentieth, century. The majority, however, date to the late seventeenth/early eighteenth centuries.

5.8.7 ***The Bowl Typology and Makers' Marks:*** Bristol was a major centre for the manufacture of clay tobacco pipes (Jackson and Price 1974) and it is not surprising that all but one of the identifiable pipes had bowl forms typical of those produced in the city. Marked pipes made by the following Bristol pipe makers are represented in the assemblage: John Abbott (layer ***1052***; Phase 3; Area ND5); Nathaniel Chilton (fill ***1068***; Phase 2; Area ND5); Henry Edwards (layer ***3400***; Phase 3; Area ND3); William Evans II (layer ***1000***; Phase 4; Area ND5); John Harvey I or II (layer ***1000***; Phase 4; Area ND5); Henry Hoar (layer ***3005***; Phase 2; Area ND3); James Jenkins (backfill ***3001*** (Phase 4) and fill ***3407*** (not closely dated); Area ND3); Thomas Owen

(layer ***3212***; Phase 2; Area ND3); and Robert Tippett II (layer ***3149***; Phase 1; Area ND3). Material produced outside the region includes a pipe bowl from layer ***3508*** (Phase 3; Area ND3), which has a tailed heel and a form that is characteristic of those made in Broseley, Shropshire, in the late seventeenth/early eighteenth century (Atkinson 1975, fig 1.5).

5.8.8 The assemblage contained five late nineteenth-/early twentieth-century pipes with decorated bowls: paired leaves on either side of the front and rear mould lines; an imitation briar type; 'basket-weave' decoration; and one with elaborate moulding. These bowl forms and types of decoration commonly occur on pipes made throughout the United Kingdom during the nineteenth and early twentieth centuries, and Bristol pipe makers are known to have been making similar examples (Insole and Jackson 2000, fig 5.33). Indeed, all the bowl forms and marks are already recorded from the city (*eg* Jackson and Price 1974; Jackson 2000b; Jackson 2006).

5.9 FERROUS AND OTHER METALWORK

5.9.1 ***Quantification:*** metalwork from the site comprised 211 objects of iron or steel, 21 objects of copper alloy, and three objects of lead, all of which were recovered from Area ND3. Most of the metalwork was in good condition, and in consequence no x-radiography was regarded as necessary at this stage in the project. Many of the objects were relatively large.

5.9.2 ***Methodology:*** this assessment was undertaken in accordance with guidance provided by English Heritage (1991a). Assessment was based on the visual inspection of all individual objects; an outline database was created using Microsoft Access. Data were recorded in a standardised format, noting provenance, type of object, material, period. The database will form the basis for any further work, or will comprise the archive record, as appropriate.

5.9.3 ***Assessment:*** a considerable proportion of the ironwork (132 fragments; 62.5% of the assemblage) from the site comprised fragments of larger objects, which are unlikely to be identified, but include small fragments of sheet metal, straps, bars, rods and drawn wire.

5.9.4 Several objects can be identified as fixtures and fittings deriving from buildings on the site. A single shelf bracket came from floor ***3030*** (Phase 3; Area ND3), five chain links from fill ***3023*** (Phase 3; Area ND3), two loops (from fill ***3505*** (Phase 3) and fill ***3738*** (Phase 3); Area ND3) and a looped pin from layer ***3351*** (Phase 3; Area ND3). Three large fragments of iron pipe were from fill ***3706*** (Phase 3; Area ND3). In addition, 34 nails and eight bolts were identified. There were no particular concentrations amongst the nails, nor any unusual forms, suggesting that all were from woodwork within buildings on the site.

5.9.5 Most of the remainder were modern tools, including spanners, which presumably derive from late activity on the site, buckets and bucket handles, tins and other iron or steel vessels, again reflecting late activity. There were, in addition, a modern teaspoon from layer ***3707*** (Phase 4; Area ND3), knives from layers ***3029*** (Phase 3; Area ND3) and ***3553*** (Phase 2; Area ND3), and keys from layers ***3008*** (Phase 2; Area ND3) and ***3012*** (Phase 3; Area ND3).

5.9.6 Of the 21 objects of copper or copper alloy, seven were fragments of wire (from wall ***3016*** (Phase 3), drain ***3045*** (Phase 3), fill ***3075*** (Phase 3), and fill ***3505*** (Phase 3); Area ND3), some associated with recent electrical fittings, and two (fills ***3041*** (Phase 4) and ***3505*** (Phase 3); Area ND3) were small fragments of sheet. A large buoy was

unstratified. The remaining copper-alloy objects fall into no particular groups and range from a modern dessert spoon from fill ***3786*** (Phase 3; Area ND3) and a small buckle from fill ***3037*** (Phase 4; Area ND3), to a single rivet from fill ***3023*** (Phase 3; Area ND3) and a door knob from layer ***3140*** (Phase 3; Area ND3).

5.9.7 Only three objects of lead were recovered, one of sheet from fill ***3041*** (Phase 4; Area ND3), a large and now distorted washer, also from fill ***3041*** (Phase 4; Area ND3), and a smaller ring or washer from backfill ***3001*** (Phase 4; Area ND3).

5.10 GLASS

5.10.1 This assessment follows MAP2/MoRPHE procedures described by English Heritage (1991a; 2006). The aims are to summarise the nature of the excavated material and assess the potential for analysis. This assessment summarises the nature of the excavated material based on:

- a visual examination of all material;
- the processing of five random soil samples;
- the chemical analysis of selected samples.

5.10.2 The material submitted consists of bags of glass (and other materials assumed to be related to glass-working) identified and collected on site, as well as sediment samples taken with the explicit aim of recovering evidence for glass-working, which is often too small to be recognised during fieldwork (*eg* threads). These bags of material were all opened during the assessment and a note made of the presence of different sorts of glass and other materials (*cf* Dungworth 2003; 2005). The main categories recorded are:

- crucible;
- glass bottles;
- other blown-glass artefacts;
- flat glass;
- glass lumps;
- glass threads, pulls, *etc*;
- opalescent glass waste;
- clinker.

5.10.3 Glass materials were divided into three main colour categories (although it is recognised that the apparent colour of glass is strongly affected by the thickness of the piece being examined):

- colourless;
- pale green;
- dark green.

In addition, small quantities of other colours (*eg* brown) were identified, but these appear to have come only from contexts which post-date the end of the glass-works in the early twentieth century.

5.10.4 In some cases, the glass-working materials recovered from the site are actually hybrids of two or more of the categories outlined above — the most extreme, but quite common, case being lumps of glass which were partially opalescent with adhering clinker. The examination of all of the hand-recovered material aimed to

assess the potential of this material to provide a basis for a more detailed understanding of the processes used in glass manufacture on this site.

5.10.5 Five sediment samples were selected at random and processed in the same way as samples from Silkstone (Dungworth 2003). The samples were wet sieved, and the >2mm fraction retained. The residue was allowed to dry and was sorted by hand into the categories described above. The sorted residues were examined, both in their own right and in relation to the hand-recovered materials to assess the potential of such samples.

5.10.6 The visual examination of material (both hand-recovered and those from soil samples) was supplemented by the qualitative chemical analysis of both common and rare examples. This qualitative chemical analysis was carried out using an energy dispersive X-ray fluorescence spectrometer (EDXRF). This enabled the identification of broad glass types, such as mixed alkali, high-lime low-alkali (HLLA), lead-potash and soda-lime.

5.10.7 ***Quantification:*** glass and glass-working materials were recovered from 168 contexts, of which 17 also provided soil samples. Soils samples were also taken from a further 26 contexts, which did not produce separately recorded glass or glass-working materials. In total, 403kg of glass and materials related to glass-working were recovered (not including that from the soil samples). At this stage no attempt has been made to provide a catalogue or fully quantified breakdown of each material type by context.

5.10.8 ***Assessment:*** ***Clinker:*** this is the vitrified ash of coal (*ibid*), formed whenever coal with a significant ash content is burnt at sufficiently high temperatures. The temperature required to vitrify coal ash varies, depending on the chemical composition of the ash as well as oxidising-reducing conditions. Coal ashes can begin to vitrify at temperatures as low as 800ºC or as high as 1000ºC. Clinker is formed whenever the right conditions are satisfied and its formation is not usually associated with any particular industrial process (Nicholls and Selvig 1932). Clinker is often found on sites where coal was used to heat furnaces for copper smelting or glass melting, but it can also be found associated with steam engines and even in domestic contexts. Some of the fragments of clinker from Glass Wharf contain regions of devitrified glass and/or opalescent waste (Plate 47). Clinker is one of the most common materials recovered from the archaeological excavations at Temple Quay but it has the lowest potential to provide detailed technical information about the glass-works.

Plate 47: Clinker (vitrified coal ash)

5.10.9 ***Opalescent waste:*** opalescent waste is a vitreous glass-working waste, which is present in various colours from cream to pale blue (referred to as opaque cream blue waste in previous reports; *ibid*). Opalescent waste often displays dichroism: it is pale blue in reflected light but brown in transmitted light (Plate 48). The colour (and dichroism) is produced by the separation of the glass into two separate compositions due to the existence of immiscibility gaps within many divalent silicate systems. The immiscibility gives rise to the separation of sub-micron-sized droplets which are responsible for the colour effects. Opalescent waste appears to form when glass is held at elevated temperatures (the exact temperature range at which immiscibility and micro-phase formation occur would depend on the composition of the glass) for long periods of time. Opalescent waste appears to be almost exclusively associated with high-lime low-alkali glass used in the seventeenth and eighteenth centuries for the manufacture of bottle glass (*ibid*); high-lime low-alkali (HLLA) glass contains high levels of oxides which display silica immiscibility gaps. Opalescent waste has been analysed from several seventeenth- and eighteenth-century sites, including Silkstone (*ibid*) and Bedminster (Blakelock 2007). In some cases, it shares the same chemical composition as the bottle glass and dark green glass waste from the same site, but in others it contains elevated levels of elements found in crucibles and/or clinker (*eg* aluminium and titanium). It is not uncommon for vitreous masses of opalescent waste to have portions with clear devitrification/crystallisation. It is believed that most opalescent waste forms when glass is spilt into the fire trench of a furnace, where it could remain at elevated temperatures for several months. Opalescent waste is likely to have been more difficult to melt than single-phase glass of the same composition, and such waste would probably have been discarded by glass-makers as useless.

Plate 48: Opalescent glass-working waste

5.10.10 Amorphous lumps of opalescent waste have relatively little potential to provide technical information about glass-working, although opalescence can be seen in some bottle wasters (*cf* Dungworth 2005). Such vessels have chemical compositions that are close to other glass-working waste from the same site and are an excellent indicator of the chemical composition of the glass manufactured.

5.10.11 ***Devitrified waste:*** glass is a material which lacks crystalline phases due to the fast cooling from a liquid to a solid state. Nevertheless, the same material is more stable in a crystalline form than in the glassy state (Plate 49). Glasses which are heated will tend to form crystals and the rate of crystallisation is proportional to temperature. The formation of crystals in glass (usually referred to as devitrification) is particularly inconvenient for the glass-maker, as it is more difficult to melt than glass which has no crystals, and so it would probably be discarded. The possible relationships between opalescent waste and devitrified waste are not clear. It is known from modern studies of glass-ceramics that the sorts of micro-phase separation seen in opalescent waste are often a precursor to the formation of crystals, although not all crystallisation requires micro-phase separation. Devitrified waste is likely to have formed under similar conditions, and under similar circumstances, as those responsible for opalescent waste, although, it is likely that, after extended periods of time, most opalescent waste would become devitrified.

Plate 49: Devitrified glass waste

5.10.12 ***Crucible:*** crucibles are the ceramic containers used for melting glass. They were made from highly refractory clays which could withstand high temperatures (Dodsworth 1982). Glass-melting crucibles from coal-fired furnaces usually have outer phases with a black or dark maroon 'glaze' formed by the action of coal ash, which is rich in silicon, aluminium, iron and potassium (*ibid*). The inner surfaces of these crucibles usually have layers of glass adhering to them (Plate 50). Where such layers are less than 1mm thick, the adhering glass is usually contaminated by glass-crucible interaction and is not a good indicator of the composition of the glass manufactured. Layers thicker than 1mm can provide a good indicator of the chemical composition of the glass manufactured.

Plate 50: Fragment of crucible adhering to opalescent waste

5.10.13 ***Furnace brick:*** these are the remains of the superstructure of a brick-built furnace, usually identified by the fact that one or more surface is heavily vitrified, and on occasion eroded. Like the crucibles, these vitrified bricks may have a dark-coloured, coal-ash glaze or adhering glass. Glass adhering to bricks may be glass which has spilt from crucibles, or may have formed as a result of reactions between volatile elements (especially alkalis) and bricks. Indeed, the use of a fritting stage, in which raw materials were partially reacted at relatively low temperatures prior to melting, was often used to prevent the excessive volatilisation of alkalis (Parkes 1823, 193-4). Furnace bricks have great potential to provide detailed information about furnace working conditions, but only when they have been recovered *in-situ*. All of the bricks assessed from Glass Wharf lack such precise provenance, and so have somewhat reduced potential to provide information about the working conditions of the furnace.

5.10.14 ***Dark green glass waste:*** dark green glass waste occurred in many different forms, from tiny threads with diameters less than 1mm to large blocks (0.5 x 0.2 x 0.2m; Plate 51). The qualitative EDXRF analysis of samples of dark green glass from a range of contexts indicates that it is always an HLLA glass (*Section 5.10.6*). The more detailed (but still qualitative) EDXRF analyses of samples from the five selected sediment samples indicate that several compositionally distinct HLLA glasses were manufactured. Some examples of dark green glass waste may not share the same chemical composition as the glass manufactured, due to contamination by coal ash and/or crucible. Contamination by either of these materials will tend to increase the iron and aluminium content of the glass waste and therefore enhance its dark green colour.

Plate 51: Large chunk of dark green glass waste

5.10.15 ***Green glass waste:*** green glass waste also occurs in many different forms and sizes. Qualitative EDXRF analysis indicates the use of HLLA, mixed alkali (kelp) and soda-lime glass. The latter glass is likely to have been made using relatively pure raw materials (in particular soda) after the abolition of the taxation and regulation

of the glass industry in 1845 (Dungworth 2012). It is not clear whether all green glass waste represents glass prepared for the manufacture of bottles or whether some has been contaminated by reactions with coal ash and/or crucibles.

5.10.16 ***Pale green glass waste:*** pale green glass waste also occurs in many different forms and sizes (Plate 52). Qualitative EDXRF analysis indicates that some of the pale green glass is a soda-lime glass. This glass is likely to have been made using relatively pure raw materials (in particular soda) after the abolition of the taxation and regulation of the glass industry in 1845 (*ibid*). It is not clear whether all pale green glass waste represents glass prepared for the manufacture of bottles, or whether some has been contaminated by reactions with coal ash and/or crucibles. Other samples of the pale green glass waste are mixed alkali glass with a strontium content indicating the use of seaweed ash (kelp) as a flux.

Plate 52: Pale green glass waste

5.10.17 ***Colourless glass waste:*** colourless glass waste tends to occur as relatively small lumps and threads of glass, with no examples of the large blocks of glass seen in various shades of green. The qualitative EDXRF analysis of examples of colourless glass waste indicates that it is usually a soda-lime glass made using relatively pure raw materials (in particular soda). Colourless glass would not have been used for the manufacture of glass bottles before the removal of the taxation on glass manufacture in 1845 (*ibid*).

5.10.18 ***Dark green bottle glass:*** a wide range and large number of dark green bottles are present in the assemblage. A few examples are free-blown onion-shaped bottles that were probably produced in the late seventeenth or early eighteenth century (*ibid*). A variety of later cylindrical types are present, some of which are relatively simple and were probably blown into two-part moulds, while others have complex moulded decoration, such as in makers' marks and trade names, and were probably made in three-part moulds (*ibid*).

5.10.19 ***Green bottles:*** these form a smaller but still significant proportion of the assemblage of bottle glass. This glass falls into two categories: a green glass with slightly yellow or brown colour, which is mostly present in forms typical of the eighteenth

century; and a slightly blue-green glass, which is mostly represented by vessels made in the nineteenth century using open and shut moulds (*ibid*).

5.10.20 ***Pale green bottles:*** pale green bottle glass is present almost exclusively in forms which indicate its use after the development of the three-part mould. In some cases, the form of the bottle is typical of forms developed in the late nineteenth century (*eg* Codd and Hamilton; *ibid*). Pale green glass is also well represented amongst tapering cylindrical and spherical stoppers. The stoppers were manufactured after the adoption of press-moulding and many examples display prominent mould seams, indicating that they were never finished or used.

5.10.21 ***Colourless bottles:*** colourless bottles are present in substantial numbers in the assemblage, but always in forms which indicate that they were manufactured after the development of the three-part mould. The colourless glass bottle can also be assumed to have been produced after the removal of taxation and associated restrictions on glass production in 1845 (*ibid*).

5.10.22 ***Brown bottles:*** these bottles are found in relatively small numbers, and in many cases the bottles are so dark that it is not clear if they form a distinct category from the dark green bottles.

5.10.23 ***Window glass:*** *w*indow glass is present in small quantities in a wide range of contexts. In some cases, the distinction between small fragments of window glass and small fragments of square moulded colourless bottles is not possible. Many later contexts have provided examples of rolled plate glass (patented in 1847) or wire-reinforced rolled glass (invented in 1855 but not commercially produced until 1898; McGrath and Frost 1937, 42).

5.10.24 ***Eighteenth-century bottles:*** glass bottles manufactured in the eighteenth century very rarely carried moulded decoration. The eighteenth-century bottles recognised in the assemblage include free-blown onion bottles of the late seventeenth or early eighteenth century, as well as cylindrical forms probably produced using dip moulds (Dungworth 2012).

5.10.25 ***Powell & Ricketts bottles:*** large numbers of the glass bottles have moulded decoration on the base, which indicates that they were produced by Powell and Ricketts. The letters present are not all the same, but the most common is 'P & R B' (Powell & Ricketts Bottles). The use of these letters indicates bottles manufactured after 1853, when the partnership of Powell & Ricketts was formed, although, the company continued to trade under this name until the 1920s, even though Ricketts died in 1856 (*Section 2.3.14*). In one case, the name Powell and not Ricketts is present, which indicates that the bottle was manufactured between 1828 and 1853 (*Section 2.3.13*).

5.10.26 ***Processing and examination of selected sediment samples:*** the >2mm fraction of Sample <1>, layer ***1026*** (Phase 2; Area ND5), contained dark green glass-working waste, a single fragment of crucible, and a large proportion of clinker. Qualitative EDXRF analysis indicates that most of the dark green glass is an HLLA glass, with minor but significant amounts of phosphorus (perhaps 1.5wt% P2O5). A small amount of the dark green glass has a markedly different chemical composition: it is essentially an aluminium-calcium-silicate, and is likely to be blast furnace slag. There are no known blast furnaces in the immediate neighbourhood of Bristol, but blast furnace slag (probably from the Forest of Dean) was used in the manufacture of bottle glass in Bristol during the eighteenth century (Berg and Berg 2001).

5.10.27 The >2mm fraction of sample <14>, fill ***1219*** (Phase 2; Area ND5), contained dark green glass-working waste, numerous fragments of pale green flat glass, and a large proportion of clinker. Qualitative EDXRF analysis indicates that both the dark green glass waste and the pale green flat glass are mixed alkali glasses with a strontium content sufficiently high (>0.2wt%SrO) to indicate the use of kelp. The dark green waste contains elevated concentrations of aluminium, iron, potassium and titanium. These elements are likely to derive from contamination by reactions with coal ash and/or crucible fabric. Kelp-fluxed glass was used for the manufacture of tablewares, but was probably principally used for window glass (Dungworth 2006; 2007; Jackson 2005). The presence of flat glass in the retained fraction supports the tentative conclusion that this context contains evidence for the manufacture of window glass. Window-glass manufacture is known to have been carried out in the early part of the eighteenth century, but it is not clear exactly when its manufacture ceased (McGrath and Frost 1937).

5.10.28 The >2mm fraction of sample <17>, layer ***3119*** (Phase 2; Area ND3), contained dark green glass-working waste and large quantities of clinker and opalescent waste. EDXRF analysis of the green glass-working waste indicates the presence of two separate types of glass. The first is a conventional HLLA glass which has a composition slightly different from that in sample <1> (it contains slightly more calcium, phosphorus and iron), but the second appears to have no parallels among previous analyses of bottle glass. This second glass is characterised by low levels of calcium (<5wt% CaO) and high levels of iron (>5wt% Fe_2O_3) and might be regarded as simply HLLA glass that has been altered by reaction with coal ash and/or crucible, except that a fragment of a bottle shared the same composition.

5.10.29 Sample <24>, layer ***3147*** (Phase 3a; Area ND3), consists of coarse beige yellow sand which contains no other glass or glass-working waste. The sample was sieved using a succession of sieves and each fraction was weighed to determine the particle size distribution (Plate 53). This shows that the sand contains a large proportion of very coarse material compared to good glass-making sands, and would not have been suitable as a raw material in the manufacture of glass. EDXRF analysis indicates that this sand also contains minor amounts of zinc, lead and arsenic. It is not clear at this stage what role this sand may have played in any industrial use.

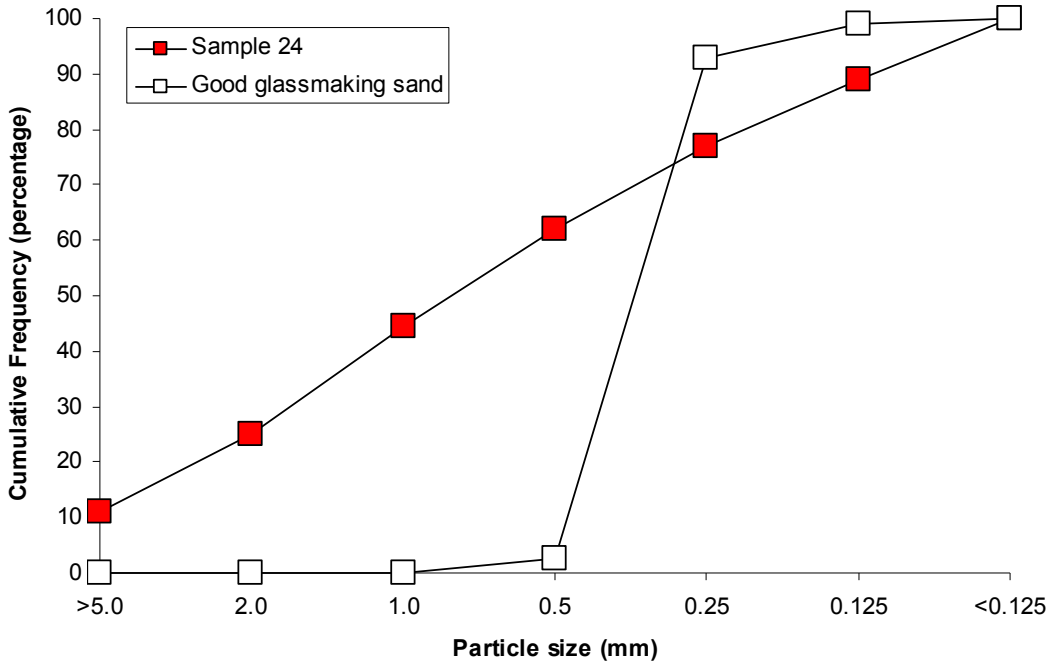


Plate 53: Particle size distribution for sample <24>, compared with a good glass-making sand (Kings Lynn, source Boswell 1918)

5.10.30 The >2mm fraction of sample <25>, layer ***3160*** (Phase 4; Area ND3), contained dark green glass-working waste, pale green droplets and threads, and clinker. EDXRF analysis of the glass-working waste indicates that both the dark green and the pale green glass-working waste are mixed alkali glasses. The only significant compositional differences between the dark and pale green glass are that the former contains higher concentrations of aluminium, potassium, titanium and iron. It is likely that these elements derive from contamination of the mixed alkali glass by coal ash and/or crucible. The same mixed alkali glass was also detected adhering to a fragment of crucible, in several fragments of flat (window?) glass, and in a fragment of opaque white-decorated tableware. All of the mixed alkali glass contains relatively high levels of strontium (>0.2wt% SrO), indicating the use of seaweed ash as a flux.

