APPENDIX.

STATEMENT of the Cost of Maintaining the Streets and Roads in the Borough of Birmingham, for the year 1853, extracted from the Accountant's Return, made to the Public Works Committee, January 16th, 1854.

		£.	s.	d.
No. 1.	Staff of Officers and Men	6,979	10	7
2.	Keep of 63 Horses, shoeing and Veterinary expenses	3,276	0	0
3.	Rag-stone and Hartshill-stone	5,949	18	6
4.	Pebbles and Gravel	4,513	7	6
5.	Water	771	3	8
6.	Cleansing-Machines and Brooms	965	6	8
9.	Team Hire	631	7	2
10.	Rent	12	0	0
11.	Gearing	114	6	4
12.	Wheelwright	423	7	3
18.	Stationery	117	17	9
22.	Sundry Accounts	2,840	6	1
		£26,594	11	6

DETAIL of the Cost of Maintaining, Cleansing and Watering the Streets and Roads in the Borough of Birmingham, during the year 1853.

	£.	s.	d.
The urban part of the Borough contains 34 lineal miles, or about 359,040 square yards, of street: the cost for material only was a fraction under fourpence per square yard.			
The materials used were 20,112 tons of rag-stone and of Hartshill-stone, at 5*s.* 11*d.* per ton	5,949	18	6
The suburban districts contain 116 lineal miles of streets and roads, or about 1,429,120 square yards: the cost for material only was three-farthings per square yard.			
The materials used were 36,107 tons of pebbles and gravel, at an average price of 2*s.* 6*d.* per ton	4,513	7	6
There are in the Borough 150 lineal miles of streets and roads; with a total area of 1,788,160 square yards.			
The materials used weighed 56,219 tons, which gave an average coating of about 1⅛ inch in thickness for the whole area; at a cost of	10,463	6	0
The total cost of maintaining, cleansing, and watering the streets and roads in the Borough was a fraction more than threepence halfpenny per square yard, or	£26,594	11	6

Mr. J. P. SMITH explained, that the sweeping-machines were drawn to the gully grates, into which the fluid portion of the material was allowed to drain off: and the grit remaining at

the bottom of the machines was then used for binding. The cost of coarse-grained schist, with 23 per cent. of lime, was 4*s.* 9*d.* per cubic yard: for heavy thoroughfares it was broken up into cubes of about 2 inches, but in some cases, where the traffic was more than ordinarily severe, the pieces were 4 inches in thickness; generally, for streets with less traffic, the thickness was about 1 inch, or 1½ inch. The size of the stones was proportioned to the wear and tear of the streets, and the season of the year.

Mr. CAWLEY said, that in macadamising, the greatest care should be bestowed to insure good binding. He wished, that the Paper had been more explicit with regard to the comparative cost of the two systems, for the experiments at Manchester were altogether in favour of paving. In May 1852, Albert Place, which contained 1,373 square yards, was macadamised under the personal superintendence of Mr. Pigott Smith, at a cost of £339 18*s.* 6½*d.*, or 4*s.* 11½*d.* per square yard: viz.—

	£.	*s.*	*d.*
606 tons 9 cwt. of stone at 10*s.*	303	4	6
Labour	11	18	8
Carting	24	15	4½
	£339	18	6½

In the summer of 1844, Albert Bridge, which had the same amount of traffic, and of which the area was 786$\frac{7}{10}$ square yards, and the cart-way 40 feet in width, was paved with Penmaen Mawr stone, at a cost of 6*s.* per square yard. The repairs of the former from May 1852 to December 1853 amounted to £116 2*s.*, or £77 8*s.* per annum for 1,373 yards, = £56 7*s.* 6*d.* per 1,000 square yards, whereas the pavement, in nine years and four months, had only cost £24 13*s.* 7*d.*, or £2 12*s.* 10½*d.* per annum for 786 yards = £3 7*s.* 3*d.* for 1,000 square yards;—showing the cost of maintaining the macadamised portion to have been 1*s.* 1½*d.* per square yard per annum, whilst that of maintaining the paving was only $\frac{8}{10}$ths of a penny per square yard. The cost of scavenging was not kept separate in the two cases, but it certainly was not greater for the paved road, than for the macadamised road.

Mr. J. P. SMITH contended, that the experiment at Manchester did not afford a fair criterion of the comparative cost of the respective systems, as the road in question led to the collieries, and a continuous stream of one-horse carts was always passing over it; moreover, the shoes of the horses being corked, or turned up, cut up the macadamised portion of the road: a larger amount of material than that generally necessary was, therefore, required. It should also be borne in mind, that a loss of £70 had been incurred, from the falling of horses upon the old paving, during the last fortnight it was in use, and that a very large extra quantity of metal was employed in filling up the holes it had left. Bull Street, at Birmingham, was not worn down 6 inches per annum, yet the number of vehicles which passed over it, during ten hours per day, amounted to two thousand four hundred and eighty-four.

