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PREFACE.

ERRATA—VOLUME XIII.

Page 59, line 8 from foot, for "morality" read "mortality."

Page 109, line 16 from foot, for "offsping" read "offspring."

Page 125, last two lines transposed.

Page 270, lines 18, 23, 29, for "Havant" read "Lavant;"
 and line 29, for "spring" read "springs."

Page 271, line 12 from foot, for "well" read "water."

Page 373, line 17, for "statement" read "statements."

of the Annual Volume of Transactions.

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P R E F A C E .

THE present Volume contains a record of the proceedings of the Institute for 1893, and includes papers read at the Sessional Meetings and the discussions upon them; a series of Special Lectures on "The Sanitation of Industries;" and two of the Lectures given in the course for Sanitary Officers, which have been frequently asked for by Members and Associates.

A record of the progress of the Library and Examinations of the Institute is also given.

The Committee have incorporated in the Volume an Illustrated List of the Exhibits to which Medals and Certificates have been awarded at the Exhibitions held since the incorporation of the Institute.

The Volume being published before the Annual Meeting cannot, of course, contain the Annual Report, but this will be sent to the Members in the Quarterly Journal of the Institute, which the Council have decided to publish in future in place of the Annual Volume of Transactions.

Congresses held by the Institute.

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Conference of Municipal and County Engineers—H. PERCY BOULNOIS, M.INST.C.E.

Conference of Sanitary Inspectors—PROF. A. WYNTER BLYTH.

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The next Congress and Exhibition will be held at Liverpool, September 24th to 29th, 1894.

LIGHT, AIR, AND FOG.

By G. V. POORE, M.D., F.R.C.P.

Read at the Sessional Meeting, February 8th, 1893.

IN considering the climatological conditions which are favourable to the formation of fog in London one cannot do better than examine actual facts; and, therefore, I have recourse to the returns to the Registrar-General for the week ending December 26th, 1891, for the purpose of making a critical study of the notable fog of Christmas, 1891, its cause and consequences.

In order that fog may be formed, the air must be laden with moisture, and consequently in London the winds which bring the fog are those which come from the eastward, over the sea and up the estuary of the Thames. Fogs are necessarily phenomena which depend upon *stillness* of the air, for they are quickly dissipated by even a moderate breeze. In order that the moisture-laden air may precipitate its moisture in the form of fog it needs to be *chilled*, and, therefore, our winter fogs only occur in cold weather. December 20th, 1891, at Greenwich was a clear frosty day with very light air from the north-east. On the following day the wind became due east and dropped to a dead calm, and then commenced a dense fog which continued till the evening of Christmas Day, when the wind shifted to the south-west and the frost and fog came to an end.

In the week ending December 26th six days were frosty, and a dense fog continued for the greater part of five days. The air was almost saturated with moisture. The mean daily value of temperature was 10·2 degrees *below* the average, and amounted to 29·1 degrees only. Out of fifty-four hours during which the sun was above the horizon, sunshine was registered at Greenwich during 4·7 hours only, and the sum of the horizontal movement of the air for the week amounted to 78½ miles, or 1,341 miles below the average.

The barometer stood at 30·49 inches at the beginning of the week and gradually fell to 29·7 at its close. These quantities are, be it remembered, the result of observations at Greenwich, and taken about 150 feet above the mean sea-level. Meteorological observations in the centre of London are not recorded with any systematic care, but we may feel tolerably sure that the temperature in London was slightly higher than at

Greenwich; that even less sunshine was recorded, and that the rate of movement of the air was even less and amounted to downright stagnation.

The characteristics of the air during a fog are, then, *darkness, coldness, dampness, and stagnation*. It appears probable (although I know of no exact observations) that the mobility of the air and the diffusibility of its component gases is diminished during a fog. One of the often-recorded phenomena of a fog is the way in which it remains stationary in banks, and with exact limits (forming real pillars of cloud), for hours at a time; and one must take it for granted that the products of respiration and combustion are not easily removed in such circumstances, but remain to irritate, and perhaps to poison, those who are surrounded by such envelopes of vapour. It is this stagnation of the air which, I believe, constitutes one of the great dangers of a fog. In estimating the effect that a fog has upon the health and comfort of those who are immersed in it, a very important matter is its *duration*. All fogs, and especially London fogs, which are laden with irritative and infective particles, are very trying to sufferers from lung disease, especially those afflicted with chronic bronchitis, and the danger to these persons may be looked upon as proportioned to the length of time they are exposed to adverse circumstances. If the fog, after a few hours' duration, clears up, the lungs get rid of the irritating matter, respiration becomes normal again, and the patient is able to withstand a second bout of fog when it returns; but if a fog continues for a few days instead of a few hours, there is no respite, and the patient succumbs. I have elsewhere compared Londoners in a fog to fish in a bowl, who suffer from the neglect of their owner to change the water; and it is evident that the longer the change be delayed, the more unfitted the water becomes for the respiration of the fish, and the greater is the danger. So the danger of a fog increases with its duration, for not only do the dwellers in it get no respite with which to obtain, as it were, a new lease of life by even a few gasps in the fresh air; but the dense fog-bank which weighs upon them gets hourly fouler and fouler from the products of combustion and the smoke (a result of non-combustion) from thousands of chimneys and the respiratory and other impurities from millions of men and animals. A very noteworthy feature of the fog of Christmas, 1891, was its duration: it began on Monday evening, and lasted, in a very dense form and without intermission, until Friday night; so that the time during which the Londoners had to endure this weather—this mixture of coldness, dampness, foulness, and stagnation—was close upon a hundred hours.

When we come to consider what effect this long-continued fog had upon the health of London we find that we have many facts to take into consideration before we can arrive at any conclusion. The effect of cold and fog upon the death-rate is produced almost immediately because there is always a large number of sufferers from chronic maladies who are ripe for departure so soon as the first adverse circumstance arrives to overtax their feeble powers. Of course there are many others who do not die at once, but whose condition is so aggravated by the fog that they succumb in a few weeks or so. When fog and cold set in on a Monday some of the results of it would certainly appear in the death-returns furnished to the Registrar-General on the following Saturday night, but, as in this particular week Christmas Day fell upon a Friday, the work of Registration was upset, and many of the deaths occurring in the week, ending December 26th, were not registered until the following week, ending January 2nd. It thus follows that in order to estimate the effects of the fog we must take the deaths occurring in the *fortnight*, ending January 2nd, and in this way we eliminate the disturbing influence of Christmas.

The estimated average number of deaths for the weeks ending December 26th, 1891, and January 2nd, 1892, respectively, is stated by the Registrar-General to be 1,813 and 1,915, giving a total of 3,728 for the fortnight. The actual number of deaths registered in these two weeks was 1,771 and 3,399, giving a total of 5,170 for the fortnight, or an excess of 1,442. The excess of actual deaths in the week ending January 2nd, over the calculated average was 1,484, so that we may, in considering the details of the excess for the fortnight, limit our attention to the second week alone. To do so will save much trouble, and will not materially influence our conclusions. The death-rate for the *fortnight* averaged 32, and for the two weeks respectively, it was 21.9 and 42. Limiting our attention to the second of the two weeks, we find the following causes of death show a marked excess over the average:—

	Average.		Excess.	
	Average.	Actual.	Gross.	Per cent.
Measles	72	154	82	114
Whooping-cough	66	180	114	173
Phthisis	182	258	76	42
Old age	66	90	24	36
Apoplexy	50	79	29	58
Dis. of the Circulatory System	154	317	163	106
Bronchitis	344	927	583	170
Pneumonia	120	253	133	111
Other Respiratory diseases..	51	120	69	135
Accidents	58	118	60	103
	1,163	2,496	1,333	115

It is noticeable that the excess of deaths is mainly attributable to lung diseases or zymotic diseases, such as whooping-cough and measles, in which lung complications are very common. Deaths from circulatory disease were also far above the average, but as anything which hampers the action of the lungs must exercise a baneful influence on the circulation, this is what one would naturally expect, and merely tends to strengthen the assertion that cold and fog kill primarily by their effect on the lungs.

