

FROM MACADAM TO ASPHALT – THE PAVING OF THE STREETS OF LONDON IN THE VICTORIAN ERA

Part 2 – Wood, Asphalt, and other surfaces

by Don Clow

INTRODUCTION

Part 1 of this article dealt primarily with unbound macadam, tar-bound macadam, and granite sett surfaces, this part deals with the introduction of wood, asphalt and a variety of other paving types in the Metropolis.

WOOD BLOCKS

Russia appears to have been the first to use wood blocks for paving. The first use in London was in Oxford Street in 1838. A painting by Scharf shows the blocks (apparently square) being laid. A tar boiler also appears in the painting and a workman is shown pouring hot tar (or pitch) as a grout between the blocks. The City of London followed in 1839 when wood blocks were laid in Old Bailey. These were of Carey's Patent System with interlocking hexagonal blocks measuring from 6 to 8 inches across, and 4 to 6 inches deep. This surface soon failed, said to be caused by the lack of a proper foundation. This installation was followed by in Mincing Lane in 1841, and Gracechurch Street in 1842, again using Carey's blocks and bedded in gravel. This time the blocks were larger, 6 1/2 to 7 1/2 inches across, 13 to 15 inches wide, and 8 or 9 inches deep. Oxford Street was reported to have been paved largely with wood by 1844. In 1849, Haywood reported on trials with three different types but concluded that wood paving was a failure. Although good for traction when dry, the surface was very slippery in damp conditions. It was expensive to maintain compared to granite as it tended to require frequent relaying especially if the foundation was inadequate. Nevertheless the performance of the Mincing Lane installation was reasonable, being replaced in 1860 after 19 years service, but which time it was the oldest wood pavement in the Metropolis. It had, in the meantime, been lifted, turned over and relaid, and again lifted and the worn tops sawn off before being relaid. The replacement paving lasted from 1860 to 1873 when, although not worn out, it was replaced by asphalt. In the City, lives between 6 and 12 years were typical for wood.

The early generation wood blocks were prone to decay, and were unhealthy in that horse manure liquid and urine tended to soak in – Major Isaacs, the surveyor of the Holborn district complained that when one got off a train at Victoria, one was greeted by a 'moist sickening odour given off by the [wood block] pavement in question'. He commented that the same odour was encountered in Victoria Street, if not so pungent. In spite of such objections, wood was much favoured by the inhabitants because of the low noise generated by traffic. Early in the use of wood blocks it was found necessary to lay them with the grain vertical for blocks with the grain vertical lasted about four times longer than those laid with grain horizontal.

The attraction of the reduction of traffic noise even led, as in Gracechurch Street, to frontagers preferring wood to such an extent that they defrayed part of the cost of laying it. Ludgate Hill, Fore Street and Coleman Street were also surfaced with wood in 1872-5. By this time other varieties of wood block were available and tried in the City. In 1870s there was a rapid growth in the use of wood surfaces in the metropolis as previous shortcomings were overcome. The most successful and a long-surviving supplier was the Improved Wood Block Pavement Company. Its system was first used in Bartholemew Lane in the City, creosote-impregnated deal blocks being laid on a foundation of two layers of one-inch deal planks saturated with tar on a four-inch bed of sand, although concrete foundations were used later with a layer of tarred felt between the blocks and the concrete. This system performed well and was used on very many major

4 LONDON'S INDUSTRIAL ARCHAEOLOGY

streets in London well into the twentieth century. The wood preservation method used by this company was the Bethell 'full cell' pressure impregnation process which considerably increased the uptake of creosote compared to simply immersing the blocks in a creosote bath.

Deal was the favoured material although Australian hardwoods, Jarrah and Karri were also used and, unlike deal, the hardwoods did not require creosoting. The conclusion drawn from the use of Jarrah on a 1:35 gradient by Charing Cross was that the hardwood lasted about five times longer than the deal blocks used in the same location previously.²

An aspect, which generated considerable debate, was the best way of dealing with the joints between blocks. One method was to leave a space $\frac{1}{8}$ to $\frac{1}{4}$ inch wide and fill the joint with gravel, afterwards pouring in creosote oil and pitch. Another method was to leave only a $\frac{1}{16}$ -inch gap between blocks and fill it with pitch. A later practice was to lay blocks tight against each other and then pour hot tar over the surface and brush it into the joints. The problem of slipperiness of wood surfaces in wet conditions was often dealt with by throwing grit over the surface. Another approach was to spread gravel over the finished surface leaving the passage of traffic to embed it into the wood.