Mr. WHITWORTH remarked, that the macadamised portion of the road at Manchester, was the terminus of five streets, whilst the paved portion was upon the bridge.

Mr. CAWLEY replied, that although five streets met together at the macadamised part, the principal traffic was more concentrated on the bridge: the former, nevertheless, was continually undergoing repairs.

Mr. HAYWOOD was of opinion, that macadamised roads were not adapted for large towns: they created too much dust and dirt, and they were also too absorbent. They would not bear any great amount of traffic, nor the heavy weights which were now moved upon narrow wheels, at a great velocity, without requiring constant repair. Parliament Street, (London,) was an example in point; the cost of maintaining it could not be less than from 2*s.* to 2*s.* 6*d.* per square yard, per annum. This street had the additional misfortune of possessing one brick sewer and two pipe sewers; and during the last two years, not a month had elapsed, without its undergoing repairs upon the surface. The reparation of Fleet Street, which had not been re-paved for seven years, cost, on the contrary, only 3*d.* per square yard per annum, and such was the average cost of repairing the streets in the City of London. Some years ago, the inhabitants of the City were seized with the same mania for macadamising, which they had, subsequently, for wood-paving: both the systems were extensively tried, but nothing could

exceed the annoyance and the loss, and stone paving was again resorted to. In New Oxford Street also, the macadam, after a fair trial had been given to it, was now replaced by paving. The advantages of the latter system were most remarkable during wet weather and after the late snow-storms: the paving became perfectly dry, whilst the macadamised roads, for days afterwards, were still rotten. His views on this subject were, in most respects, in accordance with the following extract from Mr. Newlands' Report:[1]—

"During the last two years square set paving has been, to a very great extent, substituted for boulders and macadam. Although this has been effected at an increase of cost in the first instance, its eventual economy is placed beyond a doubt. Experience every day illustrates the advisability of doing all the work in the streets, in the strongest and most durable manner. Now as the foundation of a road requires to be equally strong, whatever be the protective coating applied above it, it is of great importance, that that coating be also of a durable nature, and it is the constant renewal of it, when composed of macadam, or of boulder stones, that creates the great annual cost of maintaining the streets.

"In some streets of great traffic the cost of repairing the macadam would, in three years, pay for paving them with sets, while the set paving will last for many years without repair. The objections urged against the set paving, are mainly two,—slipperiness and noise. The first objection does not apply when the sets are narrow, and are paved with joints so wide as to afford a hold for the calkin of the horse's shoe; the second objection is the one now most loudly insisted on, and it, doubtless, would be very desirable to obviate it, by adopting some means to abate the noise. The experiment about to be tried in Berry Street, will probably be suggestive of some plan of doing this.

"But while allowing full force to this objection to square sets, it must be remembered, that macadam is not noiseless. When a fresh coating is applied, the grinding noise produced

[1] *Vide* "Report to the Health Committee of the Borough of Liverpool, on the Sewerage, Paving, Cleansing, and other works, under the Sanitary Act." By James Newlands. Liverpool, 1853. Pages 40, 41, and 42.

by the traffic is as loud, and certainly quite as disagreeable, as that produced on a pavement of dressed stones; and, as in great thoroughfares the macadam is almost incessantly undergoing repair, the roads always mending but never mended, it appears to me, that the objection applies with equal force to both; but if it did not, there are other inconveniences attached to the use of macadam, which should have due weight in a balance of advantages and disadvantages.

"The stones ground to powder become dust, or mud, as the weather may be dry, or wet. The dust necessitates the use of the watering-carts, and eventually, the stones which are prepared and laid on as macadam at so great a cost, are swept up and taken away by the scavenger. These sweepings are technically known as rubbish, and as, unlike the sweepings of paved streets, they are unfit for manure, and yield no return, their removal occasions great expense. In short, macadam in streets of great traffic requires incessant repairs; the thoroughfares in which it is used are constantly encumbered by workmen, and it necessitates constant watering and sweeping, which create additional obstructions to traffic, and are, after all, only palliatives of the evils intended to be removed. . . .

"But while macadam in streets in a town exposed to heavy traffic is objectionable, it may be advantageously used for the roads of the outskirts, in those cases where the annual cost of maintaining it in good order, would be less than the annual interest on the cost of square set paving."