The death-rate for the whole of London was 42, while the death-rates for the several districts were as follows:—

Northern	36.4
Western	43.68
Central	52.0
Eastern	47.32
Southern	39.52

It is noticeable that the western district suffered more than the northern or the southern, which is not to be wondered at, for with the slight airs from the East which prevailed the western districts would get the full effect of the foulness which drifted from the whole of the metropolis lying to the eastward. The highest fog death-rate was in the central district.

The high mortality caused by this fog was followed by a severe epidemic of influenza which lasted for six weeks, and the question naturally arises as to whether much of the mortality, apparently due to the fog, was not in reality caused by influenza. This does not seem probable, because in the week ending January 2nd, there were not more than 37 deaths from influenza recorded in London. On the other hand may it not be considered as probable that the stillness and torpidity of the atmosphere during the fog was favourable for the conveyance of the influenza poison and helped, as it were, in determining the severity and wide extent of the epidemic. This epidemic lasted for six weeks, and in these six weeks there were 17,576 deaths, or very nearly 6,000 more than the corrected average number.

As affording some evidence that infective particles are especially liable to be transported through the air during fogs, one may refer to Mr. Power's well-known report on the spread of small-pox from the Fulham Hospital in 1881. A large number of cases of small-pox occurred in the neighbourhood of this hospital during dull, foggy, calm weather, and Mr. Power remarks: "Familiar illustration of that conveyance of particulate matter, which I am here including in the term 'dissemination,' is seen summer and winter in the movements of

"particles forming mist and fog. The chief of these are, of course, water particles; but these carry gently about with them, in an unaltered form, other matters which have been suspended in the atmosphere, and these other matters, during the almost absolute stillness attending the formation of dew and hoar-frost, sink earthwards, and may often be recognised after their deposit. As to the capacity of fogs to this end, no Londoner needs instruction. And there are reasons which require us to believe particulate matter to be more easy of suspension in an unchanged form during any remarkable calmness of atmosphere. Even quite conspicuous objects, such as cobwebs, may be held up in the air under such conditions."

The presumption that the fog, apart from the cold, is a cause of the remarkable rise in the death-roll, is one which in the minds of most of us would require no proof, and we should regard it as a notorious fact. The Registrar-General's figures rather go to show that the death-rate is greatest in the central part of London where the fog is densest, notwithstanding that the temperature of the central districts of London is always higher than it is at the outskirts.

That the fog is, apart from the cold, a very virulent element of weather is also shown by the result of the notorious fog of 1873, which occurred during the Islington Cattle Show, and which so affected the beasts that 36 per cent. of them had to be hurriedly removed from the exhibition building, and many of them were as hurriedly killed in order to secure the butcher's purchase-money. It is hardly conceivable that cold, apart from fog, could have caused this potential mortality in animals, most of whom are accustomed to exposure at all times and seasons.

It is well known that a downward movement of the thermometer, apart from fog, is always followed by a rise in the death-rate from pulmonary disease, and that while the young are enjoying the exhilaration of skating in the crisp, clear, frosty air, the elderly and the delicate are succumbing before the extra work which is thrown upon the lungs and other organs in maintaining the body at its normal temperature.

It may be parenthetically remarked that it is most necessary to distinguish between that which causes a particular class of diseases, and conditions which are merely unfavourable for those who are already suffering from such diseases.

That cold *per se* is a great cause of lung disease, we have very little evidence to prove. As regards phthisis, it is well known that there is less in Northern Europe and Canada than there is in places further South, and we also recognise that many

incipient cases of phthisis do excellently well in very elevated regions where the cold is intense. It is now recognised that phthisis is a true infective disease, and that no merely physical conditions without the living *causa causans* are competent to produce it. *Acute pneumonia*, too, is now known to be a true infective disease, which not unfrequently is very contagious. phthisis and acute pneumonia both belong to the air-borne contagia, and the hygienic condition most favourable for their occurrence undoubtedly is over-crowding. That intense congestion of the lungs which occurs when the feeble are slowly dying, is a disease, if disease it can be called, probably quite distinct from acute pneumonia, and it is admittedly very common in very aged people, who succumb during cold weather. Bronchitis has always seemed to me to be mainly predisposed to by dietetic errors rather than climatic conditions, and if I were asked to name the chief predisposing causes I should say alcohol, over-crowding, and dust, placing alcohol decidedly first. Although I am not disposed to recognise cold *per se* as in any sense a great cause of lung disease, yet I nevertheless recognise that it is a *most potent* cause of death in those who are already suffering from lung disease. The sufferers from chronic lung disease are always with us in this over-grown town in enormous numbers, and with the advent of severe weather these succumb to the adverse circumstances, their enfeebled organs being unable to bear the extra strain of maintaining the animal heat.

Sufferers from lung-disease or heart-disease feel the effects of cold very quickly, and the bronchitic have always increased difficulty of breathing and increased secretion from the lungs, due possibly to congestion of the lungs induced by the cold.

If the sufferer from chronic lung disease does not like the cold, he abominates the fog; and all such are unanimous in declaring that the irritating effect of the fog is quite distinct from the effect of mere cold.

As a physician, I have no hesitation in saying that the physical condition of the air known as fog is very trying to sufferers from bronchitis and other lung troubles. Physiologists tell us that air containing about 70% of moisture is most agreeable for breathing purposes, and that quantities materially above or below this figure make the air unpleasant for respiration. The human body has to get rid of a certain amount of moisture by the lungs, and it is evident that when the medium in which the body is placed is not only bitterly cold, but saturated with moisture as well, there must be difficulty in getting rid of this moisture. Again, one would ask whether a cold and saturated air does not chill the lungs more than

tolerably dry air of the same temperature, and whether the saturation of the air with moisture does not in some degree interfere with that interchange of oxygen and carbonic acid, which is the essence of the respiratory act?

Whatever the explanation may be, there can be no doubt that the fog is in itself a very trying condition, especially for those who are the subjects of lung-disease.

But, it will be urged, we do not hear of fatal results from being in the fog on the banks of Newfoundland, nor do we hear of such occurrences in country districts. The fatality of fog seems limited to London and the big towns.

During a fog it is undoubted that the carrying powers of the air for solid particles is increased, and the dust of various kinds projected into the air has a lesser tendency to obey the force of gravity, than when the air is free from particles of moisture. It thus follows that the air of big towns becomes very impure during a fog, and it is the mere concentration of the constituents of the ordinary London atmosphere which gives the virulence to the London fog.

The importance of this conclusion is very great, for it amounts to saying that when the stagnation of the air in London reaches a certain degree, it is inevitably fatal to a large number of its more fragile inhabitants.

Let us stop to consider the composition of the London atmosphere. The fog proper depends upon causes beyond our control, but the dirtiness of the air of London may fairly be looked upon as something which is manufactured by its inhabitants, and therefore to a certain extent within our control.