5.10.31 The >2mm fraction of sample <47>, layer ***3005*** (Phase 2; Area ND3), contained dark green glass-working waste, opalescent waste (including a bottle fragment), and large quantities of clinker. EDXRF shows that the glass-working waste (including the opalescent waste) shares the same chemical composition as that in sample <17>.

5.10.32 ***Chronological distribution of material:*** a wide range of glass and materials related to glass-working was identified from 64 different contexts assigned to Phase 2 (*c* 1715–*c* 1870). The materials with the highest potential for analysis include glass waste (various colours), crucible, and bottles (including several bottle wasters; Table 4).

Material	Number of contexts
Clinker	23
Opalescent Waste	20
Devitrified Waste	1
Crucible	1
Furnace Brick	2
Dark Green Glass Waste	10
Green Glass Waste	3
Pale Green Glass Waste	4
Colourless Glass Waste	1
Dark Green Bottles	31
Green Bottles	3
Pale Green Bottles	16
Colourless Bottles	6
Brown Bottles	1
Window Glass	0
Pre-1825 Bottles	12
Powell & Ricketts Bottles	6

Table 4: Types of materials and number of Phase 2 contexts with these present

5.10.33 Phase 2 covers several significant changes in the technologies employed in the glass-works. The use of colourless glass for the manufacture of bottles is unlikely to have been used prior to the removal of the restrictions of bottle glass manufacture in 1845 (Dungworth 2012), and hence the manufacture of glass bottles may provide chronologically useful information. Fill ***4031*** of a well in Area ND4 contained colourless bottles and bottle wasters, and so probably dates to after 1845. Six contexts (layers ***3205*** (Phase 2), ***3227*** (Phase 2), ***3243*** (Phase 2), ***3349*** (Phase 2), and ***3503*** (Phase 2), floor ***3507*** (Phase 2), and fill ***3633*** (Phase 2); Area ND3) contained bottles which have the letters 'P & R' moulded on their undersides, indicating that they were produced by the firm of Powell & Ricketts, which was formed in 1851 (*Section 2.3.14*). Fill ***3207*** (Phase 3 or 4; Area ND3) contained colourless bottles, with moulded lettering identifying them as used by Bristol Dairies; this fill is unlikely to have been deposited prior to the twentieth century (*cf* Douglas and Frank 1972, 170–1). Despite the absence of window glass among the hand-recovered material from Phase 2 contexts, the examination of samples <14> and <25> indicates the production of mixed alkali window glass using seaweed ash during at least part of Phase 2 (probably the early part of the eighteenth century).

5.10.34A wide range of glass and materials related to glass-working was identified from 81 different contexts assigned to Phases 3, 3a or 3b (*c* 1870–*c* 1920), covering the period from the installation of the Siemen's regenerator to the closure of Powell & Ricketts in 1923 (*Sections 2.3.14* and *2.3.19*; Table 5). Fill ***3695*** (Phase 3; Area ND3) contains wire-reinforced rolled glass, and so was probably deposited after 1898 (*Section 5.10.23*). The materials with the highest potential for analysis include glass waste (various colours), crucible, and bottles (including many bottle wasters).

Material	Phase 3 (50)	Phase 3a (10)	Phase 3b (21)	All (81)
Clinker	6	0	1	7
Opalescent Waste	8	3	3	14
Devitrified Waste	6	0	2	8
Crucible	0	0	0	0
Furnace Brick	4	0	1	5
Dark Green Glass Waste	12	5	7	24
Green Glass Waste	7	2	1	10
Pale Green Glass Waste	7	0	3	10
Colourless Glass Waste	6	1	1	8
Dark Green Bottles	32	5	10	47
Green Bottles	4	2	2	8
Pale Green Bottles	19	2	8	29
Colourless Bottles	11	2	6	19
Brown Bottles	2	0	1	3
Window Glass	0	1	7	8
Pre-1825 Bottles	4	0	0	4
Powell & Ricketts Bottles	13	3	3	19

Table 5: Types of materials and number of Phase 3 contexts with these present

5.10.35A wide range of glass and materials related to glass-working was identified from 22 different contexts assigned to Phase 4 (after *c* 1920; Table 6).

Material	Number of contexts
Clinker	5
Opalescent Waste	7
Devitrified Waste	5
Crucible	1
Furnace Brick	4
Dark Green Glass Waste	11
Green Glass Waste	4
Pale Green Glass Waste	7
Colourless Glass Waste	2
Dark Green Bottles	12
Green Bottles	4
Pale Green Bottles	8
Colourless Bottles	6
Window Glass	5
Powell & Ricketts Bottles	3

Table 6: Types of materials and number of Phase 4 contexts with these present

5.10.36 Limited quantities of glass and materials related to glass-working were identified from contexts that are not closely phased, or unstratified. This material included some of the categories found in stratified and phased contexts, but included no material that has not already been identified from this site.

5.10.37 Overall, the assemblage of glass and glass-working waste is extensive and includes a wide range of materials that have considerable potential to provide detailed information about the operation of the glass-works on this site. The most promising areas for research are the nineteenth-century glass-working waste and the contemporary embossed bottles. The shape and finish of the dark green bottles, along with the embossed names of brewers, and other beverage suppliers that these bear, can be used to provide a detailed picture of bottle glass fabrication methods with considerable chronological finesse. The examination of these bottles can be contrasted with the contemporary green, pale green and colourless bottles.

5.11 STONE

5.11.1 ***Quantification***: in all, 16 stone objects were recovered in the course of the excavations. They range from stone roofing tile fragments to large grindstones.

5.11.2 ***Methodology:*** this assessment was undertaken in accordance with guidance provided by English Heritage (1991a). Assessment was based on the visual inspection of all stone objects. An outline database has been created using Microsoft Access. Data were recorded in a standardised format, noting provenance, type of object, material, period; no attempt was made at this stage to differentiate between different types of stone. The database will form the basis for any further work, or will comprise the archive record, as appropriate.

5.11.3 ***Assessment:*** four of the fragments were found to be unmodified and a fifth is a small lump of coal. Small amounts of stone roofing tile from fill ***1126*** (Phase 2; Area ND5) and layer ***3005*** (Phase 2; Area ND3) give some additional information regarded the appearance of buildings on the site, and a dressed fragment from layer ***3341*** (Phase 3; Area ND3) also contributes to this.

5.11.4 Two large grindstones (one iron-bound) were recovered, from layers ***1000*** (Phase 4; Area ND5) and ***3110*** (Phase 2; Area ND3), presumably reflecting activity on the site, and a whetstone came from layer ***3127*** (Phase 3; Area ND3). Three small conical objects (layer ***3012*** (Phase 2), and fills ***3023*** (Phase 3) and ***3041*** (Phase 4); Area ND3) obviously served that same purpose, but what this was is not clear, unless they too were used for grinding.

5.12 ANIMAL BONE

5.12.1 ***Methodology:*** the material was identified using the reference collection held at OA North. All parts of the skeleton were identified where possible, including long-bone shafts, skull fragments, all teeth and fairly complete vertebrae. Sheep/goat distinctions were made with reference to Boessneck (1969).

5.12.2 For each bone, the following information was recorded where appropriate: species or species group; element; number of bones; side; the diagnostic zone as either more than or less than half present; fusion state; preservation (*eg* burning); butchery; measurements; and tooth-wear development. Pathology and other developmental or congenital anomalies were also noted.

5.12.3 The diagnostic zones used followed those described in Dobney and Reilly (1988). Measurements followed those set out in von den Driesch (1976). Tooth-wear development for mandibular teeth was recorded following Payne (1973; 1987) for sheep, Grant (1982) and Halstead (1992) for pigs, and Grant (1982) and Halstead (1985) for cattle.

5.12.4 ***Quantification and assessment:*** a small collection of animal bone (127 fragments) was recovered from the excavations, and rapidly scanned for assessment. Species present included domestic and wild mammals, birds and fish. The material is in a good state of preservation, generally of a robust nature, frequently with little erosion of the surface of the bone, although often fragmented, with less than 50% of the original anatomical part represented.

5.13 MARINE MOLLUSCS

5.13.1 ***Quantification:*** a small amount of marine mollusc shell (42 single or part-valves) was recovered from a total of 15 contexts. All can be identified as edible oyster (*O edulis*), which probably represent a small amount of food debris rather than natural examples living in the river, as muddy harbours and tidal pools are not a favoured habitat for this species.

5.13.2 ***Methodology:*** this assessment was undertaken in accordance with guidance provided by English Heritage (1991a). Assessment was based on an inspection of all individual shells, and an outline database has been created using Microsoft Access. Data were recorded in a standardised format, noting provenance and species. The database will comprise the archive record, as appropriate.

5.13.3 ***Assessment:*** this group presumably represents a small amount of discarded food remains or was the result of natural deposition within a maritime environment. It is too small for any valid statistical analysis.

5.14 ORGANIC MATERIALS

5.14.1 ***Quantification:*** small amounts of wooden and leather objects were recovered from waterlogged or damp contexts on the site. There were 27 wooden objects and two small sawn samples from planks. The five leather objects recovered were all parts of shoes.

5.14.2 ***Methodology:*** this assessment was undertaken in accordance with guidance provided by English Heritage (1991a). Assessment was based on the visual inspection of the individual objects after cleaning, but before any conservation. An outline database has been created using Microsoft Access. Data were recorded in a standardised format, noting provenance, type of object, material, period. The database will form the basis for any further work, or will comprise the archive record, as appropriate.

5.14.3 ***Assessment****:* of the 27 wooden objects recovered, 26 were bottle stoppers or bungs; the remaining object was a simply carved fragment of sawn plank, perhaps part of a storage rack. Of the stoppers, 23 were unstratified. The remainder (from sleepers ***1090*** (Phase 4; Area ND5), and fills ***3041*** (Phase 4: Area ND3), and ***3683*** (Phase 2; Area ND3) contribute to the understanding of bottling practices on the site, and changes in methods of closing the vessels used, and broadly reinforce the dating of the site.

5.14.4 The small group of leather shoes, all from Area ND3 (from layers ***3140*** (Phase 3), ***3228*** (Phase 2), ***3402*** (Phase 1), and ***3607*** (Phase 3), and fill ***3706*** (Phase 3); Area

ND3), are all poorly preserved, and only that from fill ***3706*** (Phase 3; Area ND3) can be regarded as anywhere near complete. Where there is any indication of the style of the shoe, it is utilitarian, probably reflecting the style of footwear in use by workers on the site in the later nineteenth or early twentieth century. More detailed examination of this material could allow some refinement of the dating of individual shoes, and contribute to the dating of the site in general.

5.15 MODERN SYNTHETIC AND OTHER MATERIALS

5.15.1 ***Quantification:*** small numbers of objects in modern or synthetic materials were recovered (Table 7).

Material	Number of fragments
Industrial textile (machine belt)	2 (fills ***3716*** (Phase 3) and ***3718*** (Phase 3); Area ND3)
Unknown (gasket)	2 (fills ***3695*** (Phase 3) and ***3716*** (Phase 3); Area ND3)
Cardboard	1 (fill ***3023*** (Phase 3; Area ND3)
Ceramic bottle stopper	160 (fills ***3037*** (Phase 4), ***3041*** (Phase 4), and ***3077*** (Phase 3), layer ***3127*** (Phase 3), and demolition material ***3130*** (Phase 4); Area ND3)
Composition bottle stopper	26 (fills ***3023*** (Phase 3), ***3041*** (Phase 4), and ***3732*** (Phase 3) rubble ***3155*** (Phase 3), layer ***3398*** (Phase 3), and flue ***3715*** (Phase 3); Area ND3)
Plastic?	1 (fill ***3505*** (Phase 3; Area ND3)

Table 7: Quantification of modern synthetic and other materials

5.15.2 ***Methodology:*** this assessment was undertaken in accordance with guidance provided by English Heritage (1991a). Assessment was based on visual inspection of the individual objects, and an outline database has been created using Microsoft Access. Data were recorded in a standardised format, noting provenance, type of object, material, period. The database will form the basis for any further work, or will comprise the archive record, as appropriate.

5.15.3 ***Assessment***: the material represented a range of activities associated with the site, including the bottling of various liquids, especially beer and mineral water, and, like the wooden stoppers, will contribute to understanding changes in bottling technology.

6. CURATION AND CONSERVATION

6.1 RECIPIENT MUSEUM

6.1.1 Bristol's City Museum and Art Gallery will be the ultimate place of deposition for the paper and material archive, as this is the nearest museum which meets the Museums' and Galleries' Commission criteria for the long-term storage of archaeological material:

Address: Bristol's City Museum and Art Gallery
Queen's Road
Bristol BS8 1RL

Contact details: Gail Boyle (Senior Collections Officer), Tel: 0117 9223587.

6.1.2 Arrangements have been made with the museum for the deposition of the complete site archive from the 2007 investigations, which will be logged under the following information:

- Museum's acquisition number **2007/30.1**
- Site code **TQ 07.**

6.2 CONSERVATION

6.2.1 No artefacts to be retained require conservation, and none of the iron objects merit x-radiography. The long-term storage requirements for archaeological materials and archives are set out in documents compiled by the Museums and Galleries Commission (MGC) (1992).

6.3 STORAGE

6.3.1 The complete project archive, which will include records, plans, both black and white and colour photographs, artefacts, and digital data, will be prepared following the guidelines set out in UKIC 1984 and Walker 1990.

6.3.2 In line with Bristol's City Museum and Art Gallery requirements, all artefacts submitted for deposition will be individually marked up, and then will be packaged, according to the museum's specifications, in either acid-free cardboard boxes, or in airtight plastic boxes for unstable material. Metalwork constitutes the only category which is potentially unstable and, although the items will be packaged in airtight plastic boxes, they will need to be stored in controlled conditions.

6.4 PACKAGING

6.4.1 The assemblage is currently well-packed and will require no further packaging. Box lists are prepared and will be updated from the database when the identification of objects is complete.

6.5 DISCARD

6.5.1 On completion of the post-excavation analysis, a discard policy will be undertaken. This will be completed in full consultation with Bristol Museum Service staff, and will include the metalwork and animal bone, as well as elements of the synthetic and organic materials, and glass and pottery assemblages.

7. STATEMENT OF POTENTIAL

7.1 INTRODUCTION

7.1.1 Assessment of the individual elements of the archaeological dataset generated from the excavations at Glass Wharf has indicated that it has considerable potential to contribute to research agendas at a local level, and some potential to inform regional research agendas. Several interconnected themes have emerged, which inform an understanding of past habitation in conjunction with the expansive industrial landscape.

7.1.2 The remains relating to historic glass production form the more significant material from the site, and these include the structural remains of glass furnaces and associated ancillary structures in ND3, and also the dumps of glass waste present in ND5. Moreover, such dumps hold great relevance for understanding the processes undertaken at, and products from, an historic glass-works, as they represent materials that were gathered from its furnaces and disposed of on its margins. Indeed, such peripheral dumps contain the best glass to sample for analysis, in the form of minimally contaminated threads, ribbons, and moils (cylinders of glass left on the end of the blowing iron), split adjacent to the furnaces during the forming of glass artefacts, opposed to that glass waste found directly within the furnaces (D Dungworth *pers comm*); this latter material may have lain within the furnace for months, or even years, while the furnace was active, and as such it would lose the most volatile elements (sodium and potassium) and would pick up additional ones from the fuel and the walls of the furnace (aluminium, silicon, potassium, and iron) (D Dungworth *pers comm*).

7.1.3 In terms of the glass-works, work undertaken as part of the Monuments Protection Programme (MPP) emphasised the current lack of knowledge of urban centres of glass-making, which developed from the seventeenth century onwards (Crossley 1993; 1996). A functional understanding of many industrial processes in particular is required, which is one of the principal ways that industrial archaeology can contribute to the study of the past (Cranstone 2003). Moreover, archive sources that document the technological changes in glass-making during the eighteenth and nineteenth centuries are sparse; archaeological work in St Helens and Manchester has demonstrated that, in a period of rapid change in glass-making methods (*ie* during the second half of the nineteenth century), structures were modified from experience in ways which were not recorded by contemporaries (Krupa and Heawood 2002; Miller 2007).

7.1.4 A large proportion of the few glass-working sites that have been investigated archaeologically in England have been of a seventeenth- or eighteenth-century date. These include: three examples from Bristol (the Portwall glass-works (Jackson 2007); Sir Abraham Elton's in Cheese Lane (Jackson 2005); and St Thomas' Street glass-works (Jackson 2004)); three examples from Yorkshire (at Bolsterstone (Ashurst 1987); Gawber (Ashurst 1970); and Silkstone (Ashurst 1992)); and two examples from Lancashire (at Denton (Vose 1994) and Bickerstaffe (Vose 1995)). The dataset generated from the archaeological investigation of the Glass Wharf site therefore offers a valuable opportunity to contrast a nineteenth-century works with those of an earlier date as well as comparisons to others of a similar date. However, only a handful of nineteenth-century works have been subject to archaeological investigation and subsequent publication, including the Cannington Shaw Bottle

Works (Lewis and Philpott 1992) and The Hotties in St Helens (Krupa and Heawood 2002), the Percival, Vickers & Co Ltd Glass-works in Manchester (Miller 2007), and the Nailsea Glass-works in Somerset (Smith 2004).

7.1.5 Aside from the glass-works, the site also contained other significant remains which hold relevance to understanding the development of Bristol across the eighteenth and nineteenth centuries. In ND5, apart from the dumps of glass waste (*Section 7.1.2*), these included a series of clay-extraction pits, relating to historic brickmaking, which were later used as rubbish pits (*Section 3.4.109*). Significantly, some of these pits contained large volumes of glass waste (*Section 7.1.2*), ceramics, and a regionally significant assemblage of seventeenth/eighteenth-century red-ware kiln waste (*Section 5.7.32*). In addition, ND5 contained building remains relating to the occupation of this area, and the urban expansion of Bristol, during the eighteenth and nineteenth centuries, as well as the remains of a nineteenth-century dock and railway. These latter features formed important elements of nineteenth-century infrastructure, and probably served, and contributed to the success of, the nearby glass-works and other industries located in this part of Bristol.

7.2 PRINCIPAL POTENTIAL

7.2.1 The stratigraphic data has great potential, as its analysis will allow refinement to the phasing and dating of the sequence of structures and archaeological deposits from the site. Once this analysis has been completed, the revised stratigraphic data will form the framework within which other analysis will take place.

7.2.2 ***Stratigraphic data:*** analytical study of the stratigraphic record may elucidate a detailed, chronological sequence of events pertaining to the development of the site. In particular, this may inform an understanding of the implementation and development of technical innovations represented by the surviving structures. Each of the four furnaces excavated in Area ND3 retained evidence for several periods of modifications, and the implementation of new technology. Analysis of the data will allow the sequence of activity at each furnace to be determined, along with their relative use, and by doing so questions, such as which furnaces were operating at the same time, which gas producers and associated flues were in use, and how they were interlinked, should become apparent. Beyond the glass-works, a closer examination of the stratigraphy encountered in Area ND5 will enable a clearer understanding of the eighteenth-century extraction and reclamation processes that have been identified.

7.2.3 ***Documentary study:*** the significance of the excavation results is increased by the supporting primary documentary evidence available within the Bristol Record Office and archives. An appraisal of these sources has been undertaken as part of this assessment (*Section 2*) and these provide important information regarding the sequence and character of the excavated remains. However, detailed examination of the documentary evidence could provide additional information.

7.2.4 ***Artefactual data:*** although much of the artefactual material recovered from the site requires no additional analysis, analysis of the glass fragments, particularly those recovered from Area ND5 (*Section 7.1.2*) will undoubtedly provide significant details of the glass-making processes and practices, and the precise chemicals and elements used as colourants, decolourisers and opacifiers. As Crossley (1990, 242) commented, 'within the typology of glassware lies considerable variation in quality, reflecting choice of materials and competence of furnace operation. It is here that laboratory examination of furnace products is essential'. The lack of scientific

analysis of glass and comparison of different types has been highlighted as a result of detailed scientific examination of material recovered from the glass-working site at Silkstone, South Yorkshire (Dungworth 2003).

7.2.5 Some analysis should also be carried out on elements of the pottery assemblage. In particular, a detailed report should be prepared on the red-ware kiln waste, recovered from Area ND5, as this represents a regionally significant assemblage (*Section 5.7.32*).

7.3 NATIONAL PRIORITIES ADDRESSED BY THE SITE'S POTENTIAL

7.3.1 In 1991, English Heritage produced a document, *Exploring Our Past*, which included a strategy for dealing with the problems and opportunities which would be encountered during the following decade (English Heritage 1991b). Many of the ideas first raised in *Exploring our Past* were developed further in a draft document, *Research Agenda* (English Heritage 1997). Section 7 of *Exploring our Past*, *The Way Forward*, and Section 3 of *Research Agenda*, *Archaeological Research Priorities*, outlined a series of broad academic objectives, and despite the relative age of the document, many of the themes and issues are still in need of being addressed and explored. The data from the work at Bristol continue to build on the body of data already collected, with a view to continual reassessment of the ideas. The agenda distinguished between the following aspects:

- The study of processes of change (**PC**)
- Issues related to chronological periods; divided in to prehistoric (**P**) and historic (**H**)
- Themes (**T**)
- Landscapes (**L**)
- Methodological and technical development (**MTD**)
- Managing the resource (**MR**).

Those of relevance to the present site are outlined below, and supplementary comments integrated.

7.3.2 ***Processes of Change (PC)*** **- PC7 Transition from medieval to post-medieval traditions (*c* AD 1300-1700):** the late medieval to early post-medieval period is one of change in a number of agricultural, manufacturing, trade, building and institutional traditions. Some past studies have categorised evidence too rigidly, into either medieval or post-medieval aspects, leaving details of adaptation and overlap poorly understood. More work is required to enable archaeology to contribute to important debates and controversies which hitherto have been largely the preserve of economic historians, most importantly the role and extent of capitalism in the changes.

7.3.3 **PC8 The Industrial Revolution (*c* AD 1700-1850):** this should include studies of the buildings and the physical context of engineering, extracting manufacturing and transport, the chemical industry, distribution and retail, water and sewage, interiors of and services to working-class housing, and the relationship between traditional and new industries during the period of industrialisation.

7.3.4 ***Themes (T)*** **– T6 Industrial Archaeology**: if there is one archaeological topic in which England can claim to have international pre-eminence, it is in the industrial archaeology of the post-medieval period. There is still the need to improve our

understanding of single monument forms via site-specific studies and to place these activities into the broader context, such as social and economic arenas.

7.3.5 The Monuments Protection Programme (MPP), described as conducting 'vitally important thematic surveys', has done much to develop studies in industrial archaeology, but research should be devoted to expanding these surveys and using them as the basis for exploring detailed landscapes and periods.

7.3.6 This corpus of information and all future work should then be used to inform the development of new research frameworks for the management of the industrial archaeological resource.

7.3.7 **T7 Patterns of craftsmanship and industry:** the study of industry and craftsmanship is identified as a continuing area of research interest. Studies designed to synthesise the results of site-based interventions into more synthetic considerations of the development and change of specific industries and crafts are to be encouraged.

7.3.8 Studies should also include:

- the evaluation and critique of current methodological issues (*cf* MTD5 and MTD6);
- syntheses of results to enable more cost-effective implementation in future recording exercises;
- presentation of the results of archaeological research to the wider public.

7.3.9 This theme could be advanced in a number of ways, but perhaps most particularly by projects which address the following problem areas:

- investigation of a documented industrial site and comparison of the application of new technologies with the historical records of innovation and contemporary technical literature;
- assisting the analysis of the contrast between urban and rural industrial sites;
- studying waste and process material from industrial sites to determine craft procedures;
- examination of aspects of craftsmanship and manufacture deduced from a study of the finished object.