Other varieties of wood paving were also tried in the City but seemingly were not adopted to any extent. Although asphalt was to prove a strong competitor to wood, nevertheless in 1882, Haywood reported that: 'Almost every main thoroughfare in the City has for years been paved with Wood or Asphalte...', confirming that his reservations about wood of 30 years previously had been overcome. Outside the City, in 1876, wood blocks were laid in Oxford Street, in the Strand in 1877, Pall Mall in 1879, and Regent Street in 1880. By 1884, 53 miles of wood block paved streets existed in the metropolis. Like granite setts, wood blocks survived for many years

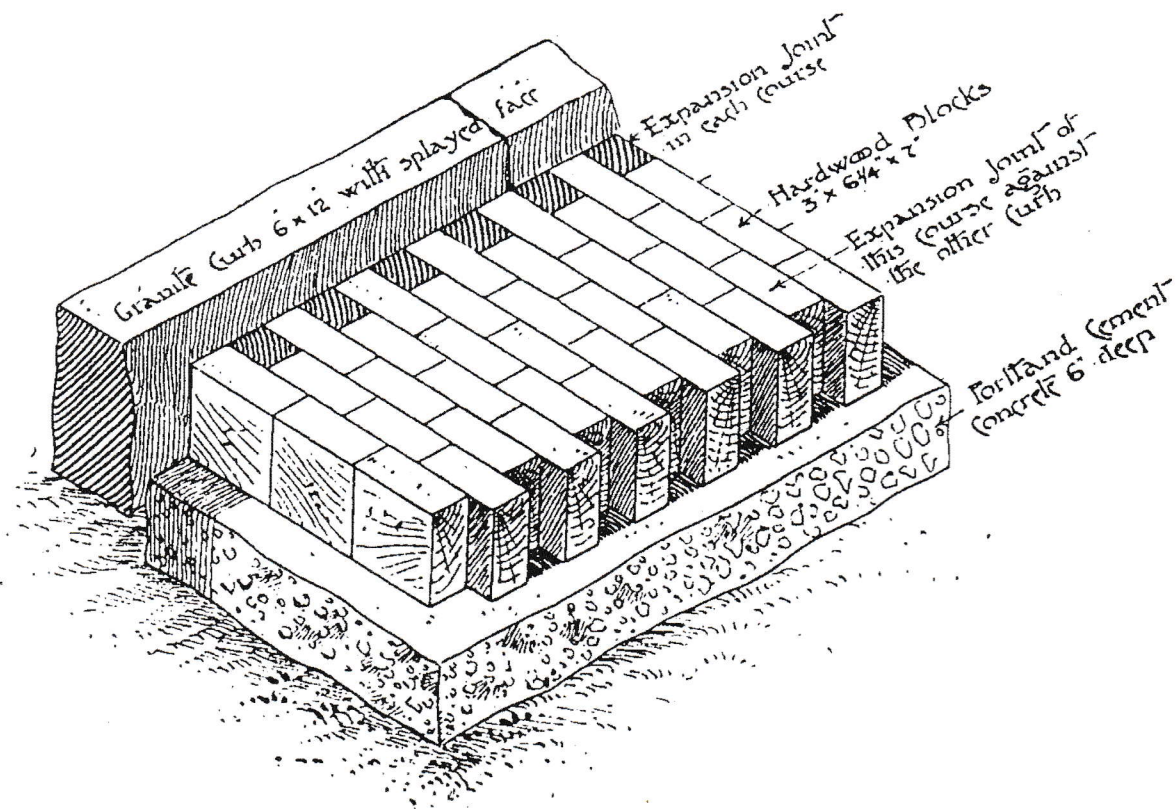


FIG. 26.

Figure 1. Typical construction using wood blocks

THE IMPROVED WOOD PAVEMENT CO.'S
**CREOSOTED
 DEAL PAVING**

3 to 5 inches deep

THE IDEAL ROAD

... FOR ...