With regard to the latter paragraph, he thought, that the main roads leading out of the Metropolis formed an exception to the rule there laid down, and that they ought to be paved. He entirely approved of the use of grit for binding fresh metalling, provided it was not mixed up with too much soil. Upon the Holyhead Roads, Telford always applied clean gravel to the new metal, and he himself had also used it with great advantage.

Mr. J. P. SMITH was not surprised at the expense of maintaining Parliament Street and New Oxford Street: they were never kept in good order, and proper cross-sections had not been made. There was a great prejudice against macadamised roads, and unless they were kept in good repair, they certainly did become very expensive; but when properly maintained, it

was evident, by the small expenditure incurred at Birmingham over 150 miles of thoroughfare, that the macadam system could be made to be more economical than that of paving.

Mr. SIMPSON, — President, — suggested, that information should be given respecting the different methods of macadamising generally employed.

Mr. HENRY BROWSE said, that the practice which, in his opinion, afforded the best results, was to prepare the surface by a layer of broken flint, and then to put on a coating of broken granite. Westminster Bridge was found to require a coating of about 5½ inches annually. He did not advocate the macadamised system for streets of large traffic. With respect, however, to Regent Street, Parliament Street, Whitehall, and other considerable thoroughfares, it should be observed, that they were formerly under the superintendence of the Office of Woods and Forests, and were then kept in excellent order, but since 1850, they had passed under the care of the parishes, and had been allowed, through want of attention, to get out of repair.

Mr. HAYWOOD said, that the first cost of laying down the best square set paving of Aberdeen granite, about 12 inches in length, by 9 inches in depth, by 3 inches in thickness, was from 15 shillings to 17 shillings per square yard, exclusive of the substratum, which would cost one shilling more: the extreme cost would thus be 18 shillings per square yard. Stone of this character, laid down in Fleet Street, would bear seven years' traffic, and at the end of that term, could be relaid; after five years' additional wear, it would be fit, after being dressed again, to be relaid in the secondary streets, where it would last nearly fifteen years longer, when it could be still turned to account, even at the end of that time, for macadamising.

The paving upon London Bridge, which was formed of cubes of the best Aberdeen granite, 3 inches in thickness, was laid in 1842, and it was taken up in 1851. From careful observation made during that period, Mr. Haywood estimated the loss from wear, at 2 inches in depth; and had it not been that more time would have been consumed by dressing and relaying the old stones, than by repaving with new material, this course would have been adopted. The total area of the carriage-way of the bridge, was 3,950 superficial yards.

	£.	s.	d.
The first cost was	3,850	16	0
The total repairs, in nine years . .	277	11	0
The total cost was therefore .	4,128	7	0
The sum allowed for the old stone, when removed in 1851, was . .	757	0	0
The actual cost of paving, during the nine years, was, therefore .	£3,371	7	0

Thus the cost of this paving, (exclusive of interest upon the first outlay,) during the nine years, was 1*s.* $10\frac{3}{4}$*d.* per yard per annum; and the cost of repairs only 1·87 penny per yard per annum. No thoroughfare in London had so large an amount of traffic as London Bridge in 1850. There passed over it daily, between 8 A.M. and 8 P.M., thirteen thousand and ninety-nine vehicles, and this constituted a fair average of the week-day traffic.

The cost of repairing the paving of the carriage-way in the Poultry, which, after being down for six years, was taken up in 1852, amounted to 2·66 pence per yard per annum.

The paving of the carriage-way in Cheapside, which was laid in 1846, with cubes of granite 3 inches thick, lasted with occasional repairs until 1853. That in King William Street, laid new in 1846, was relaid in 1851; that in St. Paul's Churchyard, laid new in 1847, was relaid in 1853; that in Fenchurch Street (east end), laid new in 1846, was relaid in 1852; that in Leadenhall Street, laid new in 1845, was relaid in 1852; that in Hart Street, laid new in 1847, was relaid in 1853.

From information furnished by M. D'Arcy, Ingénieur des Ponts et Chausées, it appeared that at Paris, the paving in the first-class streets lasted from six to eight years before requiring to be relaid over the whole surface, and in the second-class streets, from fifteen to twenty years. The paving stones used in Paris were of a very fine grit sand-stone,—generally procured from the forest of Fontainebleau; they were accurately dressed and were usually well laid.

Mr. APPOLD said, he had been informed by the late Sir

James McAdam, that the repairs of the macadamised roadway on Westminster Bridge cost £400 per annum.