7.3.10 ***Landscapes (L):*** there has been a growing sense of the need to place archaeological 'sites' within a better understanding of the landscape as a whole.

7.3.11 **L4 Historic landscape assessment:** the approach has moved away from site-specific designations to a more inclusive approach. The assessment of historic landscape character aims to promote a common national approach and regional frameworks for conservation decisions within the context of planning policies.

7.3.12 ***Methodological and Technical Development (MTD)* - MTD1 Evaluation techniques:** the success of evaluation strategies needs to be established, which can be developed from the synthesis of previous fieldwork, sampling theory, and predictive modelling.

7.3.13 **MTD3 Sampling and retrieval:** sampling strategies and theory on excavation projects require further thought and debate. While some standardisation has occurred over the past decade, there are still many areas that merit further consideration and, once again, some standards (such as the percentages of areas excavated) require closer scrutiny. An appraisal of how effective these have been should then be undertaken,

assessing to what extent their implementation on site has been practical, achievable and monitorable. Other questions, such as what limitations, if any, have these sampling strategies posed for the analytical process, can also be asked. The outcome of such sampling exercises needs to be critically evaluated and disseminated.

7.3.14 **MTD6 Scientific techniques for analysis:** excavation work should encompass the development and effective implementation of scientific techniques for analysis. This is considered to be a vital area of research.

7.3.15 It is debatable whether the complete dataset from the investigated elements of Glass Wharf could fully address all of these. However, they should nevertheless be borne in mind when addressing more local issues.

7.4 LOCAL AND REGIONAL PRIORITIES

7.4.1 ***The South West Archaeological Research Framework (SWRARF):*** the publication of an archaeological research framework for the South West provides a regional research agenda for the medieval, post-medieval, and industrial to modern periods (Webster 2008). Within this, the known evidence for the period within the region is considered, lacunae identified, and important avenues for further research defined. The research strategy stated that the need for data-gathering is still the most urgent necessity for many periods, including the post-medieval. Several key issues clearly have need for further research. This is particularly true of glass-manufacturing sites; of the numerous studies that have addressed the industrial development of the region since the late eighteenth century, remarkably few have focused on the glass industry. Indeed, the regional importance of Bristol's eighteenth- and nineteenth-century glass industry has only recently been acknowledged (Dodsworth 1982), and research is in its infancy. Few glass-manufacturing sites of this period within the country as a whole have been subject to large-scale, detailed archaeological investigation.

7.4.2 The SWRARF reviews and summarises the post-medieval, industrial and modern periods in terms of the established resources (Bone and Dawson 2008). For the South West, the resources for the period from 1540 onwards are assessed under the categories: Material culture; Identities; Food production; Rural settlement; Urban settlement; Designed landscapes; Transport and communications; Technology and production; Trade and interaction; Religion and ritual; Social provision; Defence and warfare. The category pertinent to the Glass Wharf site is mainly Technology and production, although elements have the potential to feed into Identities, Food production, Transport and communications, and Trade and interaction. The main resources are highlighted below.

7.4.3 ***Identities:*** the resource assessment suggests that there are identifiably discrete local/occupational groups. This could include the glass-workers of Bristol. Geographically, there is a definite cluster of glasshouses around Cheese Lane, Avon Street, Portwall Lane, with Redcliff not too distant (*Section 7.1.4*).

7.4.4 By the beginning of the twenty-first century, the concept that our historic environment is an important element in determining the identity of a community has become embedded in national, regional and local planning practice. Some work has been undertaken to draw together the community of the area (*eg* Stephenson and Willmott 2005) and certainly the size of the site and the remains uncovered are of a significant element of the community, including the workplaces of what may have been a good proportion of the local inhabitants.

7.4.5 ***Food production:*** the production of alcoholic and soft drinks in the brewing industry was mainly locally based until the twentieth century. Larger brewhouses were introduced in the towns from the sixteenth century, with larger-scale commercial breweries developing in the latter half of the eighteenth century, employing horse and, later, steam power. Brewery construction peaked in the late nineteenth century. The Glass Wharf site had close associations with the brewing industry, as the glass-works produced beer bottles, and the later yeast factory (*Section 3.4.79*) would have been linked to both brewing and baking. The site helps to demonstrate that Bristol had a diverse manufacturing and processing background, with many of the activities intrinsically linked. This was one of the aspects which helped sustain Bristol's economic levels and provides contrast with other more specialised cities during this period.

7.4.6 Whilst our knowledge of the archaeology of the food and drinks trades is limited, we know even less of the distribution and support services that were an essential part of the organisation of these trades. Warehouses and bonded stores have been noted in studies of ports, but little has been done on such features as brewers' depots and bottling stores or food-packaging plants. The manufacture of packaging and containers such as glass bottles, once important industries in the Bristol area, have been similarly neglected.

7.4.7 ***Transport and Communications:*** in terms of river navigation and canals, much of the region is within easy reach of the sea, but the Bristol Avon was all-important for navigation during the post-medieval and industrial periods. Powers had been granted as early as 1619 to make the Bristol Avon navigable above the tidal limit at Hanham, and this was eventually achieved in 1727, when the first boat from Bristol reached the developing city of Bath, and its growing stone-quarrying industry (Buchanan and Cossons 1969). The accessibility of the Glass Wharf site to the river Avon and the later dock must have been an important factor in its success. The use of water transport for raw materials and, once the Bath route was accessible, finished goods would be the cheapest and most efficient means available until the advent of the railways and later road networks.

7.4.8 For most of the post-medieval period, Bristol was Britain's second port. Bristol's historic quays were at the heart of the city, and the early nineteenth century saw improvements to these quays, when the Floating Harbour was constructed under William Jessop's direction. Much of the Floating Harbour's civil engineering features survive as a leisure facility, but development around its quays has threatened many dockside buildings (Lord and Southam 1983).

7.4.9 ***Technology and production, 1540 - present:*** with regard to production of capital and consumer goods, there are still a few remnants of a once-important glass-making industry in the South West. These include excavated kiln-bases at Nailsea and Bridgwater. Another survives as part of a modern hotel complex in Bristol, which was a major centre of the industry in the South West (Witt *et al* 1984), and has recently seen important further excavation (Williams and Jackson 2006).

7.4.10 ***Trade and Interaction:*** pottery studies in Exeter and Plymouth have demonstrated how archaeological evidence can elucidate the patterns of sourcing different kinds of ware for different kinds of consumption. The use of redware from South Somerset, which must have come overland from an inland production area, provides some clue as to the importance of land-borne communication (Allan 1984; Allan and Barber 1992). The bricks used in the glass-works show trade and interaction with the

Midlands. The Glass Wharf site produced glass bottles, and examination of other assemblages, both within the city and elsewhere, can show how far they were dispatched, whether filled or not.

7.4.11 The SWRARF Research Agenda identifies a series of Research Themes. Those relevant to the Glass Wharf site are listed below.

7.4.12 ***SWRARF Research Aim 2: Encourage works of synthesis within and across periods, settlements, monuments and areas***

7.4.13 In the Industrial and Modern periods, personal interest and responses to threats have produced gazetteers, assessments of significance and, latterly, emergency investigation, recording and, sometimes, developer-funded excavation. Much work is still to be published, some of the 'grey' literature is not easily accessible, and the uneven nature of the Historic Environment Records reflects this (Research Priority 12). There is, therefore, an urgent need for synthesis to develop our understanding of work already completed, and to identify better future research needs. Glass Wharf is only a part of the wider glass industry of Bristol and its publication will provide a good opportunity to synthesis briefly the other Bristol glass-working sites that have been subjected to archaeological investigation.

7.4.14 ***SWRARF Research Aim 8: Utilise the survival of medieval and later artefacts and buildings to their full extent***

7.4.15 The survival of buildings, landscapes, artefacts, archives, and the availability of oral testimony for these periods contrasts with earlier times. It is important that we take an holistic, or interdisciplinary, approach in future research which exploits all of the above. Thus, the Glass Wharf site must realise its potential by using all forms of evidence available in order to reveal as complete a story as possible. This will include the archaeology of buildings and the historical past, plus aspects of glass science and technology.

7.4.16 ***SWRARF Research Aim 45: Broaden our understanding of post-medieval to modern technology and production***

7.4.17 In terms of the glass industry, whilst there is a need to research its early development, the later application of industrialisation and large-scale manufacturing is also essential in order to comprehend this industry fully. Fortunately, the Glass Wharf glasshouses show an amazing level of complexity for later structures, and demonstrate the application of later power sources. The site also existed for over 200 years in continuous use, and the longevity of the production has great potential for charting the evolution of a Bristol glass-works.

8. UPDATED PROJECT DESIGN

8.1 UPDATED RESEARCH AIMS AND OBJECTIVES

8.1.1 This section follows the guidance of English Heritage regarding the formulation of updated project aims (English Heritage 2006, 2-3). This guidance recommends that it is helpful to treat *aims* as major themes or goals to which specific *objectives* contribute, and to consider these aims and objectives as questions.

8.1.2 The original aims of the fieldwork are still valid, but these have now been updated, with new aims and objectives derived from the statement of potential set out in *Section 7*. At the present stage of the project, these necessarily emphasise the presence, absence and sufficiency of data to support analysis of components of the archaeological record. The primary objective of analysis will be to add to the archaeological knowledge in the areas prioritised by the original fieldwork aims. In particular, the material recovered has considerable potential to contribute to an understanding of how the British bottle-glass industry developed from the 1720s to the 1920s; the excavated site saw the development and implementation of significant glass-working technologies, such as the three-part bottle mould (*Section 2.1.26*), and the Siemen's regenerative furnace (*Sections 2.1.10-21*).

8.1.2 ***Research Aims:*** the overall aims of analysis are:

1. to secure the analysis and publication of the archaeological investigation of an eighteenth- and nineteenth-century Bristol glass-works to act as a benchmark against which future work on similar sites in the region may be measured;
2. to contribute to an understanding of English glass manufacture in the second half of the nineteenth and early twentieth centuries;
3. to recount the history of the site as a whole and place it in its regional context;
4. to deposit the project archive into the public domain.

8.1.3 ***Specific objectives:*** the specific objectives which the data can address, specifically highlighting glass-working, are:

1. to characterise and date the sequence of the archaeological structures and deposits revealed during the course of the excavation, particularly in Areas ND3 and ND5;
2. identify evidence for bottle-glass manufacture;
3. identify raw materials used in bottle-glass manufacture;
4. identify chronological changes in raw materials/batch recipes used at the glass-works;

8.1.4 In addition, the data can also be used to examine briefly other activities on the site and other categories of finds. Specifically, these comprise the dumping of industrial waste in Area ND5, which included an important assemblage of red-ware kiln waste.

8.2 PRESENTATION OF RESULTS

8.2.1 It is proposed that the results of the project are presented in the following stages:

1 **Publication text:** the dataset generated from the archaeological investigation at Glass Wharf is clearly of regional significance in addition to being of considerable local interest, and thus merits publication. The most appropriate

means of disseminating the results to a wider audience would be via an academic paper submitted to an appropriate academic journal, which will present the results from the excavation in the context of the Bristol glass industry.

2 **Project archive:** the completion of the project will result in an integrated archive, which will be deposited with Bristol City Museum and Art Gallery.

8.3 PROGRAMME STRUCTURE

8.3.1 The post-excavation programme will be divided into the following stages:

- analysis;
- targeted research;
- synthesis;
- preparation of draft text and illustrative material for publication;
- archive deposition.

9. METHOD STATEMENT

9.1 INTRODUCTION

9.1.1 The programme of works is tailored to address the specific objectives, which, when achieved, will secure the general objectives outlined in *Section 8.1*.

9.2 MANAGEMENT, MONITORING AND REVIEW

9.2.1 Management and monitoring tasks have been built into the project. These tasks will include project monitoring, advice and co-ordination, problem solving, and conducting meetings with project staff and all interested external parties.

9.2.2 Review meetings will be held with the members of the project team. This will include the specialists and the OA North staff who are undertaking the analysis. These will provide an opportunity for all involved to present and receive information, to discuss the research aims, and permit exchange of ideas. The first meeting will be held to provide full information before specialist analysis is commenced, and following this meeting, specialists will be provided with the contextual and dating information they will require. The second meeting will be held on the completion of analysis and draft reports, but before completion of final reports, to allow presentation of any revised phasing, and discuss each specialist's results. All specialists will be consulted following editing and prior to publication of the site.

9.3 TRANSPORT OF MATERIALS TO SPECIALISTS

9.3.1 At an early stage in the analytical programme, arrangements will be made to transport all relevant artefactual assemblages to the appropriate external specialists to facilitate analysis and reporting of the material.

9.4 STRATIGRAPHIC ANALYSIS

9.4.1 The stratigraphic data will be analysed in greater detail in order to refine the provisional phasing. A broad stratigraphic framework has been produced for this assessment, but this will be reviewed and refined, as part of the analysis phase of work.

9.4.2 Detailed structural analysis will be undertaken on those features identified as being of major interpretative importance to the site, namely the glass furnaces, their associated flues, and the putative annealing house. An analytical text of the stratigraphic information will then be drafted. This will be incorporated into the final published article.

9.5 THE GLASS

9.5.1 A catalogue will be made, which describes the types of glass and glass-working material found by context. A programme of chemical analysis will then be undertaken. This will involve the selection of 100 samples of finished glass and glass-working waste, which will be subjected to SEM-EDS and EDXRF analyses. SEM-EDS analysis will determine the major and minor elements present in the glass, whilst EDXRF analysis will determine the trace elements present. The results will then be calibrated against suitable reference materials. The chemical analysis of closely dated bottles will add considerably to an understanding of chronological

changes in raw materials and/or batch, and also allow comparison with other relevant sites in Bristol. Following analysis, an archive report will be produced, along with a summary that will form the basis of the contribution within the published account of the site.

9.6 THE POTTERY

9.6.1 A summary report on the pottery will be prepared, which will conform to the requirements for a publication text focusing on the regionally important assemblage of red-ware kiln waste. This will describe and illustrate the main vessel forms present in the assemblage, describe the production methods which can be determined from the vessels and kiln furniture, and detail the history of the Hill/Yabbicom Pottery (*Section 5.7.32*). The report will include brief notes on the other types of kiln waste from the site in order to record their presence and place the red ware in context.

9.7 RESEARCH

9.7.1 Some documentary research will be undertaken to enhance the fieldwork results. Research will also identify comparable structures elsewhere, from either historical or archaeological sources.

9.8 OTHER FINDS

9.8.1 A summary account of the other classes of finds (clay tobacco pipes; metalwork; stone; animal bone and molluscs; and organic materials) will be produced, which will be incorporated into the publication text.

9.9 ILLUSTRATION

9.9.1 A range of illustrations will be produced for the publication (*Section 9.10*). These will include general plans, phase plans, and artefacts. Experienced illustrators, using standard conventions, will compile these illustrations, either digitally for the plans, or manually, as appropriate. A number of artefacts will be photographed for the publication.

9.10 ACADEMIC PUBLICATION

9.10.1 A publication text and illustrative material will be produced, which will then be submitted to the international academic journal *Post-Medieval Archaeology* for publication. Contact has been made with the editor who has indicated that, subject to peer-review, the paper will be published in a forthcoming edition of this journal. The draft publication text will be subject to internal revision, and will be submitted to all specialists after editing for their comments. Following submission to *Post-Medieval Archaeology*, any comments and revisions suggested by external reviewers will be addressed.

9.10.2 A provisional breakdown of the contents of the proposed academic publication is provided below. This synopsis can only be regarded as a draft, although it is anticipated that the publication will work to the following general headings and content:

1 Abstract

2 Introduction

This section will describe the location of the site and detail the circumstances that led to the archaeological excavation.

3 Overview of the Bristol Glass Industry

This section will present an overview of the historical development and significance of the Bristol glass industry.

4 ***The history of glass-working at Glass Wharf***

This section will present the documentary and cartographic evidence relevant to eighteenth- and nineteenth-century glass-working at Glass Wharf. This will include details of the Soap Boilers' Glasshouse (*Section 2.3.2*) and Hoopers' Glasshouse (*Section 2.3.9*), in operation across the eighteenth and early part of the nineteenth centuries, and the amalgamated Powell & Ricketts glass-works, which operated in the late nineteenth and early twentieth centuries (*Sections 2.3.14-19*). This section will also include details of the known technology that was employed at the glass-works, which will act as an essential prelude to the descriptions of the excavated remains.

5 Excavated remains

This section will present a summary of the Glass Wharf excavations focusing on the remains associated with the glass-works, although it will also summarise the other remains. This evidence will be ordered chronologically, and discussed in three main sub-sections. These will comprise: the Phase 1 remains (pre-glass-works); the Phase 2 remains (1715-1853); and the Phase 3 remains (1853-1925).

6 Glass analysis

This section will present the results of the analysis of the nineteenth-century glass bottles and glass waste from the site.

7 Other finds

This section will present an overview of the other artefacts recovered from the site. Its main focus will, however, reside with the important assemblage of red ware kiln waste.

8 Discussion

This section will allow the Glass Wharf site to be placed in its regional and national context. It will outline the significance of the site, and discuss it in terms of other excavated glass-works from both Bristol and across a wider national area. A particular emphasis of this discussion will be nineteenth-century glass-working and the important sequence of regenerative furnaces that were uncovered at the Glass Wharf site.

Acknowledgements

Bibliography.

9.11 ARCHIVE DEPOSITION

9.11.1 On submission of the completed text for publication, the paper and digital archive will be updated as necessary, particularly the database information. This will all be checked and indexed, and then submitted to Bristol's City Museum and Art Gallery. All artefactual material selected for deposition will be individually marked up, indexed, and boxed, and then submitted to Bristol's City Museum and Art Gallery.

10. RESOURCES AND PROGRAMMING

10.1 NAMED PROJECT TEAM

10.1.1 The team consists of a combination of internal OA North staff, and input from external consultants (Table 8). The project will be managed by Richard Gregory.

Name	Organisation	Tasks
Richard Gregory	OA North	Project management; stratigraphic analysis; research; production and editing of publication text
Chris Wild	OA North	Stratigraphic analysis; production of publication text
Vix Hughes	OA South	Documentary research
Chris Howard-Davis	OA North	Preparation of an overview of the finds (excluding pottery and glass waste) for the academic publication; quality control of specialist reports
Rachel Newman	OA North	Internal quality control and academic editing
Adam Parsons	OA North	Illustration
Marie Rowland	OA North	Illustration
Sandra Bonsall	OA North	Archive preparation
Archaeologist (tbc)	OA North	Archive preparation
David Dungworth	Consultant	Glass-ware analysis; preparation of archive report; preparation of publication text
Reg Jackson	Consultant	Pottery analysis; preparation of a summary report for the academic publication

Table 8: Named project team

10.2 MANAGEMENT STRUCTURE

10.2.1 OA North operates a project management system. The team is headed by the Project Manager, who assumes ultimate responsibility for the implementation and execution of this Project Design, and the achievement of performance targets, be they academic, budgetary, or scheduling. The Project Manager may delegate specific aspects of the project to other key staff, who both supervise others and have a direct input into the compilation of the report. They may also undertake direct liaison with external consultants and specialists who are contributing to the publication report. The Project Manager will define and control the scope and form of the post-excavation programme.

10.2.2 Communication between all concerned in the post-excavation programme is of paramount importance, and it is essential that the specialists involved liaise closely in order that comparable data are obtained. To this end, regular meetings and reviews are envisaged between all project staff and between particular groups of specialists. All information will be disseminated at regular intervals, thus ensuring that all concerned are aware of current progress, strategy and thinking.

10.3 LIST OF TASKS

10.3.1 In order to fulfil the programme of work outlined in the method statement (*Section 9*), the project has been broken down into a series of summary tasks, which are set out in Table 9.

Task	Description	Performed by	Days
	SET-UP AND MONITORING		
1	Academic Management	Rachel Newman	1
2	Management	Richard Gregory	1
	TRANSPORT OF MATERIALS		
3	Transport relevant artefactual assemblages to appropriate specialists	Sandra Bonsall Archaeologist (tbc)	1 1
	ANALYSIS		
4	Stratigraphic analysis and preparation of stratigraphic text	Richard Gregory Chris Wild	5 2
5	Glass analysis and report preparation	David Dungworth	15
6	Preparation of report on pottery	Reg Jackson	5
	RESEARCH		
8	Documentary research	Vix Hughes	2
9	Additional research	Richard Gregory	2
	ACADEMIC PUBLICATION		
10	Preparation of publication text	Richard Gregory Chris Wild	9 1
11	Preparation of summary reports on finds	Chris Howard-Davis	3
12	Preparation of publication illustrations	Adam Parsons/ Marie Rowland	9.5
13	Editing of publication text	Richard Gregory	1
14	Quality control editing of draft publication text	Rachel Newman	1
15	Addressing comments from external reviewers	Richard Gregory Adam Parsons	1 0.5
	ARCHIVING		
16	Archive preparation	Sandra Bonsall Archaeologist (tbc)	4 18
17	Archive deposition	Archaeologist (tbc)	2

Table 9: Task list

BIBLIOGRAPHY

PRIMARY SOURCES

Cartographic Sources (Bristol Record Office)

Ashmead, GC, 1855 *Map of Bristol*

Ashmead, GC, and Plumley, J, 1828 *Plan of the City of Bristol and its Suburbs*

British Geological Survey (BGS), 2004 *Bristol: solid and drift, 1:50000 scale geological map*

Goad Insurance Plan, 1939 Volume II for Bristol, covering area of east central Bristol: area roughly bounded by Temple Meads to Horsefair on north and west, Feeder Road to Clarence Place on south and east

Hicks, W, 1847 Tithe map of St Philip and Jacob (parish), Gloucestershire

Ordnance Survey 6":1mile Gloucestershire LXXVI.NW, published 1850

Ordnance Survey First Edition 1:500 plan, surveyed 1883, published 1885

Ordnance Survey 1:2500 plan, revised 1902, published 1906

Ordnance Survey 1:2500 plan, revised 1912, published 1918

Roque, J, 1742 *Plan of the City of Bristol*

Bristol Record Office

Bristol Calendar, 1792

Bristol Gazette, 13th May, 1790

Daily Post 14th November, 1738

Farley's Bristol Journal, 1752

Farley's Bristol Journal, 1765

Farley's Bristol Journal, 1819

Freeholders' Journal, 1722

Patent Office, London

British Patent (BP)

BP 167, 1861 *Improvements in furnaces*

BP 929, 1769 *Tank and furnace system*

BP 1320, 1857 *Improvements in furnaces and in the application of heated currents*

BP 1513, 1870 *Furnaces for manufacturing glass*

BP 2861, 1856 *Improved arrangement of furnaces which improvements are applicable in all cases where great heat is required*

BP 3478, 1872 *Glass furnaces*

BP 4623, 1821 *An improvement in the art or method of making or manufacturing glass bottles such as are used for wine, porter, beer or cyder*

Pilkington Archive (PA)

Minutes of the board 17th April 1873

Trade Directories

Kelly, 1925 *Directory of Bristol*, Bristol

Mathews, 1794 *New history of Bristol or complete guide and Bristol directory for the year 1793-4*, Bristol

Mathews, 1820 *Bristol and Clifton directory and almanack*, Bristol

Mathews, 1825 *Bristol and Clifton directory and almanack*, Bristol

Mathews, 1851 *Bristol street directory*, Bristol

Mathews, 1875 *Bristol street directory*, Bristol

SECONDARY SOURCES

Allan, JP, 1984 *Medieval and post-medieval finds from Exeter, 1971-1980*, Exeter

Allan, JP, and Barber, J, 1992 A seventeenth-century pottery group from the Kitto Institute, Plymouth, in D Gaimster and M Redknap (eds), *Everyday and exotic pottery from Western Europe: studies in honour of J G Hurst*, Oxford, 225-45

Angus-Butterworth, LM, 1958 Glass, in C Singer, EJ Holmyard, AR Hall, and TI Williams (eds), *A history of technology,* **4**: *The Industrial Revolution c 1750 to c 1850*, Oxford, 358-78