In 1841, a little more than half a century ago, London contained less than 2,000,000 inhabitants, and the maps of the period show that the limits of the town were (roughly) Lord's Cricket Ground in the north, Kennington Oval in the south, Knightsbridge in the west, and the London Docks in the east. Now London extends from Tottenham to Croydon and from Richmond to Woolwich, and contains, within these limits, some 5,000,000 inhabitants. The town has undergone an enormous increase in its area without any diminution in the density of its population. If we allow one chimney to every five inhabitants we must allow an increase of 600,000 domestic chimneys since 1841. If we bear in mind the enormous increase in the use of steam and gas for motive purposes we must admit that probably the fouling of the air by combustion, necessitated by manufacturing industry, has increased in a ratio greater than the increase in the number employed in such industries. We must not forget that the animal population increases with the human, and when we estimate the density of population for sanitary

purposes we ought to reckon in the domestic animals and especially the horses.

Not only is the air fouled by respiration and combustion, but also by putrefaction, and when considering the fouling of the air of London, one must remember the dung-heaps of the stables, the droppings of the streets, and the effluvia which escape from the ventilators of the 2,000 miles of sewers which lie beneath our streets. When one considers the magnitude of the fouling of the air from various causes, and when we bear in mind that a fair percentage of the inhabitants are suffering from phthisis, pneumonia, influenza, scarlet fever, whooping-cough, measles and diphtheria, and when we remember that a large number who are not suffering from definite disease, have unwholesome breath as a result of pathological conditions of the teeth, mouth and air passages, we cannot be surprised that a stagnation of the air should produce effects more or less disastrous. London can have very little power, during a dense fog, of purifying its air. Vegetation of all kinds is scanty in the central parts of London, and evergreens merely degenerate into everblacks and die. Even if green leaves did exist, their chlorophyll could not act in a place where, for a month at a time, there is no sunshine, and thus London in a stagnant fog is left to stew in its own gravy until a welcome wind blows away the filthy pall which covers it.

In the fifth volume of the Transactions of the Seventh International Congress of Hygiene and Demography will be found two most excellent papers dealing with the subject of Fog and Smoke. One is by Dr. W. J. Russell, F.R.S., on "Town Fogs and their effects," and the other, on the "Prevention of Smoke from Factories and Dwelling Houses," is by Mr. A. E. Fletcher, H.M.'s Chief Inspector under the Alkali, &c., Works Regulation Act.

Mr. Fletcher contends that the Acts introduced by Lord Palmerston in 1853 and 1856, making it penal to allow black smoke to issue from any factory chimney within the metropolis or from any steam vessel plying on the Thames, have had the effect of relieving London from nearly all the smoke of factory chimneys. "But," he adds, "the smoke of dwelling houses remained." If we accept as a fact that the smokiness of London is due to the domestic fireplace, it is nevertheless impossible not to believe that the amount of smoke emitted *per head of population* must be considerably less than formerly. The increased use of gas for cooking purposes, the improvements which have been effected in grates, and the employment of steam or hot water coils must have had, one would think, the effect of diminishing the amount of smoke per head, unless

(which is not improbable) the increase in the rate of wages and increasing luxury in the matter of hot bath, &c., has caused a demand for more heat per head of population, and thus the increased consumption of fuel has more than balanced its improved combustion.

According to Dr. Russell the amount of coal used in London (excluding that used for gas-making) was in 1879 5,833,891 tons, while in 1889 the amount had risen to 6,390,850 tons, an increase which is about proportionate to the increase in population.

Nobody who is an early riser can doubt that the domestic fire-place is the main cause of the smokiness of London. At six o'clock in the morning the air is not unfrequently clear and brilliant, but these qualities disappear an hour later when the preparations for the morning meal have necessitated the lighting of the fires. The amount of smoke is probably greatest between 7 and 8 a.m., because the best of grates will emit more or less smoke when just lighted. Later in the day the domestic smoke diminishes, and one must admit that it is not common to see the domestic chimney emitting very much black smoke.

Notwithstanding that factory smoke has been practically abolished in London and that many causes have conspired to diminish the amount of domestic smoke per head, the dirtiness of the air and the number of fogs have increased. Thus Dr. Russell states, on the authority of Mr. Brodie, that in—

1870-75	93	winter fogs occurred.
1875-80	119	" "
1880-85	131	" "
1885-90	156	" "

And I think we should all agree that the central part of London gets gradually dirtier, and that the necessity of employing artificial light in the day-time is increasingly felt.

How can it be otherwise in a place which is steadily increasing both in area and density? The circle of houses round the centre of London requires a radius of eight or ten miles for its inclusion, and in the central districts of London, no matter what may be the direction of the wind, the air is mixed with the dirty effluvia of men, animals, and chimneys, and can never be "fresh."

A more important point as leading to increased dirtiness of the air is the increased density of houses and population, especially in the centre.

It is hardly necessary to point out that a house of nine storeys has, probably, three times as many fire-places as a house of three storeys, having a similar area. In the country the

smoke of our houses is blown away and diluted and causes us no practical inconvenience; but in London we have not only been building upon every vacant space, but we have been increasing the height of our dwelling houses and building towers full of offices and huge piles of flats, and we clearly have no cause to grumble if the air gets dirtier, and the death-rate does not go down. We have legislated against back-to-back dwellings, and yet allow them to be piled nine and ten in a heap, which seems to suggest that there is one law for the rich and another for the poor. That the increased frequency of fog is due to the increase alike of area and density of the city there can be no doubt. There are more men and chimneys on a given space, and therefore the effluvia are less frequently diluted to vanishing point.

The physical and chemical aspects of fog are of great interest. Aitken has shown that fogs do not form in a pure atmosphere which is absolutely free from floating dust particles; but as there is enough dust in the air off the coast of Newfoundland to allow of the formation of fogs of impenetrable density, it is obvious that the practical bearings of this interesting discovery as affecting the air of cities are not very important, for it would be manifestly impossible to get the air of London or any big town to such a degree of cleanliness that fog would not form. The chemical impurities which are found in the air during a fog are both gaseous and solid. Carbonic acid and sulphur dioxide are the more important gaseous impurities.

Dr. Russell has found the carbonic acid during a fog to be raised from four parts to fourteen parts in 10,000 of air; and a committee of the Manchester Field Naturalists' Society have shown that the amount of sulphur dioxide present in the air of that city may vary from 0.28 milligrams per cubic metre (an amount observed at Owen's College, Manchester, on March 6th, 1891, after two days' strong wind), to 7.40 milligrams per cubic metre (an amount observed at the Town Hall, Manchester, on February 27th, 1891, during a fog). The amount of impurity increases as one passes from the outskirts to the centre of a town.

The Manchester Field Club have further estimated that during a three days' fog $1\frac{1}{2}$ cwts. of sulphuric acid per square mile were deposited in the centre of Manchester, while at an outlying station 1 cwt. of sulphuric acid and 13 cwt. of "blacks" per square mile were carried down in the same time.

Those who have a garden anywhere on the western side of London cannot fail to remember a fog in February, 1891, which covered the evergreen shrubs with a slimy deposit and gave an iridescent appearance to all the puddles in the road. Happily

the fog was subjected to scientific investigation. The matter deposited on Messrs. Veitch's Nursery at Chelsea, and on a plant house at Kew, was analysed. At Chelsea 20 square yards of roof gave 40 grammes of deposit, while at Kew the deposit on the same area amounted to 30 grammes. It is interesting to note that not only was the deposit more copious at Chelsea than at Kew, but it also contained a larger percentage of hydrocarbons and acids.