Mr. BEARDMORE remarked, that in the suburbs of London, Guernsey granite was becoming generally used, in preference to gravel, or flint, as it was found to be more economical; neither of these materials being capable of resisting the heavy wear and tear of metropolitan traffic.

Mr. WOOD said, that the system of macadamising adopted at Liverpool, by Mr. Newlands, with the view of resisting the heavy traffic, and securing good drainage, was to lay down a substratum of rough pitching of stone, to cover it with gravel, and then to put on the coating. But no system of macadamising could resist loads of 5 tons, when carried upon vehicles with only four wheels.

Mr. LEGG observed, that Bombay granite lasted much longer than Guernsey granite. The wear and tear, both on the macadamised street and on the bridge at Manchester, which had been previously mentioned, was peculiarly severe on the former, as the carts worked in a curve, and the shoes of the horses destroyed the surface of the road. In more open situations, the quantity of material required would not be so great; and it might be laid thinner, provided it was well raked in. The difference in price of the material at London and at Birmingham might account, in some measure, for the discrepancy in the cost of the macadamised system at the two places.

Mr. HAYWOOD said, that the quick and heavy traffic now carried on by vans on narrow wheels, and more especially by those belonging to the general carriers, caused rapid destruction of the roads of the Metropolis, and must, eventually, increase the rates for the highways. The system of laying the stones in diagonal courses, which had been recently advocated, had not proved to be any improvement upon the old plan, and the advantages claimed for it, of giving a surer foot-hold for the horses, and of diminishing the shocks from the wheels of the vehicles, had both turned out to be fallacious. When laid in this manner, the stones wore more irregularly, than when laid according to the old plan, at right angles to the line of traffic.

Mr. BAYLISS said, that the difference in the cost of repairing macadamised roads in London and in Birmingham was very

remarkable. He thought this system could only be used with advantage in such situations as at Birmingham, where the streets fell off on either side of the central ridge intersecting the town, and where, consequently, the natural slope of the ground afforded great facilities for cleansing, and for the discharge of the rain-fall.

Mr. GEORGE BURT said, that in 1840, his partner, Mr. Mowlem, had paved Blackfriars Bridge with Aberdeen and Guernsey stones, 3 inches by 9 inches, at a cost of about £1 per yard, including 1 foot depth of concrete. The price, then, would have been rather greater, if Guernsey stone only had been used. When the pavement had been down thirteen years, the Aberdeen stone was found to have worn away to the extent of $1\frac{1}{2}$ inch, and the Guernsey stone, $\frac{1}{4}$ of an inch only. This piece of paving was the first with stones 3 inches thick ever laid down, and the work was executed under the direction of Mr. Walker (M. Inst. C. E.)

Mr. HAWKSHAW fully coincided with the Author's views of the maintenance of macadamised roads in provincial towns, where the traffic was not, as in London, sufficiently heavy to cut up the surface, and to keep the thoroughfares either in a constantly muddy, or dusty state, or under continual repair. There were several large towns whose streets were, under this system, kept in a much better state than those of the Metropolis.

Mr. VIGNOLES said, the state of the macadamised streets in London was a convincing proof of the badness of the system employed. It was now about twenty years since the French Engineers had begun to macadamise; and it was stated that by careful attention to rolling, scraping, and sweeping, they kept up the roads at a less expense than in England.

Mr. J. P. SMITH said, with reference to the extracts from Mr. Newlands' Report, that the flat shoes which were used for horses at Birmingham and other places, did not afford them any foot-hold upon set paving; and that the noise occasioned by macadamised roads was not so great as was there stated, inasmuch as the surface was completely set in five days, and the noise might be altogether prevented, by using grit for accelerating the binding. He could not conceive, that the cost of macadamising could, by any possibility, be as much as eight

times that of paving, since in Birmingham the expense of maintenance was only threepence halfpenny per square yard per annum, and the entire cost amounted to only sixpence per square yard. The traffic at Birmingham was very heavy, especially in Bull Street, the coal waggons generally carrying 8 tons, with the main pressure upon two of the wheels, which were 9 inches wide, and about 5 feet in diameter. The streets were generally cleaned at night, and the sweeping-machines were also sent out at night, whenever the weather was favourable, the police calling the men together. The sweepings of the roads were sold for £1 per boat-load of 20 tons. His first experience in road-making was obtained twenty years ago, when he was a coach proprietor, and was in the habit of driving about 30,000 miles per annum. It was almost impossible to pass over the portions of the new Holyhead road, after they were newly metalled, until sweepings were carted upon it, for accelerating the binding, and then all difficulty was at an end.