AOC, 2002 *Report on an archaeological evaluation at land to the rear of Avon Street, Bristol*, unpubl rep

AOC, 2004 *Archaeological evaluation and follow-on-works at land to the north-west of Avon Street, Bristol*, unpubl rep

Ashmore, O, 1969 *The industrial archaeology of Lancashire*, Newton Abbot

Ashurst, D, 1970 Excavations at Gawber Glasshouse, near Barnsley, Yorkshire, *Post-Medieval Archaeol*, **4**, 92-140

Ashurst, D, 1987 Excavations of a 17th-18th century glasshouse at Bolsterstone and the 18th Century Bolsterstone Pothouse, Stockbridge, Yorkshire, *Post-Medieval Archaeol*, **21**, 147-226

Ashurst, D, 1992 The Silkstone Glasshouse, *Old West Riding*, **12**, 15-19

Askey, D, 1981 *Stoneware bottles*, Brighton

Atkinson, DR, 1975 *Tobacco pipes of Broseley, Shropshire*, Essex

BaRAS, 1995 *Archaeological evaluation of land at Avon Street, Bristol*, unpubl rep

Barrett, W, 1789 *The history and antiquities of the City of Bristol*, Bristol

Barker, D, 1993 *Slipware*, Princes Risborough

Barker, D, 2010 Producing for the table: a view from the Staffordshire Potteries, in J Symonds (ed), *Table settings: the material culture and social context of dining*, Oxford, 6-20

Barker, TC, 1960 *Pilkington Brothers and the glass industry*, London

Barker, TC, 1977 *The glassmakers*, London

Bartholomew, J, 1887 *Gazetteer of the British Isles*, London

Barton, KJ, 1961 Some evidence for two types of pottery manufactured in Bristol in the early 18th century, *Trans Bristol Gloucestershire Archaeol Soc*, **61**, 160-8

Berg, T, and Berg, P (eds), 2001 *R R Angerstein's illustrated travel diary, 1753-1755*, London

Betts Brown, A (ed), 1866 *Engineering facts and figures for 1865: annual register of progress in mechanical engineering and construction*, Edinburgh

Binford, LR, 1978 A new method of calculating dates from kaolin pipe stem samples, in R Schuyler (ed), *Historical archaeology: a guide to substantive and theoretical contributions*, New York, 66-7

Blakelock, E, 2007 *Bedminster Glue Factory, Bristol: examination and analysis of glass and glassworking debris*, English Heritage Res Dept Rep, **11/2007**, unpubl rep

Boessneck, J, 1969 Osteological differences between sheep (*Ovis aries* Linne) and goat (*Capra hircus* Linne), in D Brothwell and E Higgs (eds), *Science in Archaeology*, 2nd edn, London, 331-58

Bone, M, and Dawson, D, 2008 Post-medieval, industrial and modern, in Webster 2008, 213-67

Boswell, PGH, 1918 *A memoir on British resources of sands and rocks used in glass-making*, London

Buchanan, A, and Cossons, N, 1969 *The industrial archaeology of the Bristol region*, Newton Abbot

Cable, M, 2000 The development of glass-melting furnaces 1850–1950, *Trans Newcomen Soc*, **71**, 205-27

Cable, M, 2002 The mechanisation of glass container production, *Trans Newcomen Soc*, **73**, 1-31

Cable, M (ed), 2003 *The art of glass by Antonio Neri and translated by Christopher Merrett*, Sheffield

Cable, M, and Smedley, JW, 1987 Liquidus temperatures and melting characteristics of some early container glasses, *Glass Technol*, **28**, 94-8

Chaloner, WH, and Musson, AE, 1969 *Industry and technology*, London

Charleston, RJ, 1984 *English glass and the glass used in England c 400-1940*, London

Coleman-Smith, R, and Pearson, T, 1988 *Excavations in the Donyatt Potteries*, Chichester

Cockeram, T, 1998 *Stourbridge industry: Rufford & Co*, http://www.84f.com/chronology/1880s/188700rc.htm

Cossons, N (ed), 1972 *Rees's manufacturing industry (1819-20)*, Newton Abbot

Countryside Agency, 1999 *Countryside Character, **8**: South West*, Cheltenham

Cranstone, D, 2003 From Newby Hall to navvy camp: power, pots and people in post-medieval archaeology, in TG Manby, S Moorhouse, and P Ottaway (eds), *The archaeology of Yorkshire: an assessment at the beginning of the 21st Century*, Yorkshire Archaeol Soc Occ Pap, **3**, Leeds, 215-21

Crossley, D, 1990 *Post-medieval archaeology in Britain*, Leicester

Crossley, D, 1993 *Monuments Protection Programme: the glass industry, Step 1*, unpubl rep

Crossley, D, 1996 *Monuments Protection Programme: The glass industry, introduction to Step 3 site assessments*, unpubl rep

Curry, CK, 1993 The archaeology of the flowerpot in England and Wales, *circa* 1650-1950, *J Garden Hist Soc*, **21**(2), 227-46

Defoe, D, 1769 *A tour through the whole island of Great Britain*, **2**, 7th edn, London

Diderot, D, 1771 *Encyclopédie, ou dictionnaire raisonné des sciences, des arts et des métiers*, Paris

Dobney, K, and Reilly, K, 1988 A method for recording archaeological animal bones: the use of diagnostic zones, *Circaea*, **5**(2), 79-96

Dodsworth, R, 1982 *Glass and glassmaking*, Princes Risborough

Douglas, RW, and Frank, S, 1972 *A history of glass making*, Henley-on-Thames

Dungworth, D, 2003 *Scientific examination of glass and glass working materials from Silkstone, Yorkshire*, English Heritage Centre Field Archaeol rep, **90/2003**, unpubl rep

Dungworth, D, 2005 *Investigation of 18th-century glass and glass working waste from Limekiln Lane, Bristol*, English Heritage Centre Field Archaeol rep, **7/2005**, unpubl rep

Dungworth, D, 2006 *Silkstone, South Yorkshire: analysis of early 18th-century window glass*, English Heritage Res Dept rep, **18/2006**, unpubl rep

Dungworth, D, 2007 *St Thomas Street, Bristol: examination and analysis of glass and glass-working debris*, unpubl rep

Dungworth, D, 2012 Three and half centuries of bottle manufacture, *Ind Archaeol Rev*, **34**(1), 37-50

Dungworth, D, and Cromwell, T, 2006 Glass and pottery production at Silkstone, *Post-Medieval Archaeol*, **40**, 160–90

Ellis, J, 2002 *Glassmakers of Stourbridge and Dudley*, *1612-2002*, Harrogate

English Heritage, 1991a *Management of archaeological projects*, 2nd edn, London

English Heritage, 1991b *Exploring our past*, London

English Heritage, 1997 *Archaeology Division research agenda (Draft)*, unpubl doc

English Heritage, 2006 *Management of research projects in the Historic Environment*, London

Fletcher, E, 1976 *Antique bottles in colour*, Poole

Godfrey, ES, 1975 *The development of English glassmaking 1560–1640*, Chapel Hill

Grace's Guide Ltd, 2013 Lovatt and Lovatt, in Grace's Guide Ltd, *Grace's guide to British industrial history*, www.gracesguide.co.uk/Lovatt_and_Lovatt#Sources_of_Information

Grant, A, 1982 The use of tooth wear as a guide to the age of domestic ungulates, in B Wilson, C Grigson, and S Payne (eds), *Ageing and sexing animal bones from archaeological sites*, BAR Brit Ser, **109**, Oxford, 91-108

Grimke-Drayton, TD, 1915 The east window of Gloucester Cathedral, *Bristol Gloucestershire Archaeol Soc*, **38**, 69-97

Halstead, P, 1985 A study of mandibular teeth from Romano-British contexts at Maxey, in FM Pryor, CAI French, D Crowther, D Gurney, G Simpson, and M Taylor, *Archaeology and environment in the Lower Welland Valley*, East Anglian Archaeol, **27**(1), Cambridge, 219-23

Halstead, P, 1992 Demi & DMP: Faunal remains plus animal exploitation in Late Neolithic Thessaly, *Ann Brit Sch Athens*, **87**, 29-59

Harley, LS, 1974 A typology of brick: with numerical coding of brick characteristics, *J Brit Archaeol Ass*, ser 3, **37**, 63-87

Institute of Archaeologists (IfA), 2001a *Standard and guidance for archaeological excavation*, Reading

Institute of Archaeologists (IfA), 2001b *Standard and guidance for an archaeological watching brief*, Reading

Insole, P, and Jackson, R, 2000 The excavation of a clay tobacco pipe kiln, Temple Quay, Bristol, *Bristol Avon Archaeol*, **17**, 129-38

Jackson, R, 2000a Two groups of post-medieval pottery kiln waste from Temple Quay, Bristol, 1994, *Bristol Avon Archaeol*, **17**, 111-17

Jackson, R, 2000b Archaeological excavations at Upper Maudlin Street, Bristol, in 1973, 1976 and 1999, *Bristol Avon Archaeol*, **17**, 29-110

Jackson, R, 2003 Late 17th-century stoneware waste from the Tower Harratz Pottery, Bristol, *Post-Medieval Archaeol*, **37**(2), 217-20

Jackson, R, 2004 Archaeological excavations at Nos 30-38 St Thomas Street and No 60 Redcliffe Street, Bristol, 2000, *Bristol Avon Archaeol*, **19**, 1-63

Jackson, R, 2005 Excavations on the site of Sir Abraham Elton's Glassworks, Cheese Lane, Bristol, *Post-Medieval Archaeol*, **39**(1), 92-132

Jackson, R, 2006 *Excavations at St James's Priory, Bristol*, Oxford

Jackson, R, 2007 The Portwall Lane Glassworks, Bristol, *The Archaeologist*, **64**, 24-5

Jackson, R, Jackson, P, and Beckey, I, 1991 Tin-glazed earthenware kiln waste from the Limekiln Lane Potteries, Bristol, *Post-Medieval Archaeol*, **25**, 89-114

Jackson, R, Jackson, P, and Price, R, 1982 *Bristol potters and potteries 1600-1800*, J Ceramic Hist, **12**, Stoke-on-Trent

Jackson, RG, and Price, RH, 1974 *Bristol clay pipes: a study of makers and their marks*, Bristol City Mus Res Monog, **1**, Bristol

Jones, OR, 1986 *Cylindrical English wine and beer bottles 1735-1850*, Quebec

Jones, OR, 2007 The origins of Lund's Bristol Porcelain and the site of the Bristol Manufactory, *Northern Ceramic J*, **23**, 83-104

Krupa, M, and Heawood, R, 2002 '*The Hotties*': e*xcavation and building survey at Pilkingtons' No 9 Tank House, St Helens, Merseyside*, Lancaster Imprints, **10**, Lancaster

Latimer, J, 1887 *The annals of Bristol in the nineteenth century*, Bristol

Latimer, J, 1893 *The annals of Bristol in the eighteenth century*, Bristol

Lewis, JM, and Philpott, RA, 1992 *Cannington Shaw Bottle Shop, St Helens, Merseyside; archaeological recording of the standing structure*, Liverpool Mus Archaeol Section, unpubl rep

Lord, J, and Southam, J, 1983 *The Floating Harbour: a landscape history of Bristol City Docks*, Bristol

Louw, H, 1991 Window-glass making in Britain *c* 1660-*c* 1860 and its architectural impact, *Construction Hist*, **7**, 47-68

McGarva, A, 2000 *Country pottery: the traditional earthenware of Britain*, London

McGrath, R, and Frost, AC, 1937 *Glass in architecture and decoration*, London

Miller, I, 2007 Percival, Vickers & Co Ltd, Ancoats: the archaeology of a nineteenth-century Manchester flint glass works, *Ind Archaeol Rev*, **29**(1), 13-29

Morgan, R, 1976 *Sealed bottles: their history and evolution 1630-1930*, Burton on Trent

Museums and Galleries Commission (MGC), 1992 *Standards in the museum care of collections*, London

Muspratt, S, 1860 *Chemistry: theoretical, practical and analytical*, Glasgow

Musson, A E, 1965 *Enterprise in soap and chemicals: Joseph Crosfield & Sons, Limited 1815-1965*, Manchester

Musson, AE, and Robinson, E, 1969 *Science and technology in the Industrial Revolution*, Manchester

Neri, A, 1662 *The art of glass*, London

Nicholls, P, and Selvig, WA, 1932 *Clinker formation as related to the fusibility of coal ash*, US Dep Comm, **364**, Washington

Noël Hume, I, 1961 The glass wine bottle in colonial Virginia, *J Glass Stud*, **3**, 90-117

Noël Hume, I, 1969 *A guide to the artifacts of colonial America*, New York

Noël Hume, I, 1982 *Martin's Hundred: the discovery of a lost colonial Virginia settlement*, London

OA North, 2014 3 *Glass Wharf, Temple Quay, Bristol, Avon: summary report of archaeological works*, unpubl rep

OA North, 2016 *Plot ND9*, *Temple Quay, Bristol: summary report of archaeological works*, unpubl rep

Orangina Schweppes International, nd *Heritage timeline*, www. http://schweppes.eu/heritage/

Oswald, O, 1975 *Clay pipes for the archaeologist*, BAR Brit Ser, **14**, Oxford

Parkin, RA, 2000 *The window glass makers of St Helens*, Sheffield

Parkes, S, 1823 *Chemical essays*, **2**, London

Payne, S, 1973 Kill-off patterns in sheep and goat mandibles: the mandibles of Asvan Kale, *Anatolia Stud*, **23**, 281-303

Payne, S, 1987 Reference codes for wear states in the mandibular cheek teeth of sheep and goats, in *Capra*, *J Archaeol Sci*, **12**, 139-47

Pellatt, A, 1849 *Curiosities of glass making*, London

Pountney, WJ, 1920 *Old Bristol potteries*, Bristol

Powell, AC, 1925 Glassmaking in Bristol, *Trans Bristol Gloucester Archaeol Soc*, **47**, 211-57

Powell, HJ, Chance, H, and Harris, HG, 1883 *The principles of glass-making*, London

Price, R, 2005 Pottery kiln waste from Temple Back, Bristol, *Bristol Avon Archaeol*, **20**, 59-114

Redding, C, 1842 *The illustrated itinerary of the county of Lancaster*, London

Sempill, C, 1904 *English pottery and china*, London

Siemens, CW, 1862 On a regenerative gas furnace, as applied to glasshouses, puddling, heating, *etc*, *Proc Inst Mechan Engineers*, **13**, 21-45

Siemens, F, 1884 A new method of heating the regenerative gas-furnace, *J Iron Steel Inst*, **2**, 434-52

Smith, AF, 2004 *The Nailsea Glass-works, Nailsea, North Somerset*, unpubl rep

Stephenson, D, and Willmott, J, 2005 *Images of England: the Dings and St Philips*, Stroud

Turner, WES, 1938 The early development of bottle-making machines in Europe, *J Soc Glass Technol*, **22**, 250-8

Tyler, K, and Wilmott, H, 2005 *Excavations at John Baker's Vauxhall Glasshouse*, MoLAS Monog, **28**, London

UKIC, 1984 *Environmental standards for the permanent storage of excavated material from archaeological sites*, London

UKIC, 1998 *First aid for finds*, London

Van den Bossche, W, 2001 *Antique glass bottles, their history and evolution (1500-1850)*, Woodbridge

Von den Driesch, A, 1976 *A guide to the measurement of animal bones from archaeological sites*, Harvard

Vose, RH, 1980 *Glass*, London

Vose, RH, 1994 Excavations at the 17th-century glasshouse at Haughton Green, Denton, near Manchester, *Post-Medieval Archaeol*, **28**, 1-71

Vose, RH, 1995 Excavations at the *c* 1600 Bickerstaffe Glasshouse, Lancashire, *J Merseyside Archaeol Soc*, **9**, 1-24

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

Webster, CJ (ed), 2008 *The archaeology of South West England. South West Archaeological Research Framework: resource assessment and agenda*, Taunton

Williams, B, and Jackson, R, 2006 Portwall Lane Glassworks, *Current Archaeol*, **207**, 33

Wills, G, 1968 *English and Irish glass*, London

Wills, G, 1974 *English glass bottles for the collector*, Edinburgh

Witt, C, Weeden, C, and Schwind, A, 1984 *Bristol glass*, Bristol

Wood, FL, 2014 *The world of British stoneware: its history, manufacture and wares*, Leicester

APPENDIX 1: SUMMARY CONTEXT LIST

Context	Area	Context type	Category	Phase
1000	ND5	deposit	layer	4
1001	ND5	structure	wall	2
1002	ND5	structure	wall	4
1003	ND5	structure	dock	3
1004	ND5	deposit	fill of dock ***1003***	4
1005	ND5	deposit	fill of dock ***1003***	3
1006	ND5	cut	foundation	3
1007	ND5	structure	railway lines	3
1008	ND5	deposit	layer	2
1009	ND5	deposit	layer	2
1010	ND5	deposit	layer	2
1011	ND5	deposit	layer	2
1012	ND5	deposit	layer	2
1013	ND5	deposit	layer	2
1014	ND5	deposit	layer	2
1015	ND5	deposit	layer	2
1016	ND5	deposit	layer	2
1017	ND5	deposit	layer	2
1018	ND5	deposit	layer	2
1019	ND5	deposit	layer	2
1020	ND5	deposit	layer	2
1021	ND5	deposit	layer	2
1022	ND5	deposit	layer	2
1023	ND5	deposit	layer	2
1024	ND5	deposit	layer	2
1025	ND5	deposit	natural geology	-
1026	ND5	deposit	layer	2
1027	ND5	deposit	layer	2
1028	ND5	deposit	layer	2
1029	ND5	deposit	layer	3
1030	ND5	deposit	layer	2
1031	ND5	deposit	layer	2
1032	ND5	deposit	layer	2
1033	ND5	deposit	layer	2
1034	ND5	deposit	layer	2

Context	Area	Context type	Category	Phase
1035	ND5	cut	Linear feature	2
1036	ND5	deposit	layer	2
1037	ND5	deposit	layer	2
1038	ND5	deposit	layer	2
1039	ND5	deposit	layer	2
1040	ND5	deposit	layer	4
1041	ND5	deposit	layer	2
1042	ND5	deposit	layer	2
1043	ND5	deposit	layer	2
1044	ND5	structure	drain/culvert	3
1045	ND5	cut	drain/culvert	3
1046	ND5	deposit	fill of culvert ***1044***	3
1047	ND5	deposit	backfill	3
1048	ND5	cut	foundation	3
1049	ND5	structure	railway lines	3
1050	ND5	deposit	layer	4
1051	ND5	deposit	layer	2
1052	ND5	deposit	layer	3
1053	ND5	deposit	layer	3
1054	ND5	structure	wall	2
1055	ND5	structure	wall	2
1056	ND5	structure	wall	2
1057	ND5	structure	wall	2
1058	ND5	structure	wall	2
1059	ND5	deposit	layer	2
1060	ND5	structure	floor	2
1061	ND5	structure	wall	2
1062	ND5	structure	flue	2
1063	ND5	structure	wall	3
1064	ND5	deposit	layer	3
1065	ND5	deposit	layer	2
1066	ND5	deposit	layer	3
1067	ND5	deposit	layer	3
1068	ND5	deposit	fill of pit ***1255***	2
1069	ND5	deposit	layer	not closely dated
1070	ND5	structure	wall	2
1071	ND5	structure	wall	2

Context	Area	Context type	Category	Phase
1072	ND5	structure	wall	2
1073	ND5	structure	wall	2
1074	ND5	structure	wall	2
1075	ND5	deposit	floor	2
1076	ND5	deposit	backfill	2
1077	ND5	cut	services	4
1078	ND5	deposit	fill of cellar ***1073***	3 or 4
1079	ND5	deposit	layer	3
1080	ND5	cut	foundation	2
1081	ND5	structure	wall	4
1082	ND5	deposit	fill associated with structure ***1081***	2
1083	ND5	structure	wall	2
1084	ND5	deposit	fill of foundation ***1080***	2
1085	ND5	deposit	natural geology	-
1086	ND5	deposit	layer	4
1087	ND5	deposit	layer	4
1088	ND5	deposit	layer	4
1089	ND5	cut	timber stucture	4
1090	ND5	structure	sleepers	4
1091	ND5	deposit	layer	4
1092	ND5	deposit	layer	3
1093	ND5	structure	steps	2
1094	ND5	deposit	layer	4
1095	ND5	cut	well	not closely dated
1096	ND5	deposit	fill of well ***1097***	not closely dated
1097	ND5	structure	well	2
1098	ND5	deposit	backfill	2
1099	ND5	deposit	layer	2
1100	ND5	structure	wall	2
1101	ND5	structure	floor	2
1102	ND5	deposit	deposit	2
1103	ND5	deposit	deposit	2
1104	ND5	deposit	deposit	2
1105	ND5	deposit	deposit	2
1106	ND5	deposit	deposit	2
1107	ND5	cut	foundation	4
1108	ND5	structure	crane base	4

Context	Area	Context type	Category	Phase
1109	ND5	deposit	fill of crane base ***1108***	4
1110	ND5	structure	crane base	4
1111	ND5	structure	drain/culvert	4
1112	ND5	deposit	layer	3
1113	ND5	structure	floor	3
1114	ND5	deposit	layer	2
1115	ND5	deposit	layer	2
1116	ND5	deposit	layer	2
1117	ND5	structure	wall	2
1118	ND5	cut	drain/culvert	4
1119	ND5	structure	drain/culvert	4
1120	ND5	deposit	fill of drain/culvert ***1119***	4
1121	ND5	structure	wall	2
1122	ND5	structure	wall	2
1123	ND5	structure	wall	2
1124	ND5	cut	crane base	4
1125	ND5	deposit	fill of crane base ***1110***	4
1126	ND5	deposit	fill of pit ***1140***	2
1127	ND5	deposit	fill of pit ***1140***	2
1128	ND5	deposit	fill of pit ***1140***	2
1129	ND5	structure	drain/culvert	2
1130	ND5	cut	drain/culvert	4
1131	ND5	deposit	fill of drain/culvert ***1111***	4
1132	ND5	deposit	layer	3
1133	ND5	cut	foundation	3
1134	ND5	structure	drain/culvert	4
1135	ND5	cut	drain/culvert	4
1136	ND5	deposit	fill of drain/culvert ***1135***	4
1137	ND5	structure	wall	2
1138	ND5	structure	wall	3
1139	ND5	structure	wall	3
1140	ND5	cut	pit	2
1141	ND5	deposit	layer	2
1142	ND5	deposit	layer	2
1143	ND5	deposit	layer	2
1144	ND5	deposit	layer	2
1145	ND5	deposit	fill of pit ***1162***	2

Context	Area	Context type	Category	Phase
1146	ND5	deposit	fill of pit ***1162***	2
1147	ND5	deposit	fill of pit ***1162***	2
1148	ND5	structure	wall	2
1149	ND5	structure	wall	2
1150	ND5	structure	wall	2
1151	ND5	structure	drain/culvert	2
1152	ND5	structure	wall	3
1153	ND5	structure	floor	3
1154	ND5	deposit	layer	2
1155	ND5	structure	wall	2
1156	ND5	structure	wall	2
1157	ND5	structure	wall	2
1158	ND5	structure	wall	2
1159	ND5	structure	wall	2
1160	ND5	structure	wall	2
1161	ND5	cut	foundation	2
1162	ND5	cut	pit	2
1163	ND5	deposit	layer	3
1164	ND5	structure	wall	2
1165	ND5	deposit	layer	3
1166	ND5	deposit	layer	2
1167	ND5	deposit	layer	2
1168	ND5	deposit	layer	2
1169	ND5	deposit	layer	2
1170	ND5	deposit	layer	2
1171	ND5	deposit	layer	2
1172	ND5	deposit	layer	2
1173	ND5	deposit	layer	2
1174	ND5	deposit	layer	2
1175	ND5	deposit	layer	2
1176	ND5	group	layer	2
1177	ND5	deposit	layer	2
1178	ND5	structure	floor	3
1179	ND5	structure	wall	4
1180	ND5	cut	foundation	4
1181	ND5	structure	drain/culvert	4
1182	ND5	cut	drain/culvert	4