The following is the analysis of the deposit at Chelsea:—

Carbon	39.00
Hydrocarbons	12.30
Organic Bases	2.00
Sulphuric Acid	4.30
Hydrochloric Acid	1.40
Ammonia	1.40
Mineral matter (chiefly Silica and Iron Salts)	33.80
Water (estimated)	5.80
	<hr/>
	100.0

That these deposits proved ruinous to plants goes without saying, for the leaves were choked by it. The large amount of acid and hydrocarbons in the air also explain the intensely irritating nature of a typical London "Pea Soup" fog, and certainly a contemplation of this analysis makes it impossible to believe that the mortality accompanying a London fog is due entirely to the cold, as some have maintained. The corrosive power of London air is seen in its destructive action on metals. We all know how the metal fittings in our houses tarnish and corrode, and we all know that bronze statues exposed to the London air quickly contract a worm-eaten appearance.

The air of London is never "fresh," a quality which is to be gauged entirely by the nose. Although we may be in doubt as to the physical or chemical basis of "freshness," we are most of us inclined to attach great importance to it as one of the most valuable qualities which air can have. It is the necessity for fresh air which has compelled us to supplement the London Hospitals with a large number of Convalescent Homes at the Seaside and elsewhere, because experience has shown that the power of recovery after acute illness in London or in any large town is very much less than it is in the country. This quality of freshness consists in an absence of foulness, a condition of things which cannot exist for many miles to leeward of a big city like London. It is also almost certain that the air cannot be fresh unless there be green things to freshen it. The

chlorophyll of the green leaves of plants under the influence of sunlight is constantly engaged in absorbing carbonic acid *from* and returning oxygen *to* the air, and on this account it is tolerably certain that vigorous herbage is necessary for the freshening of the atmosphere which we breathe.

In the centre of London comparatively few plants will live, and fewer still will flourish; and even those which do flourish have to contend with an absence of sunlight, which is very prejudicial to the vigorous action of the chlorophyll. It thus follows that the regenerative power of the air in the centre of London is very small; we become entirely dependent upon the wind for our fresh air, and the stagnation of the air is consequently a more serious matter in London than it is elsewhere.

Thus one is led naturally to the discussion of another fact which is all too evident in London, viz., the absence of sunlight.

There can be no doubt as to the importance of sunlight. We know that the activity of the chlorophyll of plants is directly proportioned to the amount of sunlight, and we know that plants deprived of sunlight become etiolated and pale. When we see the radiometers rotating in the opticians' windows we have a demonstration that sunlight is a cause of motion, and all the wonders of photography are calculated to impress upon us the influence of sunlight upon chemical action. We know also of certain things which love darkness rather than light, and among them are the vegetable bodies which contain no chlorophyll, such as the fungi, inclusive of many of those which are recognized as direct causes of disease. It has been proved, with regard to some of these disease-causing microbes, that exposure to the sun's rays materially inhibits their growth.

These facts make it certain that the presence of sunlight is most important for the well-being of mankind, and the Italians have a proverb which says that the Doctor is sure to visit those places where the sun never comes.

Nevertheless we know very little that is accurate concerning the effect of sunlight upon the animal economy. It is probable that the pallor of town-dwellers is in part owing to the absence of sunlight, and it is certain that pallor must mean a deficiency either in the quantity or quality of the hæmoglobin, the red matter of the blood which is apparently analogous to the chlorophyll of plants. Such a deficiency must interfere with metabolism and development, and it seems impossible not to believe that the want of sunlight is a factor in the causation of rickets the commonest of all the diseases of London, albeit that it makes very little show in the returns of the Registrar-General.

The rickety child is anæmic and flabby, and little able to

withstand those minor ailments which seem to be the lot of all. Of the thousands of children who annually die in London of measles, whooping-cough, bronchitis, pneumonia, diarrhoea; how many were rickety to begin with? On this point our statistics are silent, but the common experience of a hospital physician would lead him to say "the majority." The infantile mortality figures (deaths under one year of age to one thousand births) are always much higher in towns than in country districts. A quickly developing child naturally feels the want of fresh air and sunlight more than an adult, and hence it follows that the air of a big city which is not good for any of us, is especially bad for children.

Having arrived at the conclusion that the increase in the amount of fog in London is due to the increase in the area and density of the city, and having also shown that the atmosphere of London in time of fog is merely an exaggeration and concentration of its normal atmosphere, it may be instructive to turn our attention to that portion of London which experiences the greatest difficulty in obtaining fresh air—the central districts of the Registrar-General.

The central districts of the Registrar-General include the districts of Holborn, the Strand, St. Martin's, St. Giles', and the City.

These districts in 1861 contained a population of 383,321; in 1871 a population of 334,369; in 1881 a population of 282,238; and in 1891 a population of 247,140.

These central districts constitute the very core of London, and, roughly speaking, extend from St. James' Park to the Tower, and from the Pentonville Road to the Thames.

They occupy 2,132 acres, and appear to have reached their maximum density of population in 1861, when they contained slightly more than 171 persons to the acre, since which time the night population has decreased, and according to the last census they contained about 115 persons to the acre.

In the "Annual Summary of Births, Deaths, and Causes of Death in London and other Great Towns, 1891," published by the authority of the Registrar-General, will be found a table (Table 9) giving the London mortality in five groups of districts, from 1841 to 1891.

Let us first take from this table the mean rate of mortality in the five decennia intervening between the beginning of 1841 and the end of 1890.

In the Western districts the mean rates of mortality have been 23.0, 22.6, 22.7, 20.8, 19.7.

In the Northern districts the mean rates of mortality have been 22.7, 22.2, 23.6, 21.9, 19.1.

In the Eastern districts the mean rates of mortality have been 26.2, 25.1, 26.9, 25.0, 23.7.

In the Southern districts the mean rates have been 26.2, 24.4, 23.4, 21.9, 19.5.

Thus it will be seen that in all these districts the rates of mortality have tended steadily to diminish between 1841 and 1891, this diminution being most marked in the southern districts and least marked in the eastern districts.

When, however, we come to the Central districts we find no such steady diminution, the mean rates of mortality for the five successive decennia having been 24.7, 24.4, 26.5, 24.9, 23.3.

This seems a fact of such prime importance that it is advisable to consider it more in detail, and accordingly I add from this table the death-rates in the central districts for every year, from 1841 to 1891.

Annual Rate of Mortality in Central Districts.

1841	25.0	1867	24.8
1842	23.6	1868	25.2
1843	25.3	1869	26.6
1844	24.4	1870	26.0
1845	24.0	1871	25.0
1846	22.9	1872	23.6
1847	27.9	1873	25.1
1848	25.3	1874	25.7
1849	27.9	1875	26.2
1850	21.1	1876	24.1
1851	24.1	1877	24.2
1852	23.9	1878	25.2
1853	25.1	1879	26.3
1854	27.4	1880	23.8
1855	25.1	1881	23.4
1856	23.0	1882	24.0
1857	23.8	1883	23.3
1858	24.5	1884	23.8
1859	24.1	1885	22.9
1860	23.3	1886	23.4
1861	25.4	1887	23.5
1862	26.2	1888	22.7
1863	26.9	1889	20.9
1864	29.5	1890	24.8
1865	27.1	1891	26.5
1866	27.1		

We thus arrive at the rather startling fact that not only has there been no material decrease of the mortality in these central districts in the half-century intervening between 1841 and 1891, but that the mortality for the last recorded year, 1891,

was actually the highest on record since 1869, and has only been exceeded on eight occasions.

Compared with the high rate in the central districts of 26.5 for the year 1891, we find that the rate for the same year in the other districts of London was as follows:—Western, 20.8; Northern, 20.0; Eastern, 24; and Southern, 19.8. The rate of mortality for the whole of London in 1891 was 21.4.