Mr. NEWLANDS said, that, at Liverpool, he had had experience of the cost of maintaining about 40 miles of macadamised roads and about 130 miles of paved roads, and he had found, that the cost of keeping in repair a macadamised road, under the severe grinding traffic to which the streets in the lower part of the town were exposed, from the heavy carts and waggons, was about six times that for a paved road; in the streets where the traffic was considerable, but of a light character, the cost was also much greater. Experiments on the tractive force required on the different kinds of paved and macadamised roads were now being carried on, and he would communicate the results to the Institution. At Liverpool, square-set paving, varying in gauge, according to the locality, from 3 inches to 4 inches, was being substituted in the streets referred to, and the use of macadam had become confined to streets where the traffic was light, and to those portions of the streets with heavy traffic, where, from the proximity of churches, schools, hospitals, &c., the noise of traversing the pavement was objectionable. The stone employed was chiefly the grauwacke from Penmaen Mawr, but much excellent stone was also obtained from Bombay and from China, whence it was brought to Liverpool as ballast. At Liverpool, macadam set very rapidly in the

busy streets. During the summer months, the rapid binding of the newly-laid macadam was aided by covering it with the road scrapings, and the new metal was always mixed with the old stone. He had never tried the experiment of setting it with asphalte, as, in his opinion, that plan had proved to be unsatisfactory at Sheffield; and the slipperiness which resulted was very objectionable.

Mr. W. TAYLOR, through the SECRETARY, said, that the cost of paving at Birmingham, which had been stated to be 15 shillings per yard, had never exceeded 7*s.* 6*d.* per yard; and that the whole of the carriage-ways of the town, which were now composed of broken stone and gravel, (for there was not a single paved street,) might be converted into the best pavement at a price not exceeding that sum. Much stress had been justly laid upon the cleansing of macadamised streets, which necessarily formed a very important item in the expenditure, for the amount of mud to be swept and carted away, must be in proportion to the quantity of material laid on annually, and even much greater, from the amount of water with which it was generally mixed, and it was acknowledged, that a macadamised road lost from 4 inches to 6 inches of metal per annum. Paving, on the contrary, produced no dirt, and therefore, no comparison could be drawn between the expenses of the two in cleansing. There were three elements in the calculation of the comparative cost of paved and macadamised roads;—first cost, repairs, and cleansing. Confining the inquiry to the streets of the greatest traffic in Birmingham, for those alone constituted a true test, and taking the period of fifteen years, mentioned in the Paper, as the duration of paving, the result would be:—

	£.	*s.*	*d.*
Paving—first cost per square yard .	0	7	6
Repairs during 15 years . . .	0	1	6
Cleansing 1*d.* per annum . .	0	1	3
	0	10	3
Deduct value of old stone . .	0	2	6
	£0	7	9

Whereas the cost of the—

	£.	s.	d.
Macadamised road, 6 inches thick—			
first cost, per square yard . .	0	1	6
Coating, 14 years, 4 inches thick, at 1*s.*	0	14	0
Cleansing, 15 years, at 4*d.* per yard	0	5	0
	£1	0	6

Thus the expense of the macadam was nearly three times the expense of paving, according to the most moderate calculations, for all streets of large traffic required metalling twice in the year.

Sir Henry Parnell,[1] after a searching inquiry, gave the cost of macadamising in London, on an average of ten years, at about five times the cost of paving; and such an authority could scarcely be questioned, as he held, for many years, the position of chief acting Commissioner of the Holyhead Road.

Macadamising was well adapted for turnpike roads, where it was freely exposed to the sun and wind; but in towns, where the streets were surrounded and shaded by lofty buildings, and were in a wet, or damp state throughout a great part of the year, any material composed of small particles mixed with grit, and subject to the constant grinding action of carriage-wheels, must, necessarily, be soon reduced to powder.

Mr. REDMAN said, that on the Commercial Road, which was 10 yards wide and 2 miles in length, the quantity of coating required was from 1 inch to 1½ inch per annum, or a total of 1,200 tons of metal: the cost of maintenance was fourpence per yard. This road could not, of course, be compared to Parliament Street, it being similar, rather, to a suburban road, and the heavy traffic travelled over a granite tramway: still he believed, that for light traffic, macadamising would prove to be cheaper then paving.

Mr. NEWLANDS said, that at Liverpool, the cost of macadamising was 2 shillings per square yard, and that of paving, 6 shillings per square yard. In the streets with heavy traffic, the former was worn away at the rate of 12 inches per annum, but now that paving was substituted, repairs were not required.

[1] *Vide* "Treatise on Roads." By Sir Henry Parnell. Pages 141, 142