Context	Area	Context type	Category	Phase
1183	ND5	structure	wall	2
1184	ND5	structure	wall	2
1185	ND5	deposit	natural geology	-
1186	ND5	structure	steps	2
1187	ND5	structure	steps	2
1188	ND5	deposit	layer	2
1189	ND5	deposit	layer	3
1190	ND5	deposit	layer	2
1191	ND5	deposit	layer	2
1192	ND5	deposit	layer	2
1193	ND5	deposit	layer	2
1194	ND5	deposit	layer	2
1195	ND5	deposit	layer	2
1196	ND5	deposit	layer	2
1197	ND5	deposit	fill of drain/culvert ***1198***	4
1198	ND5	cut	drain/culvert	4
1199	ND5	structure	wall	3
1200	ND5	structure	well	2
1201	ND5	cut	well	2
1202	ND5	deposit	fill associated with structure ***1199***	2
1203	ND5	deposit	layer	3
1204	ND5	deposit	layer	3
1205	ND5	cut	unknown	3
1206	ND5	deposit	layer	3
1207	ND5	deposit	layer	2
1208	ND5	structure	wall	3
1209	ND5	deposit	layer	3
1210	ND5	deposit	deposit	2
1211	ND5	deposit	layer	2
1212	ND5	deposit	fill associated with structure ***1158/1159***	2
1213	ND5	structure	well	2
1214	ND5	structure	floor	2
1215	ND5	deposit	fill of well ***1213***	2
1216	ND5	cut	well	2
1217	ND5	deposit	fill in pit ***1218***	2
1218	ND5	cut	pit	2
1219	ND5	deposit	fill of pit ***1220***	2

Context	Area	Context type	Category	Phase
1220	ND5	cut	pit	2
1221	ND5	structure	wall	2
1222	ND5	deposit	fill associated with structure ***1148***	3
1223	ND5	deposit	fill associated with structure ***1224***	3
1224	ND5	structure	wall	2
1225	ND5	deposit	layer	2
1226	ND5	deposit	fill of pit ***1140***	2
1227	ND5	structure	crane base	4
1228	ND5	cut	crane base	4
1229	ND5	structure	wall	4
1230	ND5	deposit	fill associated with structure ***1229***	4
1231	ND5	deposit	fill of pit ***1232***	2
1232	ND5	cut	pit	2
1233	ND5	cut	pit	2
1234	ND5	deposit	fill of well ***1235***	4
1235	ND5	structure	well	4
1236	ND5	cut	well	4
1237	ND5	deposit	layer	2
1238	ND5	deposit	layer	2
1239	ND5	deposit	fill of pit ***1255***	2
1240	ND5	deposit	fill of pit ***1255***	2
1241	ND5	deposit	fill of pit ***1255***	2
1242	-	not allocated	-	-
1243	ND5	deposit	fill of pit ***1255***	2
1244	ND5	deposit	fill of pit ***1255***	2
1245	ND5	deposit	fill of pit ***1255***	2
1246	ND5	deposit	fill of pit ***1255***	2
1247	ND5	deposit	fill of pit ***1255***	2
1248	ND5	structure	wall	2
1249	ND5	structure	crane base	4
1250	ND5	deposit	fill of crane base ***1249***	4
1251	ND5	cut	drain/culvert	2
1252	ND5	deposit	layer	2
1253	ND5	cut	pit	2
1254	ND5	cut	pit	2
1255	ND5	cut	pit	2
1256	ND5	cut	pit	2

Context	Area	Context type	Category	Phase
1257	ND5	cut	crane base	4
1258-1260	-	not allocated	-	-
1261	ND5	structure	drainage feature?	2
1262	ND5	deposit	layer	2
1263	ND5	deposit	layer	2
1264	ND5	deposit	layer	2
1265	ND5	deposit	layer	2
1266	ND5	deposit	layer	2
1267	ND5	deposit	layer	2
1268-1999	-	not allocated	-	-
2000	ND9	deposit	layer	4
2001	ND9	structure	wall	3
2002	ND9	structure	drain/culvert	3
2003	ND9	structure	wall	3
2004	ND9	deposit	layer	4
2005	ND9	deposit	layer	4
2006	ND9	deposit	layer	4
2007	ND9	deposit	layer	4
2008	ND9	deposit	layer	4
2009	ND9	structure	wall	3
2010	ND9	deposit	layer	4
2011	ND9	deposit	layer	3
2012	ND9	deposit	layer	3
2013	ND9	deposit	layer	3
2014	ND9	fill	layer	3
2015	ND9	deposit	layer	3
2016	ND9	structure	wall	3
2017	ND9	structure	wall	3
2018	ND9	structure	wall	3
2019	ND5	deposit	layer	3
2020	ND9	deposit	layer	3
2021	ND9	structure	wall	3
2022	ND9	deposit	layer	3
2023	ND9	deposit	layer	4
2024	ND9	structure	wall	2
2025	ND9	structure	wall	2
2026	ND9	deposit	layer	2

Context	Area	Context type	Category	Phase
2027	ND9	deposit	layer	3
2028	ND9	structure	drain/culvert	3
2029-2999	-	not allocated	-	-
3000	ND3	deposit	layer	4
3001	ND3	deposit	backfill	4
3002	ND3	structure	foundations	4
3003	ND3	cut	foundation trench	4
3004	ND3	deposit	natural geology	-
3005	ND3	deposit	layer	2
3006	ND3	deposit	layer	2
3007	ND3	deposit	buried soil	2
3008	ND3	deposit	layer	2
3009	-	not allocated	-	-
3010	ND3	structure	wall	2
3011	ND3	structure	wall	2
3012	ND3	deposit	layer	3
3013	ND3	structure	floor	3
3014	ND3	structure	floor	3
3015	ND3	structure	wall	3
3016	ND3	structure	wall	3
3017	ND3	structure	machine base	3
3018	ND3	structure	floor	3
3019	ND3	structure	floor	3
3020	ND3	structure	floor	3
3021	ND3	structure	floor	3
3022	ND3	structure	floor	3
3023	ND3	deposit	fill of pit ***3024***	3
3024	ND3	cut	pit	3
3025	ND3	deposit	fill of pit ***3026***	3
3026	ND3	cut	pit	3
3027	ND3	structure	floor	3
3028	ND3	structure	floor	3
3029	ND3	deposit	layer	3
3030	ND3	structure	floor	3
3031	ND3	structure	modern intrusion	4
3032	ND3	structure	floor	3
3033	ND3	structure	wall	3

Context	Area	Context type	Category	Phase
3034	ND3	structure	wall	4
3035	ND3	deposit	fill of machine base ***3036***	3
3036	ND3	structure	machine base	3
3037	ND3	deposit	fill of service ***3038***	4
3038	ND3	cut	services	4
3039	ND3	deposit	fill of service ***3040***	4
3040	ND3	cut	services	4
3041	ND3	deposit	fill of service ***3042***	4
3042	ND3	cut	services	4
3043	ND3	deposit	layer	3
3044	ND3	deposit	layer	3
3045	ND3	cut	drain	3
3046	ND3	deposit	layer	2
3047	ND3	deposit	layer	2
3048	ND3	structure	floor	3
3049	ND3	structure	modern intrusion	4
3050	ND3	structure	wall	3
3051	ND3	cut	foundation	4
3052	ND3	structure	wall	3
3053	ND3	structure	wall	3
3054	ND3	structure	floor	3
3055	ND3	deposit	backfill	4
3056	ND3	cut	foundation	4
3057	ND3	structure	wall	3 or 4
3058	ND3	cut	foundation	4
3059	ND3	deposit	fill associated with structure ***3057***	3
3060	ND3	deposit	layer	2
3061	ND3	group	building	4
3062	ND3	structure	room	4
3063	ND3	structure	room	4
3064	ND3	structure	room	4
3065	ND3	structure	room	4
3066	ND3	deposit	fill of foundation ***3067***	4
3067	ND3	cut	foundation	4
3068	ND3	structure	machine base	3
3069	ND3	deposit	fill of machine base ***3071***	3
3070	ND3	structure	floor	3

Context	Area	Context type	Category	Phase
3071	ND3	group	machine base	3
3072	ND3	structure	machine base	3
3073	ND3	deposit	layer	3
3074	ND3	structure	machine base	3
3075	ND3	deposit	fill of machine base ***3074***	3
3076	ND3	structure	room	3
3077	ND3	deposit	fill of room ***3076***	3
3078	ND3	structure	floor	2
3079	ND3	structure	floor	2
3080	ND3	structure	floor	3
3081	ND3	structure	floor	3
3082	ND3	cut	foundation	2
3083	ND3	structure	wall	2
3084	ND3	structure	floor	2
3085	ND3	structure	wall	4
3086	ND3	cut	services	4
3087	ND3	deposit	fill of service ***3086***	4
3088	ND3	structure	wall	2
3089	ND3	structure	floor	3
3090	ND3	deposit	layer	2
3091	ND3	cut	services	4
3092	ND3	deposit	fill of services ***3091***	4
3093	ND3	structure	wall	3
3094	ND3	structure	floor	3
3095	ND3	cut	foundation	3
3096	ND3	deposit	fill associated with structure ***3093***	3
3097	ND3	structure	wall	2
3098	ND3	structure	wall	2
3099	ND3	structure	wall	2
3100	ND3	structure	floor	2
3101	ND3	structure	floor	2
3102	ND3	deposit	layer	3
3103	ND3	deposit	layer	2
3104	ND3	deposit	layer	2
3105	ND3	deposit	fill of foundation ***3095***	3
3106	ND3	deposit	fill of services ***3091***	4
3107	ND3	structure	floor	4

Context	Area	Context type	Category	Phase
3108	ND3	deposit	layer	2
3109	ND3	deposit	fill of services ***3091***	4
3110	ND3	deposit	layer	2
3111	ND3	deposit	fill of ditch ***3112***	3
3112	ND3	cut	ditch	3
3113	ND3	deposit	layer	3
3114	ND3	deposit	deposit	3
3115	ND3	structure	wall	3
3116	ND3	deposit	layer	4
3117	ND3	structure	rail lines	4
3118	ND3	structure	floor	2
3119	ND3	deposit	layer	2
3120	ND3	deposit	layer	2
3121	ND3	deposit	layer	2
3122	ND3	deposit	layer	2
3123	ND3	deposit	layer	2
3124	ND3	structure	wall	3
3125	ND3	structure	floor	3
3126	ND3	structure	floor	3
3127	ND3	deposit	layer	3
3128	ND3	deposit	layer	3
3129	ND3	deposit	layer	3
3130	ND3	deposit	demolition material	4
3131	ND3	deposit	demolition material	4
3132	-	not allocated	-	-
3133	-	not allocated	-	-
3134	ND3	deposit	layer	2
3135	ND3	deposit	layer	2
3136	ND3	structure	floor	3
3137	ND3	deposit	fill above floor ***3136***	3
3138	ND3	cut	foundation	3
3139	ND3	cut	foundation	3
3140	ND3	deposit	layer	3
3141	ND3	deposit	layer	3
3142	ND3	deposit	layer	3
3143	ND3	deposit	layer	3
3144	ND3	deposit	layer	3

Context	Area	Context type	Category	Phase
3145	ND3	deposit	layer	2
3146	ND3	deposit	layer	2
3147	ND3	deposit	layer	3
3148	ND3	cut	foundation	4
3149	ND3	deposit	layer	1
3150	ND3	cut	linear feature	2
3151	ND3	cut	foundation	2
3152	ND3	structure	wall; same as ***3297***	2
3153	ND3	cut	foundation cut	3
3154	ND3	structure	wall	3
3155	ND3	deposit	rubble	3
3156	ND3	deposit	layer	4
3157	ND3	cut	well	2
3158	ND3	structure	well	2
3159	ND3	deposit	fill of well ***3158***	2
3160	ND3	deposit	layer	4
3161	ND3	deposit	layer	2
3162	ND3	deposit	fill of ditch ***3163***	2
3163	ND3	cut	ditch	2
3164	ND3	structure	wall	2
3165	ND3	structure	wall	2
3166	ND3	deposit	backfill	3
3167	ND3	deposit	layer	2
3168	ND3	structure	floor	2
3169	ND3	structure	wall	3
3170	ND3	deposit	layer	2
3171	ND3	structure	wall	3
3172	ND3	structure	floor	3
3173	ND3	structure	floor	3
3174	ND3	structure	wall	3
3175	ND3	deposit	layer	3
3176	ND3	cut	foundation	2
3177	-	not allocated	-	-
3178	-	not allocated	-	-
3179	-	not allocated	-	-
3180	ND3	cut	foundation	3
3181	ND3	structure	wall	3

Context	Area	Context type	Category	Phase
3182	-	not allocated	-	-
3183	ND3	cut	foundation	2
3184	ND3	structure	wall	2
3185	ND3	structure	wall	3
3186	ND3	structure	rendering	2
3187	ND3	deposit	fill associated with structure ***3184***	2
3188	ND3	structure	wall	2
3189	ND3	structure	wall	2
3190	ND3	structure	wall	2
3191	ND3	structure	floor	2
3192	ND3	structure	wall	2
3193	-	not allocated	-	-
3194	ND3	structure	floor	2
3195	ND3	deposit	layer	3
3196	ND3	structure	wall	2
3197	ND3	cut	foundation	2
3198	ND3	structure	rendering	2
3199	ND3	structure	wall	2
3200	ND3	cut	foundation	2
3201	ND3	structure	wall	2
3202	ND3	cut	foundation	2
3203	ND3	deposit	layer	2
3204	ND3	cut	linear feature	2
3205	ND3	deposit	layer	2
3206	ND3	deposit	fill of recut ***3210***	2
3207	ND3	deposit	fill of recut ***3210***	2
3208	ND3	cut	drain/culvert	not closely dated
3209	ND3	structure	drain	not closely dated
3210	ND3	cut	recut	2
3211	ND3	deposit	clay lining	2
3212	ND3	deposit	layer	2
3213	ND3	deposit	fill of foundation ***3218***	2
3214	ND3	deposit	fill of foundation ***3216***	3
3215	ND3	structure	wall	2
3216	ND3	cut	foundation	3
3217	ND3	structure	wall	3
3218	ND3	cut	foundation	3

Context	Area	Context type	Category	Phase
3219	ND3	structure	wall	3
3220	ND3	structure	wall	2
3221	ND3	cut	foundation	2
3222	ND3	structure	wall	2
3223	ND3	deposit	layer	2
3224	ND3	deposit	layer	2
3225	ND3	deposit	layer	2
3226	ND3	deposit	fill associated with structure ***3217***	3
3227	ND3	deposit	layer	2
3228	ND3	deposit	layer	2
3229	ND3	deposit	layer	2
3230	ND3	cut	disturbed feature	2
3231	ND3	deposit	layer	3
3232	ND3	deposit	layer	3
3233	ND3	deposit	layer	2
3234	ND3	deposit	layer	2
3235	ND3	deposit	layer	2
3236	ND3	deposit	layer	2
3237	ND3	deposit	layer	2
3238	ND3	structure	wall	2
3239	ND3	structure	drain/culvert	3
3240	ND3	cut	drain/culvert	3
3241	ND3	deposit	layer	2
3242	ND3	deposit	fill of drain/culvert ***3240***	3
3243	ND3	deposit	layer	2
3244	ND3	cut	foundation	2
3245	ND3	deposit	fill of foundation ***3244***	2
3246	ND3	deposit	fill of foundation ***3244***	3
3247	ND3	deposit	fill of drain/culvert ***3240***	3
3248	ND3	cut	foundation	3
3249	ND3	structure	wall	3
3250	ND3	deposit	fill of foundation ***3248***	3
3251	ND3	deposit	fill of pit ***3252***	2
3252	ND3	cut	pit	2
3253	ND3	deposit	fill of pit ***3254***	2
3254	ND3	cut	pit	2
3255	ND3	structure	wall	2

Context	Area	Context type	Category	Phase
3256	ND3	deposit	layer	2
3257	ND3	deposit	layer	2
3258	ND3	deposit	layer	2
3259	ND3	deposit	layer	2
3260	ND3	deposit	layer	2
3261	ND3	deposit	fill of drain/culvert ***3239***	3
3262	ND3	deposit	layer	2
3263	ND3	structure	wall	2
3264	ND3	structure	floor	2
3265	ND3	deposit	layer	1
3266	ND3	deposit	layer	2
3267	ND3	structure	well	3
3268	ND3	cut	well	3
3269	ND3	deposit	fill of well ***3268***	3
3270	ND3	cut	foundation	3
3271	ND3	structure	wall	3
3272	ND3	structure	floor	3
3273	ND3	cut	foundation	3
3274	ND3	structure	wall	3
3275	ND3	deposit	fill associated with structure ***3274***	3
3276	ND3	cut	foundation	3
3277	ND3	deposit	fill of foundation ***3276***	3
3278	ND3	cut	pit	3
3279	ND3	deposit	fill of pit ***3278***	3
3280	ND3	structure	wall	3
3281	ND3	cut	foundation	3
3282	ND3	structure	wall	3
3283	ND3	structure	floor	3
3284	ND3	cut	foundation	3
3285	-	not allocated	-	-
3286	-	not allocated	-	-
3287	ND3	structure	floor	3
3288	ND3	structure	floor	3
3289	ND3	cut	feature	3
3290	ND3	structure	wall	3
3291	-	not allocated	-	-
3292	ND3	structure	wall	3

Context	Area	Context type	Category	Phase
3293	ND3	structure	wall	3
3294	ND3	structure	wall	3
3295	ND3	structure	floor	3
3296	ND3	structure	wall	3
3297	ND3	structure	wall; same as ***3152***	2
3298	ND3	structure	wall	3
3299	-	not allocated	-	3
3300	ND3	structure	floor	3
3301	ND3	deposit	fill associated with structure ***3302***	3
3302	ND3	structure	wall	2
3303	ND3	structure	wall	3
3304	ND3	structure	wall	3
3305	ND3	deposit	fill above floor ***3300***	3
3306	ND3	structure	floor	3
3307	ND3	structure	wall	4
3308	ND3	structure	floor	3
3309	ND3	structure	floor	3
3310	ND3	structure	floor	3
3311	ND3	structure	floor	3
3312	ND3	structure	floor	3
3313	ND3	structure	floor	3
3314	ND3	structure	floor	3
3315	ND3	structure	floor	3
3316	ND3	structure	floor	3
3317	ND3	structure	wall	3
3318	ND3	structure	wall	3
3319	ND3	structure	floor	3
3320	ND3	structure	floor	3
3321	ND3	deposit	layer	3
3322	ND3	deposit	layer	2
3323	ND3	deposit	layer	3 or 4
3324	ND3	deposit	layer	2
3325	ND3	deposit	layer	2
3326	ND3	deposit	layer	3
3327	ND3	deposit	layer	3
3328	ND3	deposit	layer	2
3329	ND3	deposit	layer	2

Context	Area	Context type	Category	Phase
3330	ND3	deposit	layer	2
3331	ND3	deposit	layer	2
3332	ND3	deposit	layer	3
3333	ND3	deposit	layer	3
3334	ND3	structure	facing	3
3335	ND3	cut	linear feature	4
3336	ND3	deposit	fill of linear feature ***3335***	4
3337	ND3	cut	modern intrusion	3
3338	ND3	deposit	layer	3
3339	ND3	cut	foundation	3
3340	ND3	deposit	layer	3
3341	ND3	deposit	layer	3
3342	ND3	deposit	layer	3
3343	ND3	deposit	layer	3
3344	-	not allocated	-	-
3345	-	not allocated	-	-
3346	ND3	deposit	layer	3
3347	ND3	deposit	layer	3
3348	ND3	deposit	layer	3
3349	ND3	deposit	layer	2
3350	ND3	deposit	layer	3
3351	ND3	deposit	layer	3
3352	ND3	structure	wall	2
3353	ND3	structure	wall	2
3354	ND3	structure	floor	3
3355	ND3	structure	floor	3
3356	ND3	structure	floor	3
3357	ND3	structure	floor	3
3358	-	not allocated	-	-
3359	ND3	structure	floor	3
3360	ND3	structure	floor	3
3361	-	not allocated	-	-
3362	ND3	cut	drain/culvert	4
3363	ND3	structure	drain/culvert	4
3364	ND3	deposit	fill of drain/culvert ***3363***	4
3365	ND3	deposit	natural geology	-
3366	ND3	structure	chamber	3

Context	Area	Context type	Category	Phase
3367	ND3	structure	chamber	3
3368	ND3	structure	chamber	3
3369	ND3	structure	chamber	3
3370	ND3	group	furnace	3
3371	ND3	deposit	layer	3
3372	ND3	deposit	layer	3
3373	ND3	deposit	layer	3
3374	ND3	deposit	layer	3
3375	ND3	deposit	layer	3
3376	ND3	deposit	layer	3
3377	ND3	deposit	natural geology	-
3378	-	not allocated	-	-
3379	ND3	deposit	layer	3
3380	ND3	deposit	layer	3
3381	ND3	deposit	layer	3
3382	ND3	deposit	layer	3
3383	ND3	deposit	layer	3
3384	ND3	deposit	layer	3
3385	ND3	group	furnace	3
3386	ND3	group	room	3
3387	ND3	structure	floor	3
3388	ND3	structure	wall	2
3389	ND3	structure	wall	2
3390	ND3	structure	wall	2
3391	ND3	deposit	layer	3
3392	ND3	deposit	layer	3
3393	ND3	structure	room	2
3394	ND3	structure	wall	2
3395	ND3	structure	wall	2
3396	ND3	structure	floor	2
3397	ND3	deposit	layer	2
3398	ND3	deposit	layer	3
3399	ND3	deposit	layer	3
3400	ND3	deposit	layer	3
3401	ND3	deposit	layer	2
3402	ND3	deposit	layer	1
3403	ND3	deposit	layer	2

Context	Area	Context type	Category	Phase
3404	ND3	deposit	layer	2
3405	ND3	structure	wall	not closely dated
3406	ND3	structure	wall	not closely dated
3407	ND3	deposit	layer	not closely dated
3408	ND3	deposit	fill associated with structure ***3394***	3
3409	ND3	deposit	fill in room ***3393***	3
3410	ND3	structure	floor	3
3411	ND3	structure	drain/culvert	2
3412	ND3	structure	wall	3
3413	ND3	structure	wall	3
3414	ND3	structure	floor	3
3415	ND3	structure	wall	3
3416	ND3	structure	wooden structure	3
3417	ND3	structure	drain/culvert	not closely dated
3418	ND3	deposit	floor	2
3419	ND3	deposit	layer	3
3420	ND3	deposit	layer	2
3421	ND3	structure	drain/culvert	not closely dated
3422	ND3	deposit	floor	2
3423	ND3	deposit	layer	3
3424	ND3	deposit	layer	3
3425	ND3	deposit	layer	3
3426	ND3	deposit	layer	3
3427	ND3	cut	linear feature	4
3428	ND3	deposit	fill of linear feature ***3427***	4
3429	ND3	deposit	natural geology	-
3430	ND3	deposit	layer	2
3431	ND3	cut	foundation	2
3432	ND3	deposit	fill of foundation ***3431***	2
3433	ND3	cut	services	4
3434	ND3	deposit	fill of services ***3433***	4
3435	ND3	deposit	fill of services ***3433***	4
3436	ND3	structure	modern intrusion	4
3437	ND3	cut	rectangular feature	not closely dated
3438	ND3	deposit	fill of rectangular feature ***3437***	not closely dated
3439	ND3	deposit	natural geology	-
3440	ND3	deposit	fill of drain/culvert ***3421***	not closely dated