We naturally look for some explanation of this high mortality in the centre of London. Is it due to the hospitals contained in the central districts of London, and do the inhabitants of outlying districts flock to hospitals and institutions in the central districts to die in them, and thus unduly swell the mortality?

The answer to this is "No," for a table (Table 11) given on p. xii. of the report from which I am quoting, gives a corrected return of birth and death-rates for the districts of London in 1891, in which the deaths of non-residents occurring in hospitals have not been included.

From this it appears that the corrected death-rates for the districts of London were as follows, and for the sake of comparison I have placed the uncorrected death-rates alongside them:—

District.	Corrected death-rate.	Uncorrected death-rate.
Western	19.5	20.8
Northern	20.0	20.0
Central	27.6	26.5
Eastern	23.9	24.0
Southern	20.2	19.8

It thus appears that more persons left the central districts to die elsewhere than came from the other districts to die in them, and that the true death-rate of the central districts for 1891 was 27.6.

Turning to another table on p. xvii. of the report, in which the corrected death-rate for 28 great towns is given for 1891, we find that the figure for central London (27.6) is higher than that for any of these big towns.

The deaths of children under one year of age to every 1,000 births were, for the whole of London, 154, for the central districts 177.

Before the death-rate of the central districts can be acknowledged as true a further correction must be made for age distribution. This correction would certainly tend further to augment the figure, but to what extent it is difficult to say without an exact knowledge of the number of persons living at each age in the districts. In London, as is well known, there

is a deficiency of persons at the extreme and most vulnerable periods of life, the population of the central districts especially being maintained by the constant immigration of selected adults from the country, among whom the death-rate should be low. Again, we must bear in mind that the corrections made in the death-rate by the Registrar-General are corrections which are entirely in the interests of London. Care is taken that the London death-rate should not be swollen by the inclusion of visitors from outside who die within its limits; but no correction is made in the interests of the country, as a whole, for persons who, falling ill in London, go out of it to die. I cannot but believe that in this matter our exports would considerably more than balance our imports; for it is notorious that directly a man falls ill in London, we send him to the country to regain his strength or die, as the case may be.

There can, I think, be no doubt that this high death-rate of 27.6 is, nevertheless, considerably too low if we are to honestly compare it with the mortality figures of the country as a whole.

But it may be urged that these central districts are poverty stricken, and there can be no doubt that there is a considerable amount of poverty concealed by the palatial buildings which abound in them. These central districts are certainly not so poor as the eastern districts, and although there is no little poverty in Holborn, Clerkenwell, and St. Luke's, it is largely counterbalanced by the wealth of the Strand, the City, and Bloomsbury. These districts may be poor, but most certainly the poor which live in them are better off than they were fifty years ago, and the gradual and complete disappearance of typhus fever may be taken as evidence that there cannot be any large amount of serious want. The disappearance of typhus is due to cheap food; and cheap food in cities has been brought about by Free Trade.

In looking at these death-rates for the central districts from 1841 to 1890 one cannot but be struck with their comparative uniformity, and the absence of figures which seem to point to any particular years as especially pestilential. In 1846, 1847, 1848, and 1849—years memorable for want, social disturbance, and cholera—the death-rate averaged 26 only. In 1854—a year of cholera—it was 27.4, and in 1866—another cholera year—it was 27.1.

The highest death-rate was in 1864 when it stood at 29.5, the lowest recorded was in 1850 when it stood at 21.1.

The fact that the Cholera years make so small a show in the death-rates is interesting, because, as is well known these districts have enjoyed the excellent water-supply of the New River, and did not in 1854 and 1866 get any material part of

their water from the Thames between the bridges or from the polluted Lee.

There is in fact no reason why these central districts should suffer from the effects of water-borne contagia, more than any other districts, and it appears evident that the high mortality which persists in them is not due to any defect of water supply.

It is rather mortifying to contemplate the persistent high death-rates in these districts, when we consider the money which has been laid out in them for the express purpose of improving their sanitary condition.

The opening of the New River, the rebuilding after the great fire in 1666, the removal of the city walls and gates, the covering of the Fleet Ditch, the making of the main-sewers, the construction of the Thames Embankment, the closing of the City churchyards, the laying out of the New Road, Cannon Street, Queen Victoria Street, the Holborn Viaduct, Northumberland Avenue, Farringdon Street, Shaftesbury Avenue, New Oxford Street, the Metropolitan Railway, the improved lighting, the magnificent paving, enforced vaccination, enforced education—these are among the public measures of "betterment," every one of which should have the effect of improving the Public Health.

Again, we have new markets, new bridges, model dwellings, an Adulteration Act, a Notification Act, an army of inspectors for slaughterhouses, dairies, and factories, and a complete set of hospitals and asylums in neighbouring counties to which are sent paupers, lunatics, imbeciles, and cases of infectious fevers.

These central districts form a city, which is equal in magnificence to any city in the world, and which, when viewed upon a fine day, is calculated to inflame the imagination and rouse every feeling of patriotic pride. Nowhere on the globe can one see a greater concentration of municipal magnificence or a greater variety of fine buildings, whether public or private. Nowhere, probably, is to be found such ample and luxurious hotel accommodation for visitors, and nowhere is there a Vanity Fair more profusely furnished with theatres and halls of pleasure, with shows and shops. Were it not for the fact that the Registrar-General drags a mummy across the scene marked with the figure 27.6 our enjoyment would be unalloyed.

The hygienic difficulty with which these central districts have to contend is not that of water-supply, sewerage, or food supply, but a difficulty in getting an adequate supply of fresh air.

On paper they appear to have undergone a diminution of population, but from the hygienic point of view such a statement is obviously misleading. It is true that fewer people sleep in these districts than was the case thirty years ago; but

for at least eighteen hours out of every twenty-four the overcrowding is excessive. Is there any time of the day or night when these districts have not in them some thousands in excess of the sleepers? After the eighteen theatres have closed their doors, the printing-offices of the daily papers are crammed to repletion, and then come the market people; and these are followed by the daily toilers on the busy scene. Judging from the day census of the city proper, it is quite safe to say that at least a million people visit these central districts daily, of which probably half-a-million have occupation there; and these help not only to use up the air, but not improbably leave it "seeded" with a fair percentage of infective particles. If we look rationally at these central districts we must admit that for practical purposes the over-crowding is infinitely greater than it ever has been.

It is somewhat humiliating to find that after all our efforts the death-rate of Central London has undergone no material change during the last 52 years.

It is also rather humiliating to have to admit that the lowering of the death-rate in districts other than the central, is probably due to dilution rather than genuine improvement. In 1841 London contained some 1,800,000 inhabitants; to-day it contains 4,250,000, an increase of 2,550,000. At the same time the central districts have decreased to the extent of 136,000 and from this we are entitled to conclude that of the 4,250,000 inhabitants of London, at least 2,686,000 are living in absolutely new districts which having been developed since 1841, and stretching from the centre into the country, have served to dilute the central death-rates. It is not very far from the truth to say that 60 per cent. at least of the inhabitants of London live in a city which was non-existent 50 years ago, and considering the amount of building which has been carried out since 1841, it is certain that considerably more than 60 per cent. live in houses which are absolutely new.

Although no improvement has taken place in the death-rate of the central districts of London I do not wish to be understood as speaking lightly of the sanitary work which has been carried on in those districts. Far from it, for it is certain that without the strenuous efforts which have been made to try and grapple with the sanitary problems in such a hemmed-in and crowded area, the death-rate must have risen to a far higher figure than any of those which I have quoted.