HEAVY MOTOR TRAFFIC

as proved in the Principal Thoroughfares of the

CITY AND WEST-END OF LONDON

and the leading Provincial Towns for over forty years

The Most Sanitary and Most Durable of all WOOD PAVEMENTS
 Non-Slippery, Noiseless. Over 400 MILES laid by the Company

*Municipal Authorities should notice the traffic on the Creosoted Deal Paving in
 the following London thoroughfares:—*

Aldgate	Finchley Road	Old Brompton Road
Adelaide Road	Gracechurch Street	Parliament Street
Bayswater Road	High Street (Notting Hill)	Pimlico Road
Bishopsgate	Hanover Square	Praed Street
Brompton Road	Holborn	Queen Victoria Street
Brixton Road	Harrow Road	Queen's Road (Pad- dington)
Brownhill Road	Hammersmith Road	Strand
Bond Street	Haymarket	Smithfield
Bishops Road	Hyde Park Corner	Shaftesbury Avenue
Borough High Street	King William Street	Tower Bridge Ap- proaches
Cannon Street	Kennington Road	Victoria Street
Catford Hill	Kensington Road	Whitehall
Chancery Lane	Kensington High Street	Waterloo Road
Clapham Road	Lambeth Palace Road	Westbourne Grove
Chiswick High Road	Ludgate Circus	Westminster Bridge Road
Earls Court Road	Ladbroke Grove	Waterloo Bridge
Edgware Road	Marble Arch	
Fleet Street	Middlesex Street	
Farringdon Street	Old Bailey	
Fulham Road		

And numerous thoroughfares in the suburbs and in such places as Bir-
 mingham, Bradford, Brighton, Liverpool, Southport, Weymouth, etc., etc.

THE IMPROVED WOOD PAVEMENT CO., LTD.

46 QUEEN VICTORIA STREET, LONDON

ESTABLISHED 1872

Figure 2. Advertisement by the best known supplier

6 LONDON'S INDUSTRIAL ARCHAEOLOGY

in London streets, like setts, often hidden by an overlay of tarmacadam or asphalt.

ASPHALT

The search for an economic, hygienic, quiet, and safe surface as an alternative to wood blocks led to asphalt being tried. Naturally-occurring 'rock asphalte' (the French spelling was often used in the nineteenth century) came from sources in Europe, notably at Limmer near Hanover, Val de Travers in the Swiss Canton of Neuchatel, Seyssel near Annecy in France, and Ragusa in Sicily. It occurs in the form of rock, usually limestone, impregnated with asphalt (a bituminous substance). When used for road surfacing, rock asphalt was crushed, heated and laid hot, compressed gently with hot irons, then rammed and rolled to compact it – hence known as 'compressed rock asphalte'. The other form in which it was used was 'mastic asphalt' in which rock asphalt was ground and mixed with 'asphaltic cement', a bitumen-based binder containing fine mineral matter; it was laid hot and trowelled smooth by hand. European rock asphalt typically contained between 7 and 12% of bitumen by weight, but Trinidad Lake asphalt was about 50% bitumen and contained finely-divided mineral flakes.

Compressed rock asphalt had been laid in Paris in 1854, followed in 1858 by construction of a pavement 'more nearly representing modern practice'.³ Some form of asphalt had been used in Oxford Street, London in 1838-39, and mastic asphalt was used for footways, notably in 1864 in Trafalgar Square but these applications were either limited in extent or else unsuccessful. At the 1843 'State of the Large Towns and Populous Districts' Committee of Inquiry, Thomas Cubitt remarked that asphalt had been used as a paving material but did not say where, and William Thorn, a cleansing contractor, commented that in his experience the only place where asphalt had been used was on a road leading to Vauxhall Bridge.⁴ It is probable that the latter application used the 'Patent Lava Stone' manufactured by J.H. Cassell at Millwall.⁵ It is uncertain if this was natural asphalt, it could have used a coal tar derivative or perhaps a mixture of tar and asphalt. Problems with early applications of asphalt led to Henry Law stating in the 1855 edition of his textbook: 'Asphaltic pavements have undergone a like trial [as wood blocks] and have been also found to fail after a few year's service'.

It should be that a number of products related to coal tar were called either 'artificial asphalt' or more misleadingly simply as 'asphalt'. (The term 'asphalt' at the present day been used in a much looser sense and encompasses material that utilises various bitumastic substances from the petroleum refining industry. The modern term 'black top' is useful when referring to a modern flexible construction road without having to define the type of bituminous material used.)