Context	Area	Context type	Category	Phase
3441	ND3	structure	drain/culvert	4
3442	ND3	deposit	layer	2
3443	ND3	cut	pipe trench	4
3444	ND3	deposit	layer	2
3445	ND3	deposit	layer	2
3446	ND3	deposit	layer	2
3447	ND3	deposit	layer	2
3448	ND3	deposit	fill of drain/culvert ***3441***	4
3449	ND3	cut	modern intrusion	4
3450	ND3	structure	modern intrusion	4
3451	ND3	deposit	natural geology	-
3452	ND3	deposit	layer	2
3453	ND3	cut	ditch	2
3454	ND3	deposit	layer	2
3455	ND3	deposit	layer	2
3456	ND3	cut	pit	not closely dated
3457	ND3	deposit	fill of pit ***3456***	not closely dated
3458	ND3	deposit	fill of pit ***3456***	not closely dated
3459	ND3	cut	feature	2
3460	ND3	deposit	Fill of foundation ***3464***	2
3461	ND3	structure	wall	2
3462	ND3	deposit	layer	2
3463	ND3	deposit	natural geology	-
3464	ND3	cut	foundation	2
3465	ND3	deposit	layer	3
3466	ND3	deposit	layer	3
3467	ND3	deposit	layer	3
3468	ND3	deposit	fill of pit ***3471***	2
3469	ND3	deposit	layer	2
3470	ND3	deposit	layer	2
3471	ND3	cut	pit	2
3472	ND3	deposit	layer	2
3473	ND3	deposit	layer	2
3474	ND3	deposit	layer	2
3475	ND3	deposit	layer	2
3476	ND3	structure	drain/culvert	3
3477	ND3	structure	floor	3

Context	Area	Context type	Category	Phase
3478	ND3	structure	floor	3
3479	ND3	structure	floor	3
3480	ND3	structure	floor	3
3481	ND3	structure	floor	3
3482	ND3	structure	floor	3
3483	ND3	deposit	layer	2
3484	ND3	structure	floor	3
3485	ND3	deposit	rubble	3
3486	ND3	deposit	rubble	4
3487	ND3	deposit	layer	1
3488	ND3	structure	modern intrusion	4
3489	ND3	cut	foundation	3
3490	ND3	deposit	fill of drain/culvert ***3491***	4
3491	ND3	cut	drain/culvert	4
3492	ND3	deposit	layer	3
3493	ND3	deposit	layer	2
3494	ND3	deposit	layer	3
3495	ND3	deposit	layer	3
3496	-	not allocated	-	-
3497	-	not allocated	-	-
3498	ND3	deposit	backfill	4
3499	ND3	structure	wall	3
3500	ND3	structure	drain/culvert	not closely dated
3501	ND3	structure	drain/culvert	not closely dated
3502	ND3	group	furnace	3
3503	ND3	deposit	layer	2
3504	ND3	deposit	layer	3
3505	ND3	deposit	Fill of switch room ***3506***	3
3506	ND3	group	room	2
3507	ND3	structure	floor	2
3508	ND3	deposit	layer	3
3509	ND3	structure	wall	2
3510	ND3	structure	wall	3
3511	ND3	structure	wall	2
3512	ND3	structure	wall	3
3513	ND3	structure	floor	3
3514	ND3	structure	floor	3

Context	Area	Context type	Category	Phase
3515	ND3	structure	wall	3
3516	ND3	structure	floor	3
3517	ND3	structure	floor	3
3518	ND3	structure	floor	3
3519	ND3	structure	wall	3
3520	ND3	structure	wall	4
3521	ND3	structure	room	4
3522	ND3	structure	drain/culvert	not closely dated
3523	ND3	deposit	fill of foundation ***3632***	4
3524	ND3	structure	well	not closely dated
3525	ND3	structure	wall	4
3526	ND3	structure	access passage	4
3527	ND3	structure	floor	3
3528	ND3	structure	wall	2
3529	ND3	structure	drain/culvert	4
3530	ND3	structure	wall	2
3531	ND3	deposit	fill of services ***3532***	4
3532	ND3	cut	services	4
3533	ND3	deposit	layer	3
3534	ND3	structure	drain/culvert	3
3535	ND3	deposit	layer	3
3536	ND3	deposit	layer	1
3537	ND3	deposit	natural geology	-
3538	ND3	deposit	backfill	4
3539	-	not allocated	-	-
3540	ND3	cut	services	4
3541	ND3	deposit	fill of services ***3540***	4
3542	ND3	deposit	layer	2
3543	ND3	deposit	layer	2
3544	ND3	deposit	layer	2
3545	ND3	deposit	layer	2
3546	ND3	deposit	layer	2
3547	ND3	deposit	layer	2
3548	ND3	deposit	layer	2
3549	ND3	deposit	layer	2
3550	ND3	deposit	layer	2
3551	ND3	deposit	layer	2

Context	Area	Context type	Category	Phase
3552	ND3	deposit	layer	2
3553	ND3	deposit	layer	2
3554	ND3	deposit	layer	2
3555	ND3	deposit	layer	2
3556	ND3	deposit	layer	2
3557	ND3	deposit	layer	2
3558	ND3	deposit	layer	2
3559	ND3	deposit	layer	2
3560	ND3	deposit	layer	2
3561	ND3	deposit	layer	2
3562	ND3	cut	foundation	2
3563	ND3	deposit	fill of foundation ***3562***	2
3564	ND3	structure	wall	2
3565	ND3	structure	wall	2
3566	ND3	structure	wall	3
3567	ND3	structure	floor	3
3568	ND3	deposit	layer	2
3569	ND3	deposit	layer	4
3570	ND3	deposit	fill of drain/culvert ***3639***	4
3571	ND3	cut	drain/culvert	4
3572	ND3	deposit	fill of drain/culvert ***3529***	4
3573	ND3	structure	wall	3
3574	ND3	deposit	backfill	4
3575	ND3	structure	wall	2
3576	ND3	structure	floor	3
3577	ND3	deposit	layer	3
3578	ND3	cut	foundation	2
3579	ND3	structure	wall	2
3580	ND3	cut	drain/culvert	4
3581	ND3	structure	drain/culvert	4
3582	ND3	structure	wall	3
3583	ND3	structure	wall	3
3584	ND3	structure	modern intrusion	4
3585	ND3	deposit	fill of foundation ***3067***	4
3586	ND3	cut	services	4
3587	ND3	deposit	layer	2
3588	ND3	cut	well	2

Context	Area	Context type	Category	Phase
3589	ND3	deposit	fill of well ***3588***	2
3590	ND3	structure	wall	3
3591	ND3	structure	drain/culvert	3
3592	ND3	structure	floor	2
3593	ND3	structure	wall	not closely dated
3594	ND3	structure	floor	3
3595	ND3	structure	wall	3
3596	ND3	structure	wall	4
3597	ND3	structure	floor	3
3598	ND3	structure	wall	3
3599	ND3	structure	wall	2
3600	ND3	structure	wall	2
3601	ND3	structure	floor	2
3602	ND3	structure	wall	2
3603	ND3	structure	wall	2
3604	ND3	deposit	layer	3
3605	ND3	structure	modern intrusion	4
3606	ND3	deposit	layer	3
3607	ND3	deposit	layer	3
3608	ND3	deposit	floor	2
3609	ND3	deposit	layer	2
3610	ND3	structure	drain/culvert	4
3611	ND3	structure	floor	3
3612	ND3	cut	foundation	2
3613	ND3	deposit	backfill	2
3614	ND3	deposit	layer	3
3615	ND3	structure	drain/culvert	2
3616	ND3	structure	drain/culvert	3
3617	ND3	group	machine base	4
3618	ND3	deposit	fill of drain/culvert ***3615***	3
3619	ND3	deposit	fill of drain/culvert ***3616***	3
3620	ND3	deposit	fill of drain/culvert ***3616***	3
3621	ND3	deposit	layer	1
3622	ND3	structure	floor	2
3623	ND3	structure	wall	2
3624	ND3	group	room	3
3625	ND3	cut	foundation	3

Context	Area	Context type	Category	Phase
3626	ND3	structure	wall	3
3627	ND3	cut	foundation	4
3628	ND3	cut	foundation	not closely dated
3629	ND3	structure	drain/culvert	3
3630	ND3	structure	tank	2
3631	ND3	deposit	layer	2
3632	ND3	cut	foundation	4
3633	ND3	deposit	fill of passage ***3526***	2
3634	ND3	cut	foundation	2
3635	ND3	structure	well	2
3636	ND3	deposit	fill of well ***3635***	2
3637	ND3	structure	floor	3
3638	ND3	structure	floor	3
3639	ND3	structure	drain/culvert	4
3640	ND3	structure	wall	3
3641	ND3	structure	floor	3
3642	ND3	structure	floor	3
3643	ND3	structure	floor	3
3644	-	not allocated	-	-
3645	-	not allocated	-	-
3646	ND3	structure	wall	3
3647	-	not allocated	-	-
3648	-	not allocated	-	-
3649	ND3	structure	wall	3
3650	ND3	structure	wall	3
3651	ND3	structure	wall	3
3652	ND3	structure	flue	3
3653	ND3	cut	disturbance	3
3654	ND3	structure	flue	3
3655	ND3	structure	flue	3
3656	ND3	structure	wall	3
3657	ND3	deposit	fill of flue ***3659***	3
3658	ND3	structure	wall	3
3659	ND3	structure	flue	3
3660	ND3	deposit	layer	2
3661	ND3	structure	floor	2
3662	ND3	structure	room	3

Context	Area	Context type	Category	Phase
3663	ND3	deposit	fill of room ***3662***	3
3664	ND3	structure	manhole	4
3665	ND3	group	furnace	3
3666	-	not allocated	-	-
3667	ND3	cut	drain/culvert	4
3668	ND3	deposit	fill of manhole ***3664***	4
3669	ND3	deposit	fill of flue ***3652***	3
3670	ND3	structure	wall	2
3671	ND3	structure	wall	2
3672	ND3	structure	wall	4
3673	ND3	structure	modern intrusion	4
3674	ND3	cut	well	2
3675	ND3	structure	well	2
3676	ND3	deposit	fill of well ***3675***	2
3677	ND3	structure	wall	2
3678	ND3	structure	wall	3
3679	ND3	structure	floor	3
3680	ND3	structure	flue	2
3681	ND3	structure	wall	2
3682	ND3	structure	room	3
3683	ND3	deposit	fill of room ***3682***	2
3684	ND3	structure	furnace	2
3685	ND3	structure	furnace	3
3686	ND3	structure	furnace	3
3687	ND3	structure	furnace	3
3688	ND3	structure	floor	3
3689	ND3	structure	floor	3
3690	ND3	structure	switch room	3
3691	ND3	structure	flue	3
3692	ND3	structure	flue	3
3693	ND3	deposit	fill of furnace ***3684***	3
3694	ND3	deposit	fill of furnace ***3685***	3
3695	ND3	deposit	fill of furnace ***3686***	3
3696	ND3	deposit	fill of furnace ***3687***	3
3697	ND3	cut	modern intrusion	4
3698	ND3	structure	modern intrusion	4
3699	ND3	deposit	fill of modern intrusion ***3698***	4

Context	Area	Context type	Category	Phase
3700	ND3	deposit	fill of flue ***3680***	3
3701	-	-	not allocated	-
3702	ND3	structure	room	3
3703	ND3	deposit	fill of room ***3702***	3
3704	ND3	deposit	fill associated with structure ***3737***	3
3705	ND3	deposit	fill above floor ***3638***	3
3706	ND3	deposit	fill of room ***3708***	3
3707	ND3	deposit	layer	4
3708	ND3	structure	room	3
3709	ND3	structure	gas producer	3
3710	ND3	deposit	fill of flue ***3711***	3
3711	ND3	structure	flue	3
3712	ND3	structure	flue	3
3713	ND3	structure	chimney	3
3714	ND3	structure	floor	3
3715	ND3	structure	flue	3
3716	ND3	deposit	fill in switch room ***3690***	3
3717	ND3	deposit	fill in flue ***3715***	3
3718	ND3	deposit	fill in flue ***3720***	3
3719	ND3	deposit	fill in flue ***3720***	3
3720	ND3	structure	flue	3
3721	ND3	deposit	fill in flue ***3720***	3
3722	ND3	structure	flue	3
3723	ND3	deposit	fill in flue ***3722***	3
3724	ND3	deposit	fill in flue ***3712***	3
3725	ND3	structure	flue	3
3726	ND3	deposit	fill in flue ***3725***	3
3727	ND3	structure	wall	3
3728	ND3	structure	flue	3
3729	ND3	structure	gas producer	3
3730	ND3	deposit	fill in gas producer ***3729***	3
3731	ND3	structure	surface	3
3732	ND3	deposit	fill in gas producer ***3709***	3
3733	ND3	deposit	fill in chimney ***3713***	3
3734	ND3	structure	wall	2
3735	ND3	structure	wall	3
3736	ND3	deposit	layer	2

Context	Area	Context type	Category	Phase
3737	ND3	structure	wall	3
3738	ND3	deposit	fill associated with structure ***3738***	3
3739	ND3	structure	wall	3
3740	ND3	structure	wall	2
3741	ND3	deposit	layer	2
3742	ND3	structure	chimney	3
3743	ND3	structure	furnace	3
3744	ND3	cut	well	2
3745	ND3	structure	well	2
3746	ND3	deposit	fill in well ***3744***	2
3747	ND3	structure	flue	3
3748	ND3	structure	flue	3
3749	ND3	structure	wall	2
3750	ND3	structure	wall	3
3751	ND3	structure	wall	2
3752	ND3	structure	floor	3
3753	ND3	structure	wall	3
3754	-	not allocated	-	-
3755	ND3	structure	base	3
3756	ND3	structure	wall	3
3757	ND3	structure	wall	2
3758	ND3	structure	wall	2
3759	ND3	structure	wall	3
3760	ND3	structure	wall	3
3761	ND3	structure	wall	3
3762	ND3	structure	wall	3
3763	ND3	structure	wall	2
3764	ND3	structure	wall	3
3765	ND3	structure	wall	3
3766	ND3	structure	wall	3
3767	ND3	structure	wall	2
3768	ND3	structure	wall	3
3769	ND3	structure	wall	2
3770	ND3	structure	wall	3
3771	ND3	structure	wall	3
3772	ND3	structure	floor	3
3773	ND3	structure	wall	4

Context	Area	Context type	Category	Phase
3774	ND3	structure	wall	2
3775	ND3	structure	wall	2
3776	ND3	group	furnace	3
3777	ND3	structure	furnace	3
3778	ND3	structure	furnace	3
3779	ND3	structure	furnace	3
3780	ND3	structure	furnace	3
3781	ND3	structure	flue	2
3782	ND3	structure	wall	3
3783-6	-	not allocated	-	-
3787	ND3	structure	drain/culvert	4
3788	ND3	structure	wall	3
3789	ND3	structure	floor	2
3790	ND3	structure	floor	3
3791	ND3	deposit	layer	4
3792	ND3	structure	wall	3
3793	ND3	structure	wall	2
3794	ND3	structure	wall	2
3795	ND3	structure	wall	2
3796-7	-	not allocated	-	-
3798	ND3	structure	wall	3
3799	ND3	structure	wall	3
3800	ND3	cut	drain/culvert	4
3801	ND3	structure	modern intrusion	4
3802	ND3	structure	floor	3
3803	ND3	deposit	floor	3
3804	ND3	structure	floor	3
3805	ND3	structure	floor	3
3806	ND3	structure	floor	3
3807	ND3	structure	wall	3
3808	ND3	deposit	layer	3
3809	ND3	deposit	layer	3
3810	ND3	deposit	layer	3
3811	ND3	deposit	layer	2
3812	ND3	structure	wall	2
3813	ND3	structure	wall	2
3814	ND3	structure	wall	2

Context	Area	Context type	Category	Phase
3815	ND3	structure	wall	2
3816	ND3	cut	foundation	2
3817	ND3	structure	wall	2
3818-3999	-	not allocated	-	-
4000	ND4	deposit	modern intrusion	4
4001	ND4	deposit	layer	4
4002	ND4	structure	wall	2
4003	ND4	structure	wall	2
4004	ND4	structure	wall	3
4005	-	not allocated	-	-
4006	ND4	structure	wall	2
4007	ND4	structure	wall	2
4008	ND4	structure	wall	2
4009	ND4	structure	floor	3
4010	ND4	structure	wall	3
4011	ND4	structure	wall	2
4012	ND4	structure	well	3
4013	ND4	deposit	fill in well ***4012***	3
4014	-	not allocated	-	-
4015	ND4	structure	wall	3
4016	ND4	structure	wall	2
4017	ND4	deposit	layer	2
4018	ND4	deposit	layer	2
4019	ND4	deposit	layer	2
4020	ND4	deposit	layer	2
4021	ND4	deposit	layer	2
4022	ND4	deposit	layer	2
4023	ND4	deposit	natural geology	-
4024	ND4	structure	drain/culvert	3 or 4
4025	ND4	deposit	fill in drain/culvert ***4024***	3 or 4
4026	ND4	structure	drain/culvert	3 or 4
4027	ND4	deposit	fill in drain/culvert ***4026***	3 or 4
4028	ND4	structure	room	4
4029	ND4	cut	well	2
4030	ND4	structure	well	2
4031	ND4	deposit	fill in well ***4030***	2
4032	ND4	cut	drain/culvert	3 or 4

Context	Area	Context type	Category	Phase
4033	ND4	cut	drain/culvert	3 or 4
4034	ND4	cut	foundation	2
4035	ND4	cut	foundation	2
4036	ND4	cut	foundation	2
4037	ND4	cut	foundation	2
4038	ND4	cut	well	2
4039	ND4	structure	floor	not closely dated
4040	ND4	structure	wall	2
4041	ND4	structure	wall	2
4042	ND4	structure	wall	2
4043	ND4	structure	wall	2
4044	ND4	structure	wall	2
4045	ND4	structure	wall	2
4046	ND4	structure	drain/culvert	3 or 4
4047	ND4	cut	drain/culvert	3 or 4
4048	ND4	structure	drain/culvert	3 or 4
4049	ND4	deposit	layer	2
4050	ND4	structure	drain/culvert	3 or 4
4051	ND4	structure	floor	3
4052	ND4	structure	wall	2
4053	ND4	structure	wall	2
4054	ND4	structure	well	2
4055	ND4	deposit	layer	3
4056	ND4	cut	well	not closely phased

APPENDIX 2: SUMMARY POTTERY CATALOGUE

Abbreviations used in the table:

* Entirely or mainly kiln waste
RW: Red ware
STW: Stoneware with Powell's improved glaze (post-1835)
KF: Kiln furniture
SSTW: English brown salt-glazed stoneware
CSTN: Cistercian ware
SSDN: South Somerset (Donyatt) ware
ND: North Devon gravel-tempered and fine wares
TGW: English tin-glazed ware
STSL: Staffordshire/Bristol yellow slipware
STMO: Staffordshire/Bristol mottled glazed ware
STRE: Staffordshire red ware
WEST: Westerwald stoneware
SWSG: Staffordshire white salt-glazed stoneware
PORC: English porcelain
CREA: Cream ware
PEAR: Pearl ware
BBAS: Black basalt ware
TPW: Transfer-printed earthenware
WCH: White china
MED: Medieval
RT: Roof tile
MISC: Miscellaneous

CONT	RW	STW	KF	SSTW	CSTN	SSDN	ND	TGW	STSL	STMO	STRE	WEST	SWSG	PORC	CREA	PEAR	BBAS	TPW	WCH	MED	RT	MISC	TOTAL
1000	26	1		6			1	1						1	7		1	3	4			1	52
****1001***			1	10																			11
1004	3	5		1																			9
****1005***	43	2	3	1																	1		50
****1008***	229		8																				237
****1009***	53		4																				57
****1010***	90		2																				92
****1011***	153		15																				168
****1012***								118															118
****1013***	4			36				1													1		42
****1021***								2															2
****1023***								4															4
****1026***	3		6	1																			10
****1027***								3															3
****1028***								2															2
****1032***								1															1
****1038***			1	4																			5
****1040***	56		3						1														60
1041	1						4	3	6													3	17
****1050***	71	4	2												1	1		6	6		3	1	95
****1051***	22								1														23
****1053***	2		1	26														1	2				32
****1057***	2		1																				3
****1058***	6			2																			8
****1059***	23		6	1															6				36
****1064***	1			8																			9
****1066***	20																		1				21
****1067***	3		2																				5
****1068***	283		95																				378
1078				2																	1		3
1079	3																				1		4
****1094***	9																	1					10
****1096***			2	35				1															38
****1098***	161		3						7												21		192
****1099***	18																						18
****1101***	25		1																				26
****1102***	136		1																				137

CONT	RW	STW	KF	SSTW	CSTN	SSDN	ND	TGW	STSL	STMO	STRE	WEST	SWSG	PORC	CREA	PEAR	BBAS	TPW	WCH	MED	RT	MISC	TOTAL
1103	158		1																				159
1104	65		20																				85
1105	106		1																				107
1112	51														1								52
1114	42		20																				62
1115	39		14																				53
1116	9		2																			2	13
1126	210		1					6					5										222
1127	296																						296
1128	1113		6	1				3					2										1125
1141								2															2
1144	3																						3
1145	252																						252
1146	30								1														31
1147	7		1																				8
1151	5														1			1			1		8
1187	31									1					2								34
1191	173		12																				185
1192	59		19																				78
1194	24		10																				34
1195	13		6																				19
1197	1																						1
1210	33																						33
1212	1																				11		12
1223		2																4					6
1225	1																						1
1226	5		4																				9
2000	2	1		6					5	1													15
2005	2			2														5	2				11
2006	7			2											2			2	2				15
2008	21			2					1					1	1	1		9	4		1		41
2015	32	1	1	6					2						6			2	1				51
2019	10			2				2											2				16
2020								1										1	3				5
2022	22	1		1														1					25
2023				26																			26
2026	7																						7
2027	18			1																			19
2457							1																1
3000		3		2			2	2	4													2	15

CONT	RW	STW	KF	SSTW	CSTN	SSDN	ND	TGW	STSL	STMO	STRE	WEST	SWSG	PORC	CREA	PEAR	BBAS	TPW	WCH	MED	RT	MISC	TOTAL
***3001**	9	53	7	5		1		3	3					1				1				3	86
3004						1	2		1														4
3005						3		6	14												1		24
3007							1																1
3008	2								1			3											6
3012		3																	2				5
3020															1								1
3023		2																	3		11	1	17
3035																			1				1
3045		4																					4
3059		2																					2
3077		2																	2		1		5
3096							2																2
3109								1				1											2
3113		21																					21
3114		2																					2
3127	1											1										2	4
3129		4																					4
***3130**	42	101		5			1												1			1	151
3137		2																					2
***3140**	61	66	2	2				1	1						1			1	50				185
3149	9					2		1	13													1	26
3155		2																	5		6		13
3162	1															1							2
3167							2		1	1			1										5
3189									2														2
3201							1	1															2
3203									3													1	4
3204						1		1	3												1	2	8
3209								2	1													2	5
3212	2			1		3	6	6	11												2		31
3223	2			2			3	1	4														12
3224								1				2	1									2	6
3225							1	1															2
3226		4										1							1		1		7
3227	2				1			2															5
3228			1				1	1	1										1		1		6
3233																				1			1
3237						2		2															4
3243	1	2																	1				4

CONT	RW	STW	KF	SSTW	CSTN	SSDN	ND	TGW	STSL	STMO	STRE	WEST	SWSG	PORC	CREA	PEAR	BBAS	TPW	WCH	MED	RT	MISC	TOTAL
3245							4																4
3256							3		1														4
3269		3																					3
3277		1																				1	2
3333						2			4													2	8
3341		1																					1
3343		1							1										1		60		63
3347						1																	1
3348		1																					1
3349		8		1																			9
3350														3									3
3351		2	1																				3
3386	2		1			1	3	2	14														23
3396	4																						4
3398	1											2						1					4
3400	3						4	5	5			1										1	19
3401	2	1	1			1	4	1	4	1	1												16
3402						1			1														2
3403		1	17			1		1	4									1				6	31
3405	1	3						1	1					1									7
3407	8						4	3	1			1											17
3408			21											2									23
3426							3	2	2														7
3428			1																				1
3429							1																1
3430									1														1
3438									1														1
3443									2														2
3446								4	3														7
3452																					2		2
3460								4			3												7
3462				1										1									2
3464	2								1														3
3465									1														1
3468									2												8	3	13
3487	6			1		3	7	37	13	1					1							1	70
3495									7										1			1	9
3503										1													1
3504	1			1			2	3															7