Again, we must be careful to distinguish between crowding *out of doors* and crowding *indoors*, and we must remember that crowding in houses and under a common roof is infinitely the most dangerous form of crowding.

Now a city like Central London which has been built upon no fixed plan, and with no universally applicable rule for keeping a due relation between the cubic contents of a building and the area it occupies must constantly be in need of surgical interference to relieve congested areas. William Cobbett, in his "Rural Rides," invariably speaks of London as "The Wen," *i.e.*, he regarded it as a pathological growth, and there can be no doubt he is correct in his point of view, as is shown by the frequent recurring necessity for surgical interference. We have cut broad streets and avenues through the slums in various directions, and a new scheme of civic surgery, which is to cost three and a half millions, is just now occupying the minds of our County Councillors.

Now this process of Haussmannizing a City may add greatly to its architectural beauty and doubtless serves to facilitate traffic and business, but it is tolerably certain that such schemes by increasing the over-crowding *indoors*, are more likely to increase than to decrease the death-rate. When we sweep a path through the snow the snow is piled on either side, and when we cut a thoroughfare through the slums the inhabitants (unless they be driven out of the district entirely), are piled up in so called model dwellings, at the sides of the new boulevard, and those who probably had a house to themselves with a little backyard for airing the children, find themselves provided with "quarters" in a barrack, and under the same roof with dozens of others, a most admirable arrangement for the mutual exchange of scarlet fever, whooping-cough, measles, diphtheria, influenza, and other infective commodities.

The concentration of houses, and the concentration of inhabitants under a common roof, must increase the amount of air-borne disease, and there can be no doubt that with the increasing height of our houses and the ever increasing area of the city, the mortality of the centre of London is certain to increase.

In the first quarter of last year (1892) we had a very sharp epidemic of influenza in London which lasted for six weeks and caused, approximately, 1,000 extra deaths per week while it lasted. The effect of this epidemic, which was due to air-borne contagia, is shown in the corrected returns of the Registrar-General for the first quarter of 1892.

The death-rate for the whole of London during this quarter was 27.8, and the total deaths amounted to 29,529.

A glance at the returns shows that, roughly speaking, the death-rate of the various districts rises as we proceed from the circumference to the centre of London, and certainly the central districts of the Registrar-General show a rate of mortality which

is deserving of attention. Taking these central districts in order of mortality we find that the death-rates for the first quarter of 1892 were as under:—

Strand	44.0
Holborn	36.6
St. Luke's	35.5
Clerkenwell.. .. .	35.3
St. Giles's	35.1
City	33.0
St. Martin's	27.7

The infant mortality figure, which for the whole of London stood at 179, was no less than 317 in the Strand, 244 in the City, 229 in Holborn, 217 in St. Martin's, 212 in Clerkenwell, 186 in St. Giles's, and 170 in St. Luke's.

In St. Luke's the birth-rate for this quarter was exceptionally high (45.2), and the births exceed the deaths by 99. In each of the other central districts, however, the deaths considerably exceeded the births, a fact which was due as much to the exceptionally low birth-rates as to the exceptionally high death-rates. If we exclude St. Luke's we find that in the six remaining districts the deaths exceeded the births by 452.

The smallness of the birth-rates (St. Martin's, 16.9; City, 17.5; Strand, 24; Holborn, 27; St. Giles's, 30.4; Clerkenwell, 33.5) shows how abnormal must be the age distribution, and that when the human birds pair they have largely given up the central districts for nesting purposes.

The over-crowding which is so marked a feature, not only in London but in all modern cities both here and in America, may be usefully looked at from another point of view. This over-crowding has arisen from a too absolute neglect of what may be called the "earth unit." Not only does every living being require for his support a certain definite average amount of pure air and pure water but also a definite average amount of the earth's surface, to provide him with food and clothing. What this average definite amount of the earth's surface is, it is difficult, perhaps impossible, to say, but I have given some figures in a paper which I lately contributed to the *Medical Magazine* which lend support to the supposition, that in the British Isles about one acre of cultivable land might reasonably be taken as an earth unit sufficient for the bare support of each individual of the population (including both sexes and all ages). If the individual really inhabited his unit there need be no difficulty about fresh air, water-supply, or burial. Steam and Free Trade have enabled us to neglect this unit absolutely, for dwellers in cities may and do draw their supplies from the Antipodes, and there is no longer any absolute necessity for

market gardens or farms in the immediate neighbourhood of cities. Free Trade has facilitated the crowding into cities, and our modern methods of sanitation have enabled us to build houses of any height and as close together as it is possible to pack them. We have neglected the earth unit absolutely, and we are encountering serious difficulties in consequence, and one of these is the thick impure atmosphere of cities, and dense black fogs when the climatic conditions are favourable for their formation.

Thus far we seem to have arrived at the conclusion that the increase in fog and darkness in London is a natural consequence of the increase both in area and density of the City, whereby too many fire-places are packed on a given area. In considering remedies for this state of things we must have regard both to the sanitary and commercial aspects of the question. If the air of London could be purged of its dirt there can be no doubt that the beauty of the city would be immensely increased, and that the saving of money would be very great. It is difficult to estimate the money loss to London tradesmen, caused by a fog like that of Christmas, 1891. In damage to goods, loss of custom, and increased difficulty and expense in the transit of goods the loss must be prodigious, and on this ground, if on no other, we should make every effort to lessen the dirt of the London air.

Let us suppose that all our houses were warmed by steam coils; all our cooking done by gas, and all our artificial light generated by electricity. The London atmosphere would then be comparatively clean, but for the dust raised by 5,000,000 people in incessant motion.

Would London be any healthier in consequence of such a reformation? The answer to this is doubtful. We have seen that there is good reason for supposing that the evil effects of a London fog are due in a great measure to the stagnation of the London atmosphere; and it seems needless to insist that such stagnation is far more intense indoors than in the street. Now, our open fire-places undoubtedly serve in a marvellous way to renew the air in our dwellings; to sterilise all air which passes through the fire into the chimney, and also, doubtless, to cause currents and movement in the air round the tops of the chimneys where the hot gases escape. With the utopian reformation I have imagined the open fire-place would disappear, and I am on the whole disposed to believe that the death-rate in the central parts of London would increase as a consequence. I do not for an instant believe that our smoky atmosphere has any antiseptic action, as has sometimes been suggested, but I do believe that the increased movement of the air caused by open

fires, must lessen the risks of infection, especially among such as are crowded under a common roof.

Let us suppose a reform rather less sweeping than the one I have imagined, and let us consider what would be our condition if by the use of smokeless fuel, such as gas, coke, anthracite, and by the employment of improved grates the smoke from our chimneys were practically abolished. Now we must remember that it is impossible to burn fuel without fouling the air, for even if we get rid of the "blacks," which are not the result of combustion but rather of wasteful non-combustion, we should still have the true products of combustion to deal with, viz., carbon-dioxide, probably some carbon-monoxide, watery vapour, sulphurous acid, sulphuric acid, and hydrochloric acid. None of these would be lessened, however perfect the combustion, and all of these (except the watery vapour) are either poisonous or irritating or both. I fail to see that (except for the lessened dirtiness) we should be much better off, and I believe that a prolonged winter fog would continue to have the same effect upon the death-rate as at present.