A trial of asphalt, which was to firmly establish its future use, took place in the City of London in 1869 at the instigation of Haywood when he had 'Compressed Asphalte of Val de Travers' laid in Threadneedle Street.⁶ In 1870, the same material was laid in Cheapside and Poultry, and by Limmer Asphalte in Lombard Street. Both companies had to replace the surfaces after premature failure, but thereafter asphalt was used successfully and extensively in the City and by the end of 1873, 60,802 sq. yds., had been laid. It was laid directly on a concrete foundation and to a thickness of about 3 inches, which after rolling was compressed to about 2 inches. The Limmer company had problems in 1877 when it was found that their mastic asphalt could not withstand heavy traffic and the City refused to use it on busy thoroughfares and insisted on the use of compressed rock asphalt. This posed a problem for the Limmer Co., which was bound to purchase the German rock which would not compress. Eventually, Limmer was allowed to obtain rock from the Sicilian mines at Ragusa.

As a result of his experience, Haywood concluded that asphalt was suitable for all streets of suitable gradient although where heavy cartage was prevalent or where horses must start heavy loads, granite performed better, especially when streets were not clean. In general, asphalt reduced the labour of horses, and its first cost was about the same as granite. In 1873, when reporting on accidents to horses on the carriageway, he noted that while asphalt was most slippery

when damp, it was safest when dry, in contrast to granite which was most slippery when dry, but safest of all surfaces when wet. Overall, asphalt was probably about as safe for horses as granite. The reduction in noise of an asphalt surface compared to granite setts was much welcomed. Asphalt was also found to have an appreciably longer life in standing up to heavy traffic than tar-macadam, although shorter in life than granite. It was difficult to estimate the reduction in thickness due to wear of asphalt as traffic also compressed the surface. A calculation based on the City experience with Val de Travers compressed rock asphalt suggested that wear amounted to about $\frac{1}{5}$ inch per year. Haywood expected a surface to last 4 to 6 years.

Trinidad Lake asphalt was tried in Princes St. in June 1872 – the paving consisted of the pitch from the Trinidad Lake, broken stone, chalk and other ingredients mixed together and laid hot. By October the surface had failed and replaced by Val de Travers material. The first successful application in Britain was in 1896 in Fulham and Kensington. The Trinidad Lake Asphalte Co. Ltd. was formed in 1894 and the company put down a trial area of rolled asphalt in Chelsea but this failed and had to be replaced with compressed rock asphalt. A revised mixture was used satisfactorily in the 1896 application.

Edwin Chadwick was an enthusiastic propagandist for asphalt (as with most issues he took up) and, complaining of setts stated that:

‘We know that for ladies of the well-to-do class, it is found necessary at times to spread straw in the street, to prevent vibration and deaden the sound of carriages.’

and when asphalt replaced setts:

‘Tradesmen in Cheapside, testify, that without shutting their shop doors, they can hear their customers, and can make themselves heard by them without shouting, as heretofore, to overcome the noise of carriages over the granite pavement.’⁷

Haywood gave a detailed assessment in the 1871 report to his Commissioners on the performance of asphalt.⁸ A shorter version of that report was submitted jointly by Bazalgette and Haywood to the Metropolitan Board of Works.⁹ Haywood summarised the advantages and disadvantages of asphalt (compared to granite) as:

- Convenience: Traction much reduced.
Reduces wear to horses and carriages.
Smooth for pedestrians.
- Safety: When dry, less slippery.
Rain cleans the surface.
About the same as granite in snow and frost.
More slippery in light rain but dries rapidly and sand is available to street orderlies to spread on the surface in such conditions.
No more horses fall than on granite.
- Cleansing: More easily cleaned of dirt or snow.
If kept clean, then washing not necessary.
- Construction and repair:
More dependent on weather.
Can be repaired in winter, unlike granite where the grout freezes.
Fit for traffic in a few hours, whereas granite has to be covered.
Asphalt covered with fine gravel when new for 1 or 2 weeks, some dust or mud then washed into gullies. Granite with asphalt joints does not need

8 LONDON'S INDUSTRIAL ARCHAEOLOGY

covering with sand.

Durability: Insufficient experience but probably not as durable as granite.

Although asphalt found favour for principal streets because of its hard-wearing properties and its cleanliness and quietness, the sanitary aspect found favour too in very different situations – Newington district used it for 'courts, alleys, streets' in the poorest areas. Mile End New Town was more blunt for it stated it used 'asphalte for small back neighbourhoods occupied by the dirty class of people'!