CONT	RW	STW	KF	SSTW	CSTN	SSDN	ND	TGW	STSL	STMO	STRE	WEST	SWSG	PORC	CREA	PEAR	BBAS	TPW	WCH	MED	RT	MISC	TOTAL
3505		9																					9
3507	1						1																2
3508		1					1												1			3	6
3536					1			1	1														3
3538		5							1									1			1	2	10
3553																			1				1
3572																					1		1
3587																					5		5
3607	1										1												2
3621								3	1														4
3624								1															1
3633		2																1	1				4
3683		1																	1				2
3693																			1				1
3694		4		1															1			1	7
3706		1																					1
3707		1																1					2
3709																			1				1
3710		1																1					2
3716		7																1				1	9
3717		3																					3
3718		10																1					11
3719		2																					2
3767		2							1										31				34
4013																					8	1	9
Totals	4458	361	327	204	2	23	65	250	160	6	5	12	9	10	24	3	1	46	140	1	150	47	6304

APPENDIX 3: CLAY TOBACCO PIPE CATALOGUE

Context	Quantity and Description	Date/Details of Pipe Maker
1000	1 heeled bowl 1 spurred bowl with the three-line mark 'I/HAR/VEY' in a circle, all in relief on the side of the bowl 1 spurred bowl with the initials 'WE' incuse on the back of the bowl 1 spurred bowl 1 bowl with elaborate moulded decoration 5 stem fragments	*c* 1660-80 Made by either John Harvey I or II. I obtained his freedom in 1706 and one of them was working until at least 1746 (Jackson and Price 1974) Made by William Evans II, obtained his freedom in 1667 and working until at least 1713 (*ibid*) Eighteenth century Late nineteenth/early twentieth century
1009	1 stem fragment	
1013	3 stem fragments	
1023	1 stem fragment	
1028	1 bowl fragment 4 stem fragments	
1041	38 stem fragments	
1050	1 bowl fragment with leaves in relief down either side of the front mould line 28 stem fragments	Nineteenth century
1052	1 spurred bowl with the three-line mark 'I/ABBO/TT' in a circle, all in relief on the side of the bowl 2 stem fragments	Made by John Abbott, obtained his freedom in 1651, probably dead by 1696 (*ibid*)
1053	2 stem fragments	
1057	1 stem fragment	
1059	1 stem fragment	
1068	2 spurred bowls with the initials 'NC' in a circle, all in relief on the side of the bowl 9 stem fragments	Made by Nathaniel Chilton, obtained his freedom in 1703, died 1730 (*ibid*)
1092	1 stem fragment	
1098	3 stem fragments	
1103	1 stem fragment	
1112	1 stem fragment	
1126	1 stem fragment	
1127	6 stem fragments	
1128	4 stem fragments	
1147	8 stem fragments	
1187	6 stem fragments	
1215	1 stem fragment	
1222	1 stem fragment	
1223	1 stem fragment	

Context	Quantity and Description	Date/Details of Pipe Maker
2000	1 spurred bowl 4 stem fragments	Eighteenth century
2005	2 stem fragments	
2008	4 stem fragments	
2015	5 stem fragments	
2022	2 stem fragments	
2027	1 bowl with moulded 'basket-weave' decoration 1 spurred bowl with fluted decoration	Late nineteenth/early twentieth century Late nineteenth century
2457	7 stem fragments	
3000	11 stem fragments	
3001	1 spurred bowl with the initials 'II' in a circle, all in relief on the side of the bowl 2 bowl fragments 22 stem fragments	Made by James Jenkins, obtained his freedom in 1707, still working in 1739 (*ibid*)
3004	4 stem fragments	
3005	1 spurred bowl with the initials 'HH' incuse on the rear of the bowl 2 heeled bowl fragments 29 stem fragments	Made by Henry Hoar, obtained his freedom in 1699, died 1728 (*ibid*) Late seventeenth century
3007	1 spurred bowl fragment 1 stem fragment	
3020	2 stem fragments	
3035	1 stem fragment	
3039	1 stem fragment	
3069	1 spurred bowl fragment 1 stem fragment	
3077	1 stem fragment	
3109	1 stem fragment	
3119	5 stem fragments	
3124	5 stem fragments	
3127	1 spurred bowl 1 spurred bowl fragment 2 bowl fragments 10 stem fragments	Eighteenth century
3130/ 3131	4 stem fragments	
3149	1 spurred bowl with the initials 'RT' incuse on the rear of the bowl 1 spurred bowl 2 spurred bowl fragments 7 bowl fragments 38 stem fragments	Made by Robert Tippet II, obtained his freedom in 1678, died 1722 (*ibid*) Late seventeenth/early eighteenth century Late seventeenth/early eighteenth century
3152	2 stem fragments	
3155	1 stem fragment	
3167	3 stem fragments	

Context	Quantity and Description	Date/Details of Pipe Maker
3189	1 heeled bowl	Mid-seventeenth century
3190	2 bowl fragments 2 stem fragments	
3196	2 stem fragments	
3199	1 stem fragment	
3203	1 heeled bowl fragment 1 bowl fragment 51 stem fragments	Late seventeenth century
3204	1 heeled bowl fragment 2 spurred bowl fragments 37 stem fragments	Late seventeenth century
3212	1 spurred bowl with the initials 'TO' incuse on the rear of the bowl 4 spurred bowls 2 bowl fragments 36 stem fragments	Made by Thomas Owen I, obtained his freedom in 1698, dead by 1725 (*ibid*) Late seventeenth /early eighteenth century
3223	1 bowl fragment 5 stem fragments	
3224	1 spurred bowl 11 stem fragments	Late seventeenth /early eighteenth century
3225	3 stem fragments	
3226	1 spurred bowl 3 stem fragments	Late seventeenth /early eighteenth century
3227	1 stem fragment	
3228	1 spurred bowl with an unreadable mark in a circle, all in relief on the side of the bowl 13 stem fragments	Eighteenth century
3231	1 stem fragment	
3237	2 stem fragments	
3243	4 stem fragments	
3256	1 stem fragment	
3279	2 stem fragments	
3333	2 stem fragments	
3347	2 stem fragments	
3373	3 stem fragments	
3386	2 bowl fragments 9 stem fragments	
3398	1 heeled bowl fragment 10 stem fragments	
3400	1 spurred bowl 1 bowl fragment with the mark 'H/EDWARDS' around a shield containing a hand, all in a circle in relief on the side of the bowl 2 bowl fragments 31 stem fragments	Late seventeenth/early eighteenth century Made by Henry Edwards, obtained his freedom in 1699, working until at least 1739 (*ibid*)
3401	2 spurred bowls	Late seventeenth/early eighteenth century

Context	Quantity and Description	Date/Details of Pipe Maker
3402	8 stem fragments	
3403	15 stem fragments	
3404	3 stem fragments	
3407	1 bowl fragment with the initials 'II' in a circle, all in relief on the side of the bowl 1 heeled bowl fragment 3 bowl fragments 17 stem fragments	Made by James Jenkins, obtained his freedom in 1707, still working in 1739 (*ibid*)
3420	3 stem fragments	
3426	4 spurred bowl fragments 18 stem fragments	Late seventeenth/early eighteenth century
3438	2 stem fragments	
3442	38 stem fragments	
3443	25 stem fragments	
3446	15 stem fragments	
3452	1 stem fragment	
3468	1 spurred bowl fragment 4 bowl fragments 55 stem fragments	Late seventeenth/early eighteenth century
3476	5 bowl fragments 30 stem fragments	
3487	1 heeled bowl 5 spurred bowls 1 heeled bowl fragment 2 spurred bowl fragments 1 bowl fragment 96 stem fragments	Late seventeenth century Late seventeenth/early eighteenth century
3498	6 stem fragments	
3503	2 spurred bowl fragments 1 stem fragment	Late seventeenth/early eighteenth century
3504	2 heeled bowls 2 spurred bowl fragments 1 bowl fragment 34 stem fragments	Late seventeenth/early eighteenth century Late seventeenth/early eighteenth century
3505	1 stem fragment	
3508	1 bowl with a tailed heel 1 stem fragment	Probably made in Broseley, Shropshire, in the late seventeenth/early eighteenth century
3536	9 stem fragments	
3538	1 bowl fragment 5 stem fragments	
3553	1 stem fragment	
3607	2 spurred bowl fragments	
3621	2 spurred bowl fragments 4 stem fragments	Late seventeenth/early eighteenth century
3706	1 spurred bowl	Eighteenth century

Context	Quantity and Description	Date/Details of Pipe Maker
	1 stem fragment	
3707	2 spurred bowls 1 spurred bowl fragment 1 stem fragment	Late seventeenth/early eighteenth century
3718	1 imitation 'briar' pipe bowl	Late nineteenth/early twentieth century
4013	2 stem fragments	
4021	1 stem fragment	
4022	1 bowl fragment 14 stem fragments	
TOTAL	**1046 pipe bowls and fragments**	

ILLUSTRATIONS

Figures

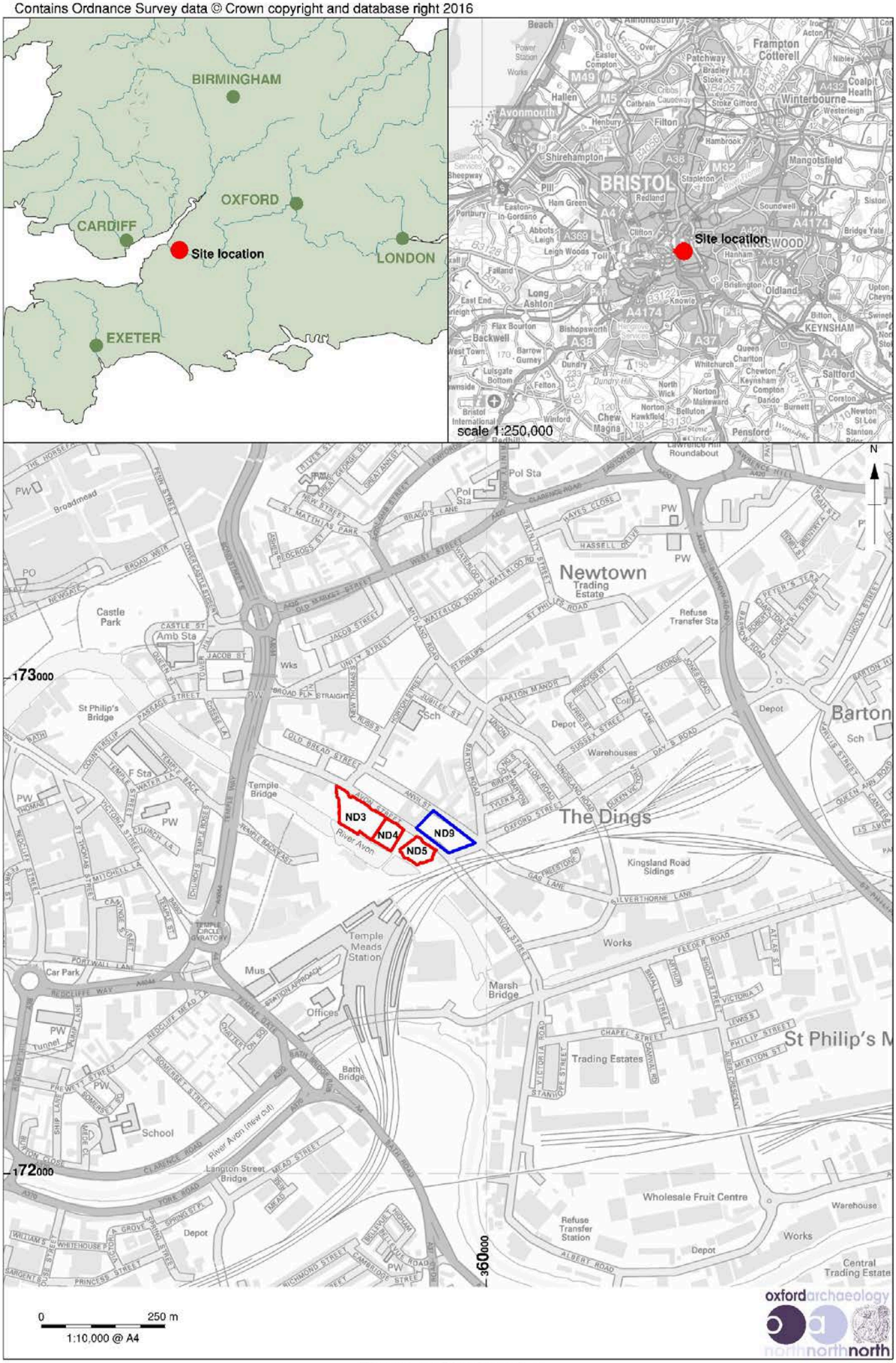


Figure 1: Site location

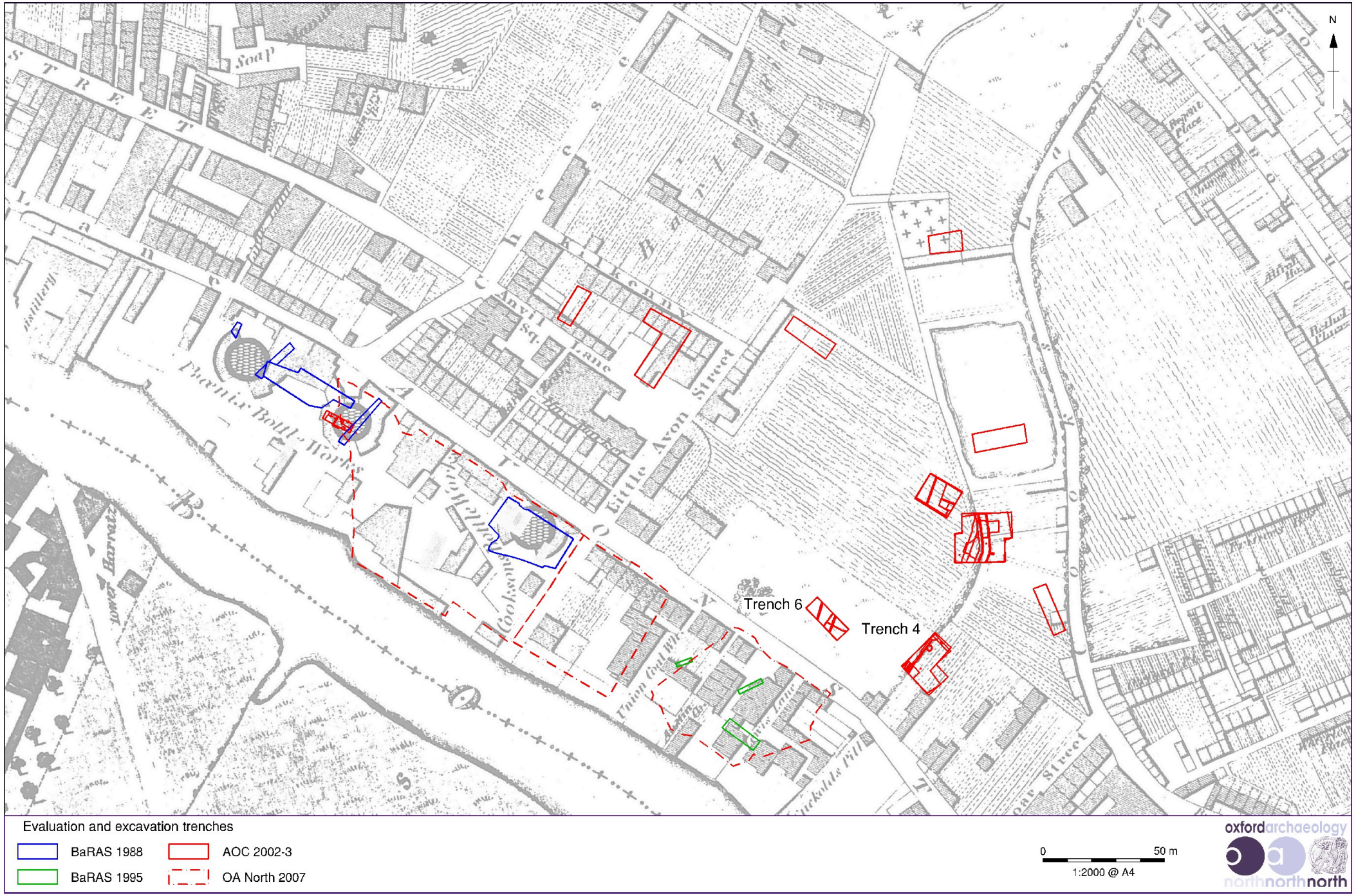


Figure 2: Previous archaeological interventions, superimposed on Ashmead and Plumley's map of 1828

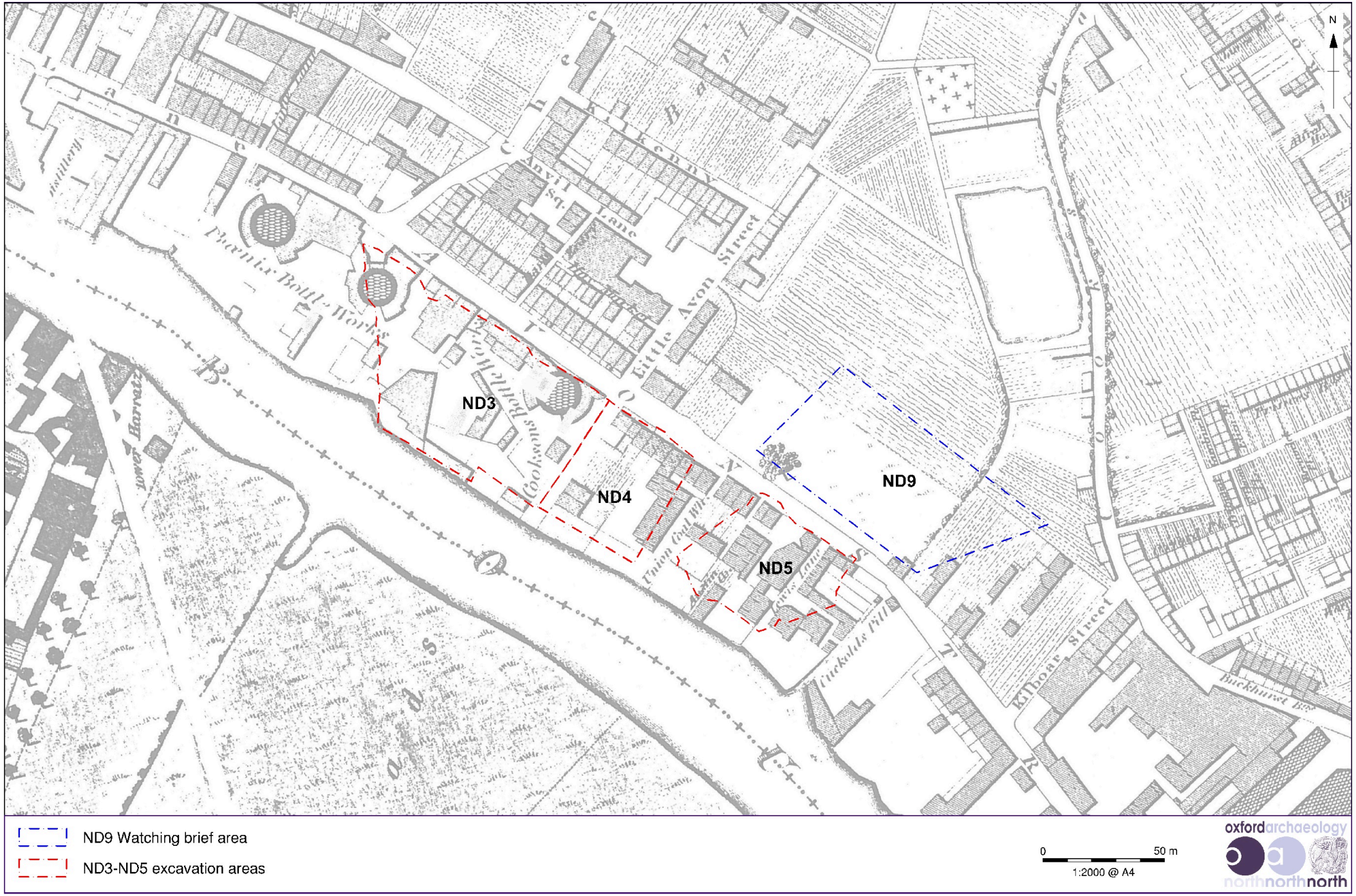


Figure 3: Excavation areas, superimposed on Ashmead and Plumley's map of 1828

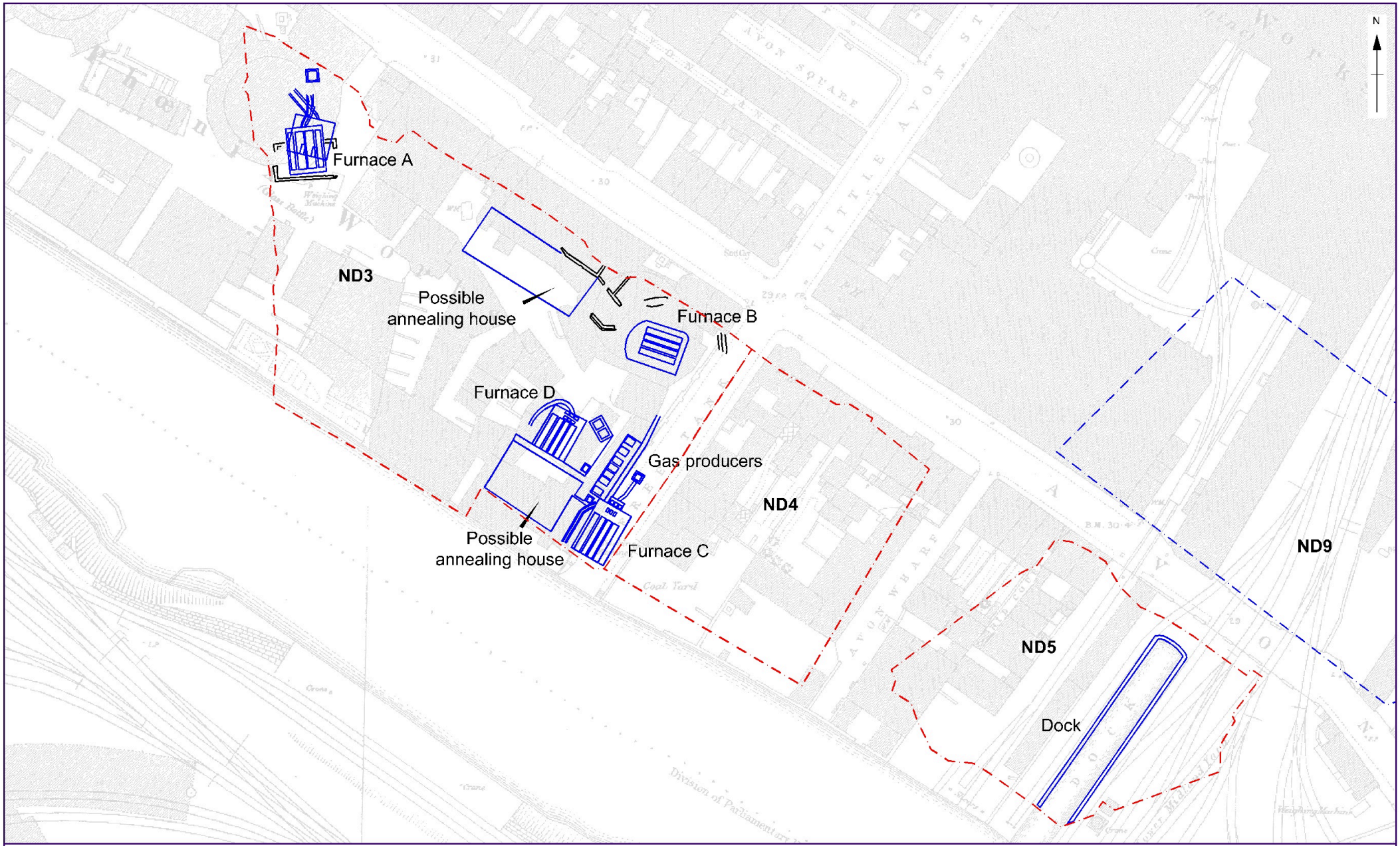


Figure 4: Principal structures excavated, superimposed on the Ordnance Survey map of 1885