The abolition of "blacks" in London is indeed a "consummation devoutly to be wished," and for the attainment of this end, it would be worth while to make very considerable sacrifices; but I doubt very much whether the means proposed (smokeless fuel and perfect combustion in our grates) would produce a perfect cleanliness of the air. We all know, for instance, how dirty gas is and how black it makes our ceilings and our walls, and it is hardly rational to suppose that combustion in our grates can be more perfect than the ordinary combustion of gas. Then again I will remind you that in every 100 grammes of the solid deposit collected in February, 1891, on Veitch's plant houses at Chelsea, 39 grammes consisted of carbon and nearly 34 grammes consisted of metallic iron, magnetic oxide of iron, ferric oxide, and mineral matter, chiefly silica. This seems to show that the hot blast from our grates carries with it not only mineral dust from the fuel, but probably siliceous particles and debris of iron from the chimneys and chimney pots.

It seems, in fact, tolerably clear that of the amount of solid particles in the air of London, not more than half could be abolished by improved grates and smokeless fuel. This seems to me, in the present state of our knowledge, to be the highest ideal attainable.

Again it is not possible to suppose that all the dirt in the air of London is due to the chimneys. A good deal of it must be caused by the incessant traffic and movement of some five million persons on a limited area.

In short, the density of our fogs is largely due to the density

of population, and it is doubtful whether any Parliament would attempt to limit the population density of our cities, because to do so would seriously interfere (so it is thought) with money making.

Of late years, what may be called a new phenomenon in connection with the air of London has frequently been observed, viz., the high fog or high darkness, which, while leaving the streets quite free from mist, effectually shuts off the light of the sun, and gives us a darkness in every way comparable to the darkness of night. This must be due to a bank of fog hovering over the city, and the explanation of this new phenomenon is probably to be found in the enormous increase in area which the city has undergone of late years. The smoke of some densely populated outlying part is caught as it were in a passing cloud of vapour, which, drifting far over the tops of the houses, acts as an absolutely opaque screen between us and the sun.

Although I am of opinion that the dirt in the London air can only be cured to a limited extent, it is nevertheless our duty to do our utmost in the matter.

When the Coal Dues were removed by the London County Council it would have been well, perhaps, if the remission of tax had not been extended to bituminous fuel. Certainly the removal of the Coal Dues was not in itself a measure likely to diminish smoke. Whether it would be possible to penalize the domestic chimney for misbehaving itself in the matter of smoke is very doubtful, and whether such penalty should fall upon occupier, owner, or ground landlord is again doubtful.

The dirtiness of London air being mainly due to the density and area of the City in the matter of people, houses, and chimneys, can nothing be done to lessen the density? I am afraid the answer to this must be that such measures do not come within the range of Practical Politics. London is regarded as a place for making money in, and people who come to it for that purpose are very unwilling to be pestered with vital statistics. People rush into London from the country, go to their offices, and rush out again, and as a consequence they have no local feeling for a place which is associated with the toils of life rather than its amenities. Even in the residential quarters the inhabitants must be regarded as birds of passage, for a lease terminable in 7, 14, or 21 years represents the only tie which fixes them in one locality, and the depreciation of value in the house which they inhabit, owing to the too near approach or increased height of other houses, is not a matter which very greatly concerns *them*, and as for the ground landlord the closer the houses the greater the profits.

That London will go on for some time yet getting progressively worse there can be little doubt, but, nevertheless, it is useful to point out how its troubles have arisen, for although one may have no local feeling for what Cobbett called "the Wen," one would be sorry to see her bad example in sanitary matters recklessly imitated. The popularity of London has arisen from its natural advantages of situation on a fine navigable river. These advantages are increased now that it is the terminus of every important railway in the country. The communication by means of steam with the rest of the country and the rest of the world, has enabled it to draw its supplies from immense distances, and it has been able to build, without a thought for the consequences, on the ground which formerly was indispensable for growing vegetables and feeding cows.

Free Trade, by the removal of all restrictions on imported food, has increased the facility of feeding town populations. Free Trade has probably been the main cause of the disappearance of typhus, but, inasmuch as it facilitates the crowding into towns, it is a measure which has exercised a very doubtful influence on the public health.

Steam and Free Trade have undoubtedly stimulated the growth of London, and steam again must be held answerable for the most serious element in its growth—its increased density of population owing to increased height of the houses. This has come about by the possession of *water under pressure* and the *cast iron water pipe* whereby water supply and filth removals can be efficiently provided for in even the loftiest buildings. This it is which has caused the great increase in the height of the houses and has encouraged the tenement house with its inevitable overcrowding. This fact was pointed out by me last year in a free lecture delivered at University College, London, and it was also insisted upon that the modern City is distinctly a modern invention, that it had no counterpart in ancient times, and that as overcrowding is by far the greatest of all sanitary evils, the modern tendency to build houses without any curtilage, is a most dangerous one, and calculated to more than counteract the efforts which have been made to improve the health of our cities.

I am quite willing to admit that it is not a matter of very great consequence whether the death-rate of London be high or low, and I feel very confident that if its inhabitants were polled as to whether they would like a lowering of death-rate or an increase of trade profit they would choose the latter. Nevertheless, I hold the opinion strongly that if a city is to be kept healthy, its density must not be allowed to pass certain limits, and the building operations must be carried on in accordance

with some principle by which a proportion is maintained between the cubic contents of a house and the area of ground it occupies. That the interpenetration of the houses by open spaces, and the making of house curtilage obligatory, are both necessary measures if a city is to continue decently wholesome I have no doubt. I shall be told such a proposition is not practical on account of the high price of building land. I am sorry for it, but I have not been able to think of any other regulation which would serve to prevent the overcrowding of a city, and, as for the high price of building land, that is largely due to the absence of any adequate rule for defining the proportion between the cubic contents of a house to the curtilage which shall surround it. Any such rule to be of any use, must be an universal rule applicable to the whole country.

Many attempts have been made from the days of Elizabeth downwards to restrict the growth of London, but all such attempts have proved unavailing. The most determined of these attempts was in 1657, under the Commonwealth, when an Act was passed which inflicted a fine of one year's rent upon all builders and occupiers of houses which had been erected within ten miles of the City Wall since the 25th day of March, 1620, and further directed a fine of £100 to be levied on all persons who should erect "Any dwelling-house, out-house, or cottage within the limits mentioned without assigning four acres of ground to every such dwelling-house, &c., respectively." In 1757 when what is still called the New Road from Paddington to Islington was made, the Building Act provided that no house should be erected within fifty feet of the road, showing that in the days of George II. our legislators had some sense of the necessity for checking overcrowding of houses. This law with respect to the New Road has been flagrantly broken, however, dozens of times, and since then Moorfields has been built upon and the Drapers' Gardens in the City has been covered with offices.

Our modern methods of water-supply and filth-disposal have given a fatal facility to the overcrowding of houses, an overcrowding which ought if possible to be checked.

In addition to the scientific building regulations, I think the incidence of local taxation might be regulated so as to check overcrowding. Houses should be rated in proportion to the cubic contents, and open spaces round houses should be very leniently dealt with when valuing for rating purposes.

I think the whole of the sanitary rates should be levied *en bloc* from the ground landlord. It is the ground landlord who makes the chief profit out of overcrowding, and it is overcrowding, more than any other condition, which sends up

the sanitary rates. Again, overcrowded districts inevitably deteriorate in value in time, and if rates were regulated by cubic contents of houses, and levied on the ground landlords, these persons would safeguard their own interests by observing due care in laying out their building plots.