OTHER CARRIAGEWAY PAVING TYPES

Various other paving types appear in the documentation but their performance is often unrecorded presumably they failed to meet expectations but some are mentioned below.

Iron

Iron paving was tried in Blackfriars in 1816; in 1859, iron was again used at Paddington Station. In 1861 an iron surface was provided in King Street, Westminster, and was reported to have performed well. A specimen of Allan's cast iron pavement was laid in a large but unnamed thoroughfare in 1852. Haywood's report for 1853 recorded that a carriageway of Metropolitan Compound Metallic Paving had been laid experimentally at the east end of Threadneedle Street - this consisted of a hard cement in iron frame together with some wood. Turner ¹⁰ noted that an unidentified iron pavement laid in 1862 in Poultry proved to be unsatisfactory as it wore unevenly under heavy traffic and the iron blocks cracked. It was also more dangerous for horses if they fell. This may be a reference to 'Carey's iron tooth-edged trams'. These might have been the same as 'Carey's Cast Iron Channels' which consisted of an iron block filled with concrete. These were used in Poultry and Foster reported that they needed no maintenance over a 9-year period and in Regent Street for 15 years with little sign of wear. The channels were however expensive. Haywood was at later date to comment that he had great doubts as to durability and economy of cast iron.

Brick

Vitrified brick does not appear to have been used in the public highway but it was certainly used on commercial and industrial premises.

Rubber

Rubber in sheet form 11ft. 1 1/2 ins. long, 3ft. 10in. wide, and one inch thick, was laid at Euston station and lasted 14 years with only minor patching. It was however very expensive, although possessing attractive properties. Boulnois ^{11a} does not give the date of installation. Also in 1870, rubber sheets 2 inches thick were laid at St Pancras station. The surface was in good condition in 1926, additional sheets having been added and worn edges renewed. ^{11b}

Cork

Cork blocks 9 x 4 1/2 x 2 in. in size were laid in some parts of Lambeth, Paddington and Chelsea. Pickfords, the hauliers, also used cork blocks at the exit from their City depot. These were made from ground cork pressed into a bituminous mixture. Cork was also used at Liverpool St. station. Boulnois writing in 1895 states that the blocks had been recently introduced. He mentions that Greenwich had tried a small portion of patent cork pavement but traffic by the side of tram tracks had been too great for it.

FOOTWAYS

Haywood's 1881 report records that in the City a variety of surfaces were in use on footways



Figure 3. York flags on footway (in Manchester)

10 LONDON'S INDUSTRIAL ARCHAEOLOGY

– notably, York stone paving slabs ('flags'), usually 3" thick, some of which still survives. Elsewhere in London, stone slabs were in general use even in the poorest districts. The York flags were of sandstone from the Yorkshire coal measures. They provided a good non-slip surface and, although they wore quite quickly in busy streets, they could be turned over and re-used. Those laid in Lombard Street in 1828 were completely worn out by 1846. In contrast, flags in Kennington lasted 25 years in main streets, and then re-used in minor streets for another 20 years. Boulnois estimated the wear rate in the Strand amounted to $\frac{1}{16}$ in. for every 9 million pedestrians using the footway. Later in the century the introduction of artificial stone slabs tended to supersede York flags. Several types were produced, nearly all of which were cast from granite chippings and Portland cement, some with added sodium silicate. Types listed in Law and Clark included Adamant stone, Indurated stone, Stuart's granolithic stone, clinker stone, Metallic lava, Victoria stone, Ransome's stone, and Imperial stone. Artificial stone proved to be very satisfactory and as noted in Law and Clark (p354):

'As a proof of the enduring qualities of Stuart's granolithic pavement, it may be mentioned that it was laid seventeen years ago in Leadenhall Street, London, during which time it is computed that over fifty-two millions of people have passed over it, and yet no signs of wear are visible after this enormous amount of traffic.'

In situ concrete casting was used to some extent but proved to be very difficult to repair after pipe works.

Tarmacadam and mastic asphalt was used successfully. Asphalt, however, was apt to 'creep' if laid on a gradient. One tar-based surface used as early as 1840 was known as 'Lord Stanhope's composition', it consisted of Stockholm tar, chalk and sharp sand. The composition was boiled in cauldrons and laid hot.