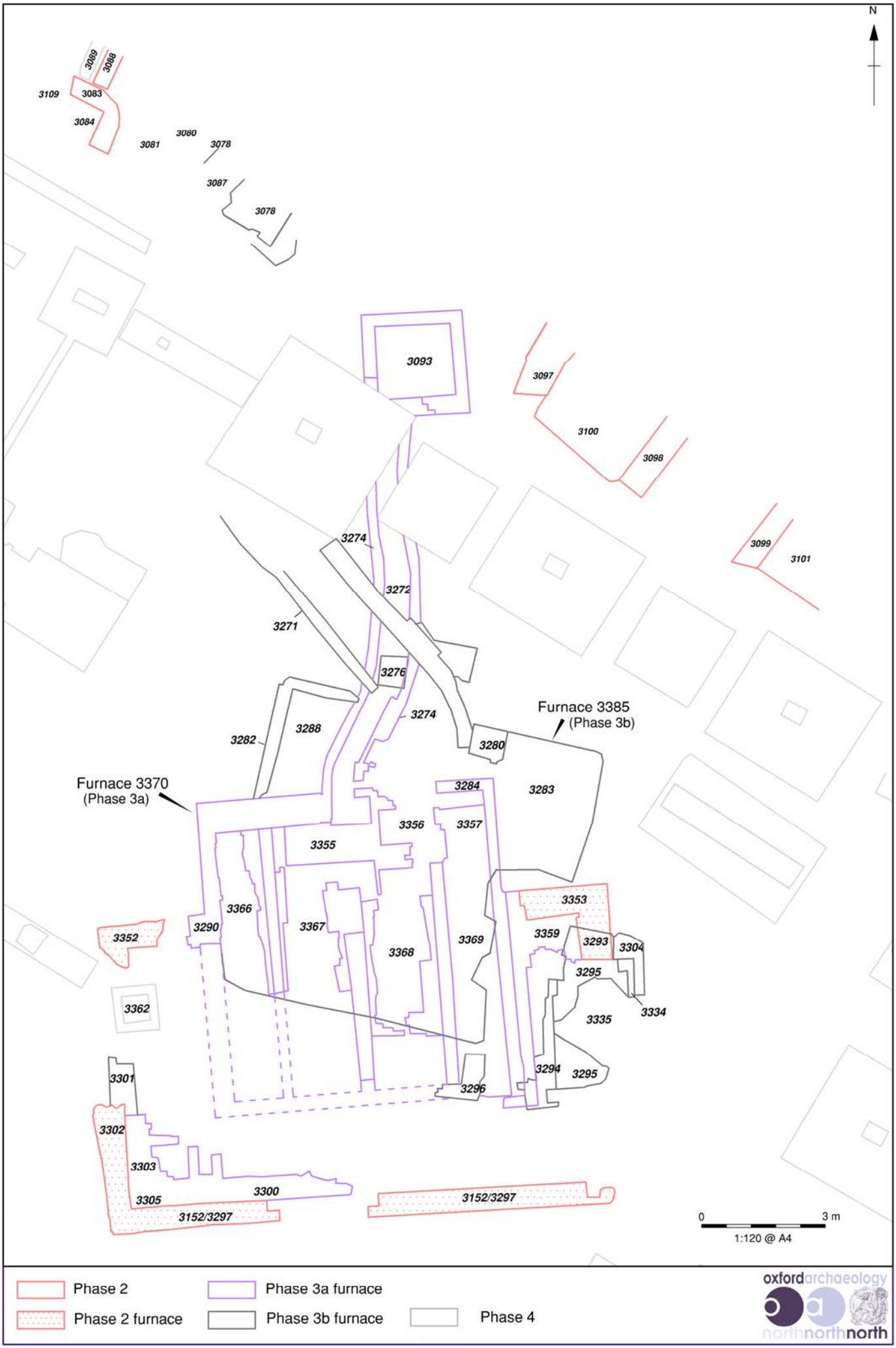


Figure 5: Plan of Furnace A

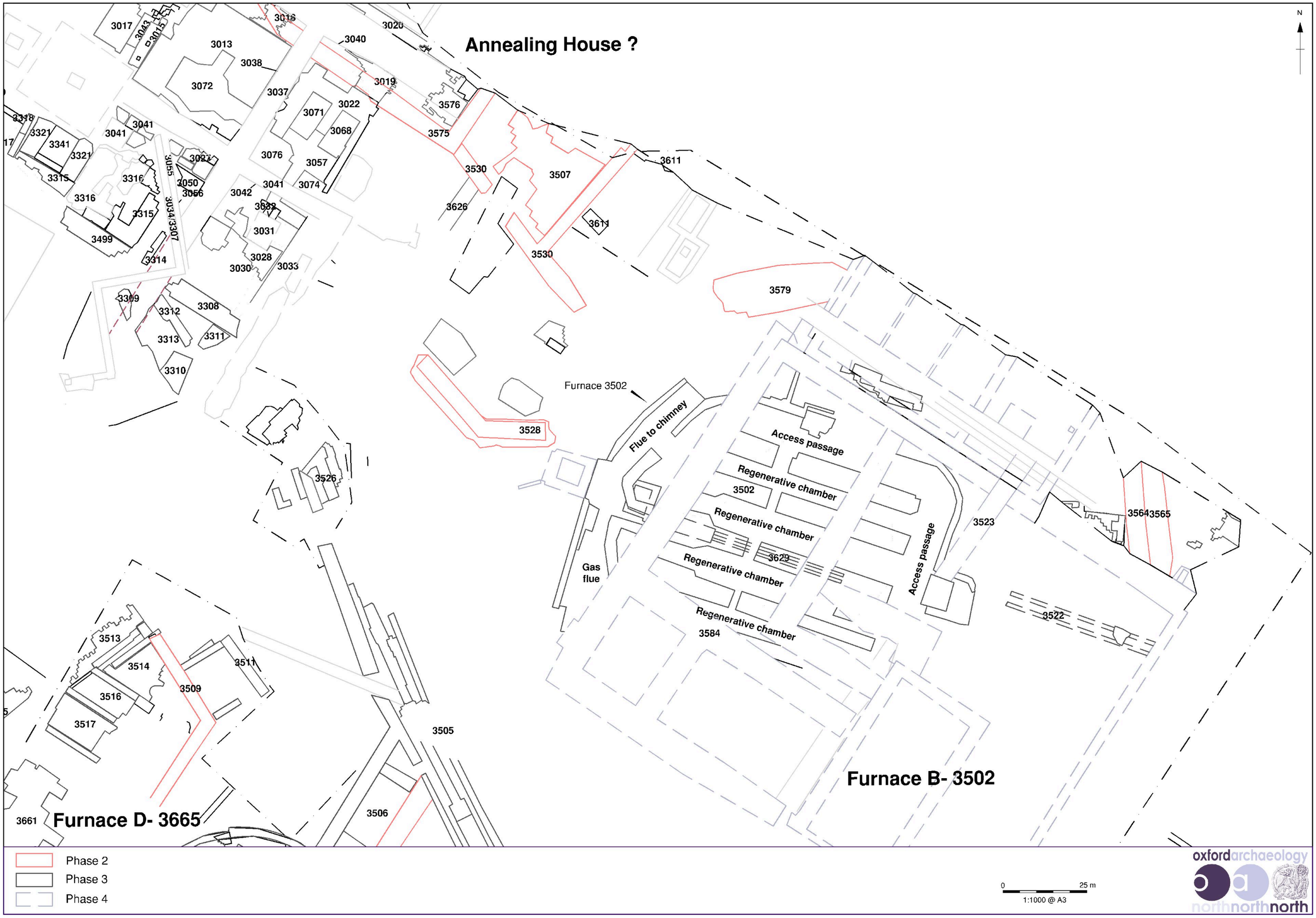


Figure 6: Plan of Furnace B

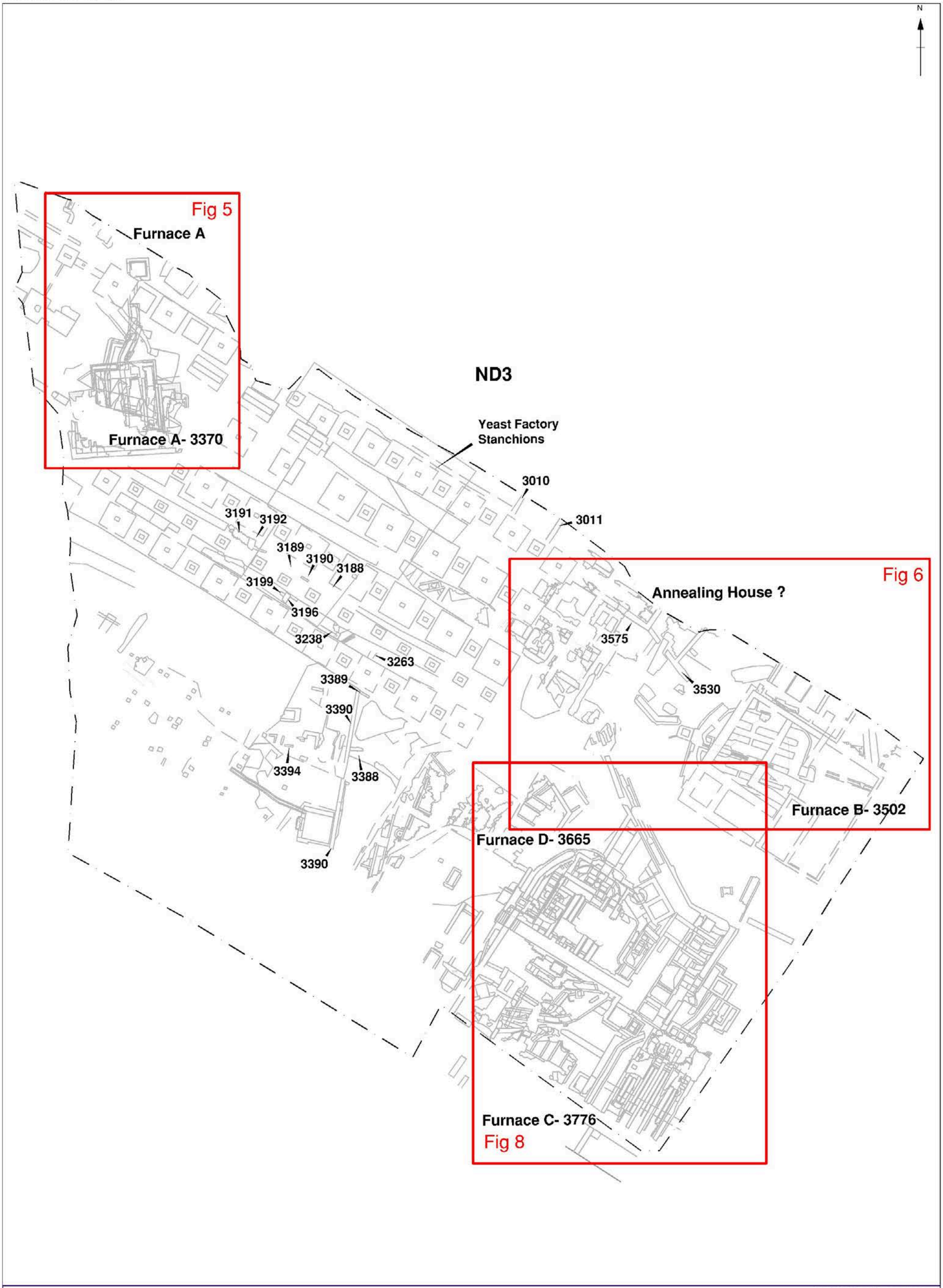


Figure 7: Plan of ND3

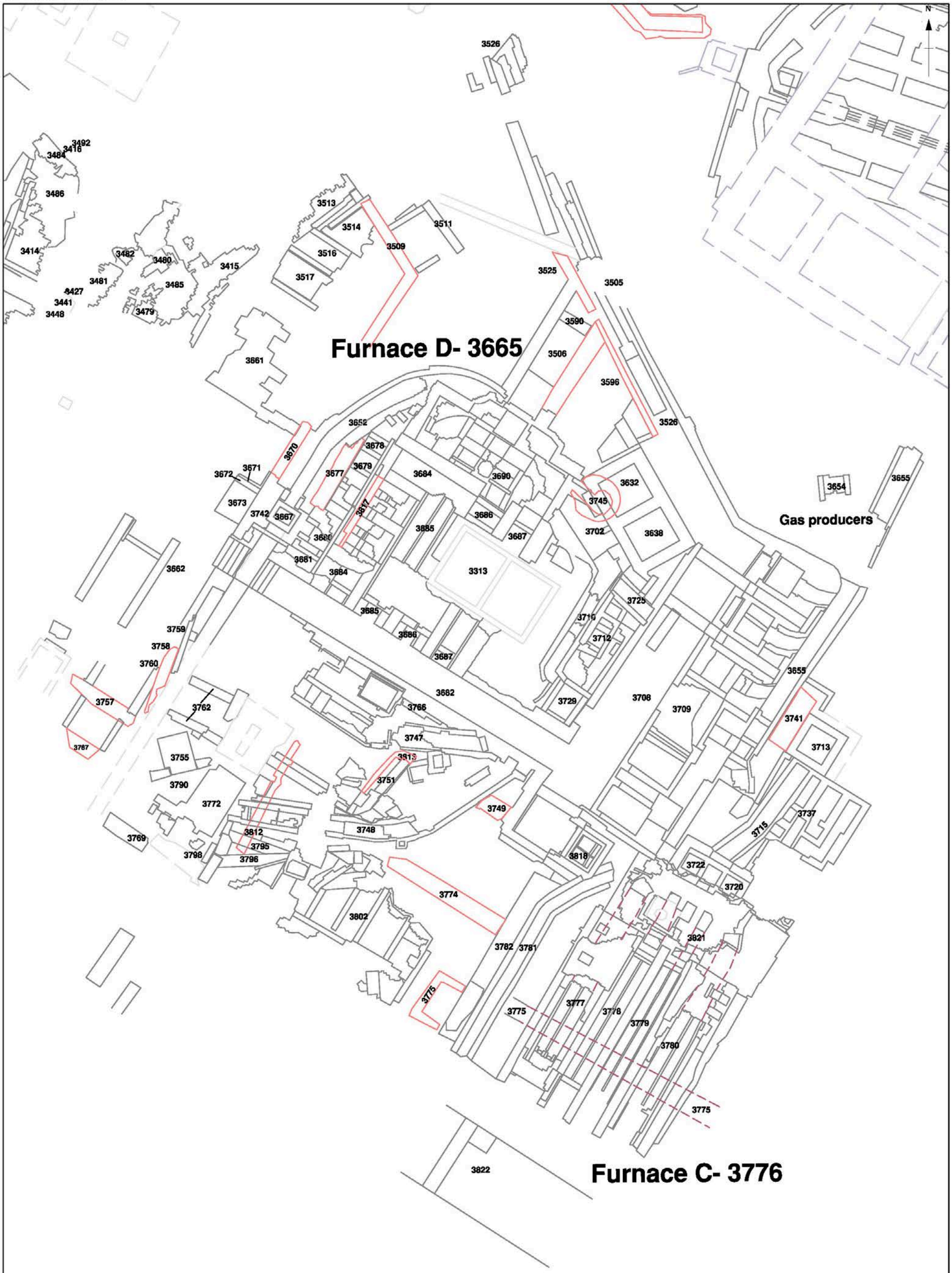


Figure 8: Plans of Furnaces C and D

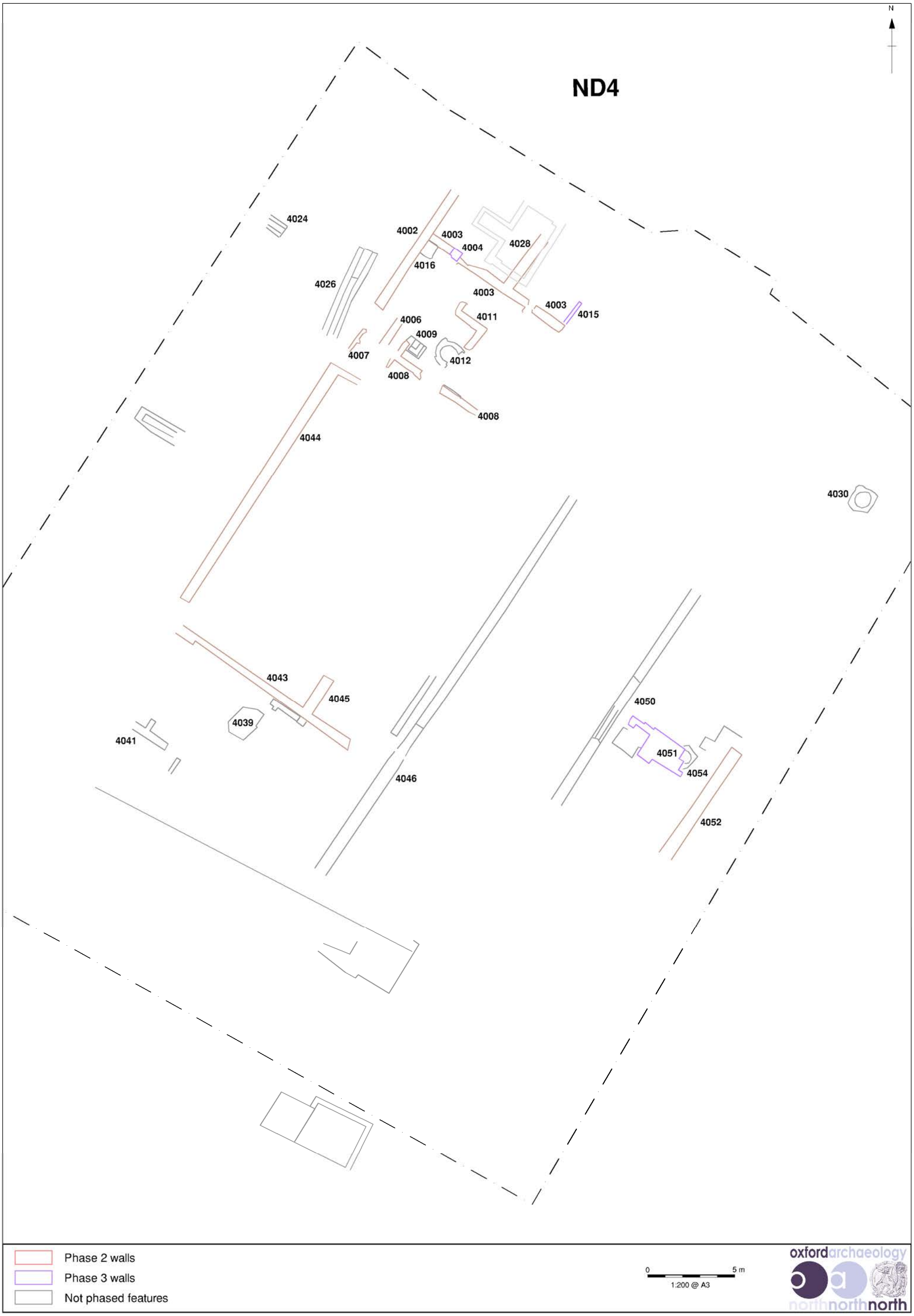
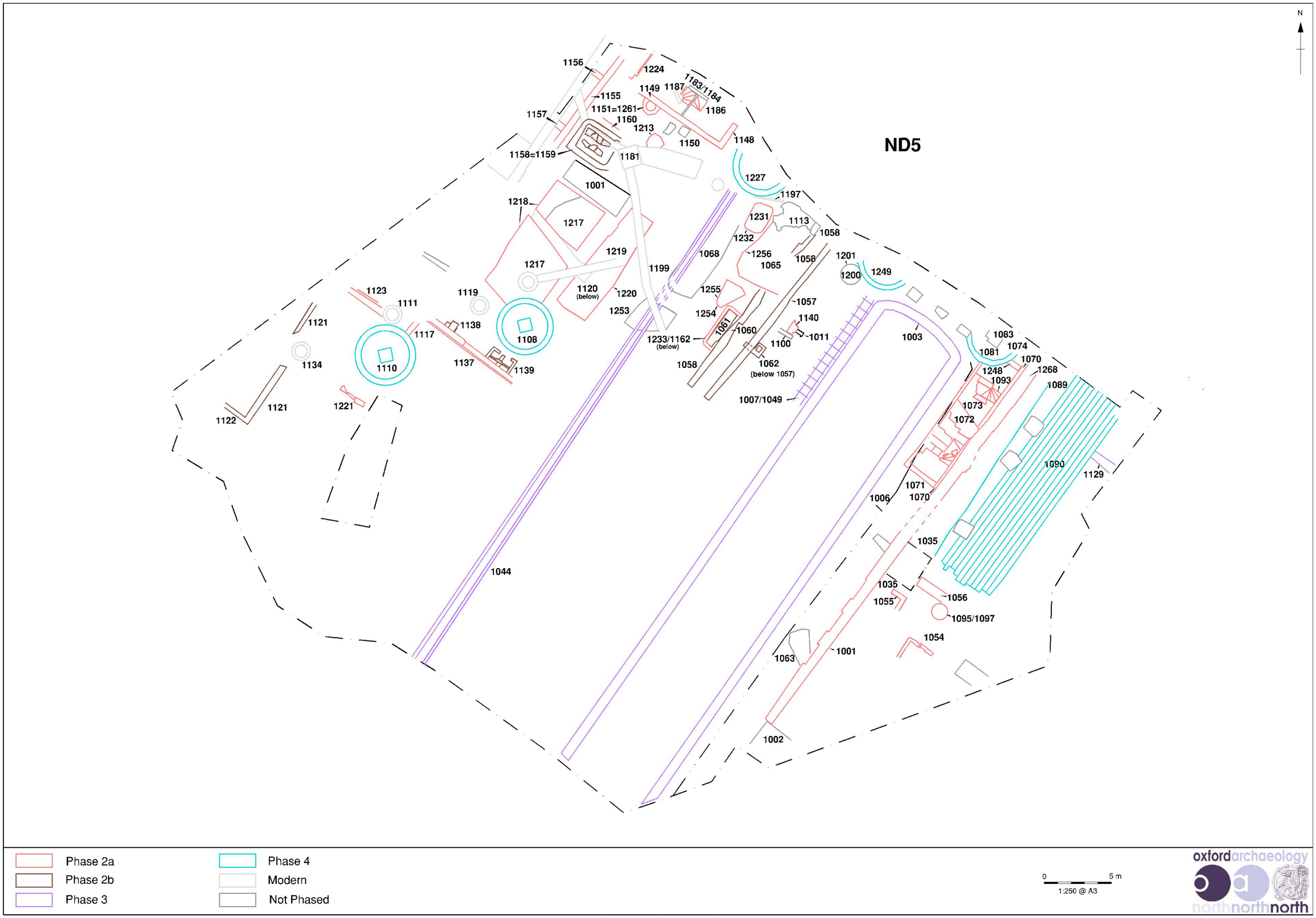


Figure 9: Plan of ND4



RG'L10960'MAT'May 2016

Figure 10: Plan of ND5

Figure 11: ND9 watching brief, with evaluation trenches, superimposed on the Ordnance Survey map of 1885

Figure 12: ND9 watching brief, with evaluation trenches, superimposed on Ashmead and Plumley's map of 1828

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