Paving using vitrified bricks appears to have been used to a limited extent for footways in London although used extensively in Europe and the USA. Cooper (12), writing of his experience in Wimbledon, thought brick was of poor appearance and was not a pleasant surface to walk on and slippery if vitrified.

IMPACT OF PIPE AND CABLE WORKS

A repeated complaint of the highway authorities from the early nineteenth century (and right up to the present day) has been that inadequately reinstated excavations for pipe and cable works in the street caused severe damage to the roads and seriously shortened the life of some forms of road construction. Although legal powers had been granted for laying water pipes under the street as early as the sixteenth century, it was not until the second decade of the nineteenth century that the problem of reinstatement quality began to be a major issue. Many excavations resulted from public sewer construction and the rapid growth of competing private gas and water companies. It was not uncommon for two or more companies supplying the same product to install pipes in the same street. Complaints about their activities were not uncommon, for example, Samuel Clegg, one of the pioneers of the gas industry, received a letter from no less than the Attorney General complaining of the state of Great George Street where the gas company had its mains and 'it was feared that it was not just the Attorney General alone who was inconvenienced'¹³ The problems with poor reinstatement work were two-fold, the use of quite unsuitable back-fill material, and what there was, was inadequately (or not at all!) compacted. However, it must be said that the original structure of the street itself was frequently very poor. Later in the nineteenth century, other services were added to those needing to excavate in the street – electricity and telegraph cables, hydraulic mains and pneumatic telegraph tubes!

Both the Metropolitan Board of Works and the Corporation of London constructed large subways to accommodate water and gas pipes, and, later, cables.¹⁴ The intention as stated in the preamble to the Metropolitan Subways Act 1868, as: 'In order to prevent inconvenience to the public by the frequent breaking up of streets and roadways.' Such major works could only be resorted to

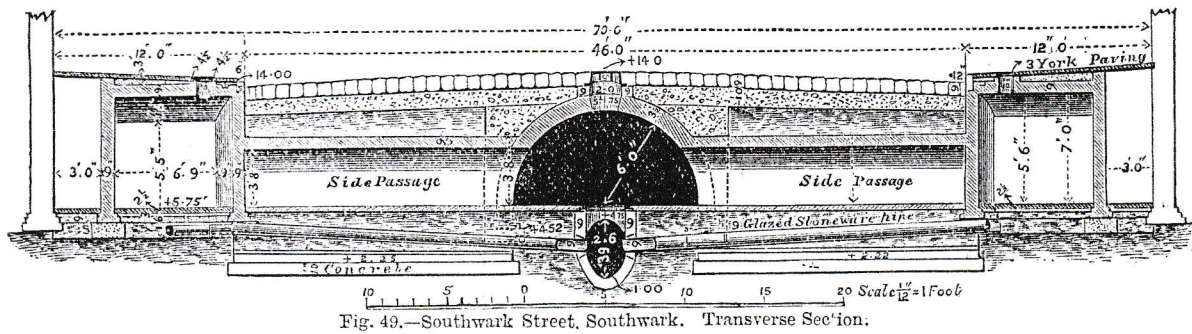


Figure 4. Cross Section of Southwark Street

if a new street or a major reconstruction of an old one was being undertaken.

CLEANSING OF STREETS

Photographs of Victorian London are illuminating in that they often throw light on the cleanliness (or lack of) of road surfaces. Very many illustrations give clear evidence of a substantial coating of dust or mud and horse manure such that wheel tracks show up clearly.

Falls of horses were a common occurrence on all surfaces but more likely to happen on smooth surfaces such as wood and asphalt if dirty and wet. The problem could only be tackled by regular washing and sweeping and spreading gritty material on the surface when damp. St Mary's, Battersea had four Glover's Patent sanding machines in the 1890s. St James, Westminster spread cockleshells to improve grip on asphalt! In the 1890s, Kensington washed and swept wood surfaces daily and other principal thoroughfares were so treated at least twice a week. The City of London employed a street orderly system which kept the streets in a notably clean state. Street cleaning was a very labour-intensive operation - by the end of the century, St Pancras was employing nearly 200 full-time men on street cleaning! The quantity of road dirt removed continued to be very large until the gradual demise of horse traffic - Fulham Borough Council collected 14,189t of street refuse in 1906-7, by 1913-14 this had reduced to 7,000t and in 1960-61 to 1,500t!¹⁵

Sweeping machines were used to some extent, the earliest being Joseph Whitworth's machine used in the 1850s in Westminster and the City. The Whitworth machine was horse-drawn and had a series of brushes on an endless belt that swept the debris up into the vehicle body. A later more widely used sweeper was a cart under which had a long rotating cylindrical brush driven from the wheels and angled to the direction of travel so that debris was swept into the kerb, then to be cleared by street orderlies. These machines were sometimes used in echelon to sweep a wide street. The City of London successfully employed some form of mechanical sweeper for footway cleansing. Haywood stated: 'I may state that upon stone pavements sweeping machines of a simple character always have been and still are used in the City' but 'Upon the whole, it appears to me that, in streets of large traffic such as those of the City, and which are paved with wood, or asphalt, street sweeping machines generally can only be used with advantage occasionally.'¹⁶

CONCLUSIONS

Boulnois writing in 1895 when nearly 20 years experience of asphalt had been accumulated attempted to give a performance rating under 12 separate categories for the principal types of surface discussed in this article. Asphalt gained 5 firsts, granite 3, and wood 2. He emphasised that it was very difficult to draw conclusions for:

'much depends upon local surroundings, such as nature and quantity of traffic, the rateable

12 LONDON'S INDUSTRIAL ARCHAEOLOGY

value of the district, available materials, local opinion (though this may often be quite wrong), physical conditions and even climate, width and gradient of the carriageways, the class of property facing the street, and many other considerations which will occur to the officer who is responsible for the condition of the carriageways.'

By the 1890s, the general preference was for granite setts on roads carrying heavy traffic and on steeper gradients. Wood was used where noise reduction was an important consideration. The use of asphalt was well established and its use growing, albeit cautiously. Lightly-trafficked roads often used water-bound macadam. The results from Boulnois' enquiries of the 1890s are extracted for the London districts in Table 2. He omitted macadam and other unbound surfaces in practice, macadam predominated outside of the central districts and even at that late date was the preferred paving in Hampstead.

After the Victorian era, granite setts, wood block, and natural asphalt continued to pave the streets of London but bituminous road surfaces were to dominate using bitumens from the refining of crude tars and petroleum. The latter part of the twentieth century has seen a revival in the use of cobbles, setts, and bricks for decorative use and in pedestrianised zones.

ACKNOWLEDGEMENTS

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TABLE 1**PAVINGS IN USE IN LONDON DISTRICTS IN THE 1890s****(lengths in miles, unless otherwise stated)**

DISTRICT	GRANITE	WOOD	ASPHALT
Bermondsey	16	0.5	
Camberwell	4		
Chelsea	4.4		
Greenwich	4	0.5	
Fulham	0.06	4.5	0.176
Hammersmith	0.14		
Holborn	9.20	1.2	2.23
Kensington	5.20	(196,314 sq.yds)	
Mile End Old Town	5.5		
Lambeth	1.75	8	
Newington	3.14	0.5	0.25
Paddington	1.09	8.08	
Plumstead	2		
St George's- in-the-East	14		
St Giles	9	0.75	6
St George's, Hanover Sq	5	12	2
St James, Westminster	0.75	3.5	5.25
St John, Hampstead	0.5	1.25	
St Leonard, Shoreditch	15	0.25	1
St Martin-in- the-Fields	1	3.75	1
Whitechapel	18	used in the vicinity of hospital & churches	0.5
St Mary, Islington St Mary,	12	0.5	0.5

14 LONDON'S INDUSTRIAL ARCHAEOLOGY

Battersea	for tram tracks	
St Olave	(4326 sq yds)	
Westminster	(135,500 sq yds)	48,055 sq yds
Woolwich	2	

TABLE 2

History of Paving used in Cheapside and Poultry

Cheapside:

1829 Aberdeen granite. 6 in. x 9 in.

1843 wood

1846 & 1847 with granite again

1861 newly paved

1870 Val de Travers compressed asphalte

Poultry:

1841, 1843 wood

1846 partly granite

1852 partly granite

1859 new stone and granite trams

1862 partly cast iron pavement & Redman's iron trams

1863 partly again in 1863

1865 new granite and Carey's iron tooth-edged trams

1870 taken up as in bad condition, replaced with Val de Travers compressed asphalte