Again, I think we should be careful how we abandon any customs which serve to mitigate the evils of overcrowding. We are now engaged in burning all organic refuse, and some of us are urging the cremation of the dead. I hold very strongly that the proper destination of all organic refuse, including the dead body, is burial, and that the necessity of providing land for cemeteries, and for the productive utilisation of organic refuse, is a great and undoubted boon to the living, by serving to perpetuate open spaces in the neighbourhood of towns. Destructors and crematoria may be necessary, but it is impossible to regard the burning of organic refuse as a scientific method of disposal, and most certainly it must add impurities to our already too foul atmosphere. Effete organic matter of all kinds, if rationally treated (*i.e.*, superficially buried) will freshen the air and yield an increase for the living. When we wantonly burn such valuable matter we ought to feel a twinge of conscience, as we hope the servant-girl does when she lights the kitchen fire with slices of bacon.

There can be no doubt that in England the rural districts have been sacrificed for the sake of the towns, and that the free importation of food has much impoverished the agricultural classes. I believe that it is possible for the towns to materially help the agriculturist if they will make some serious attempt to supply him with organic manure at a cheap rate. If this is to be done the refuse matter should be intelligently dealt with and sorted. A mixture of garbage, chemicals, broken bottles, and clippings of tin, is of no use whatever until it has been sorted. It is easy to put it all into a furnace, but an intelligent and properly-instructed person would do something better than that. The most productive ground in the whole country is probably that devoted to market gardening round London, and the reason for this is to be found in the fact that stable dung is to be got from London very cheap indeed—almost for nothing. I have it as a fact from more than one market gardener near Isleworth that these gardens take habitually sixty or seventy tons of dung to the acre per annum, and that hungry land is able to consume as much as two hundred tons per acre. It is to me an astonishing thing that no London parish has had the enterprise to arrange for the systematic carriage of its organic refuse into the country by trains, and the establishment of a farm colony for its unemployed. These market gardens produce a

prodigious amount of food, and pay (as compared with farmland) very large weekly sums in wages, for they employ a great many hands even in the depth of winter.

When in spring the train runs through these gardens all ablaze with blossom and redolent of wallflower, with rows of men and women busy planting, or hoeing, or weeding, or gathering, and ultimately as it enters London pulls up opposite a gaunt enclosure with a furnace in the middle and a despairing notice on a big spoil heap, that clinkers will be *given* away, it is impossible not to make comparison between the *right* as opposed to the *wrong* use of refuse. And if Trafalgar Square should happen to be filled with unemployed one is still further driven to the reflection that possibly such gatherings are but an illustration of the old proverb that "wilful waste makes woeful want," and that one of the legitimate occupations of these unemployed should be to turn the organic refuse of the city to productive purposes, and so extract work and food and wages from their only source, the earth, and in so doing maintain open spaces near cities, to regenerate the freshness of the air and keep the inhabitants to some extent apart.

SIR THOMAS CRAWFORD, K.C.B. (London), thought the paper an able review of some Sanitary points pressing on the people, and that if the remarks lead to finding remedies for the evils arising from fogs it would be very valuable. He was fascinated by Dr. Poore's reference to the advisability of every inhabited house being surrounded by four acres of ground, which reminded him of the famous three acres and a cow, a state of things which would be very advantageous, but would, he was afraid, be impossible. Dr. Poore had pointed to a growing danger, namely, that of substituting elevated crowding for surface crowding. He (Sir Thomas Crawford) doubted whether this substitution would prove a remedy for overcrowding. He was himself in favour of splitting up the crowded portions of the City by wider streets, and advocated the increase of open spaces, but he did not agree with Dr. Poore in the increase of burial grounds. He concluded by proposing a hearty vote of thanks to Dr. Poore for the very able paper which he had placed before the meeting, and remarked on one important point which Dr. Poore had raised, namely, the danger of being led away by statistical figures, which, taking it on the average, were apt to make London appear as a healthy place, whereas many places in London were very unhealthy.

Mr. G. J. SYMONS, F.R.S. (London), said it was difficult to decide on the most important point raised by the Lecturer, as he had given so many. He thought that the London County Council had already

enough to do without undertaking the fog question. He thought that London fogs were not more frequent or opaque now than they were forty years ago, he having vivid recollections of some splendid specimens when a boy, but he thought they were becoming dirtier. He said that the supplanting of grass in London by pavement had tended to counteract other causes of the increase of fogs. He cited an experiment on the blackness of fogs he had made at Camden Square. At 3 o'clock in the afternoon of a day on which there was a black fog, he had been unable to distinguish white papers on a table near the window from the black leather covering of the table itself, whereas on an ordinary day it was possible to do so at 10 o'clock at night. He remarked on the distance blacks would travel. Referring to "The Doom of the Great City," he said the theory of this pamphlet was that carbonic acid had increased to such an extent that everybody died where they were. He pointed out the fact that in Manchester, owing to the amount of sulphur in the air, umbrellas had the reputation of lasting a shorter time than elsewhere; and as a good illustration of the dirty state of the atmosphere, remarked on the distance and with what clearness street lamps were visible after a good shower of rain as compared with after there had been no rain for weeks. Illustrative of the thickness of the atmosphere he said there were three prominent objects situated, two within a quarter of a mile of his house, and the third one mile away; and that in winter even the two of these were visible only about two days in a month. Sunshine in London was certainly on the decrease, as evidenced by the fact that roses would not now grow in the Botanical Gardens, and that whereas he (Mr. Symons) had ripe grapes on the walls of his house some time ago, none would ripen there now. He had great pleasure in seconding the motion.

Mr. CAPPER (London) spoke of the advantages to be derived from the use of anthracite coal. He personally had been using it for years and found it much cheaper than any other coal. It could be easily ignited with a gas poker. He thought that if the blackness were to be eliminated from fog it would be a great addition to health, and it would not interfere with labour. He thought that houses were being built too high for coal storage, and were outgrowing their cellar accommodation. He recommended anthracite coal, as it gives no fumes, can be fingered without harm, and creates no dust. It burns slowly, and can be obtained already broken up, and burns much longer. He recommended that a trial should be given it as a means for diminishing the blackness in fog.

Dr. J. F. J. SYKES (London) raised the question of the difference between the effect of inhaling vapour and smoke. In inhaling a cold vapour it takes the heat away from the lungs, whereas a pea-soup fog chokes one. Kinds of fogs vary from moist vapour to dense smoke, hence the difficulty of comparison. He stated that there were plenty of vapour fogs which did little harm, and thought that the stagnation

of the air and not the vapour was the cause of harm. He stated that the density of a London fog could be gauged by the horizontal movement of the wind. It was a curious fact that the Strand should have such a high death-rate, seeing that there was such a large open space in front of the district, namely, the river. He thought that the front space of houses should increase with their height. He said that Medical Officers of Health have no standard of light and air required by human beings. He thought this was very unfortunate, and was of opinion that it should be somewhat as follows:—No habitable room that does not possess a window to which light can gain access at least at an angle of 45° to the sill should be considered healthy. He pointed out two things overlooked by Dr. Poore, which would prevent animal refuse from being carried out of London, as he had suggested, viz., the cost of transport and of labour. He was afraid that anthracite coal would not improve matters. He advocated the use of gaseous fuel, as its fumes diffuse more rapidly than the smoke of coal. The distinction between these two is apparent, if one takes the instance of a Russian vapour bath and a room in which there is a smoky chimney. Smoke requires to be blown away, whilst gases diffuse and condense.

Sir DOUGLAS GALTON, K.C.B. (London), said there was a point in the paper read with which he did not agree, namely, that high buildings were as insanitary as overcrowded low houses on the level of the ground. With regard to the Strand, he said that the district is cut off from the river by high houses and densely-populated districts. He said the reason why the death-rate in model lodging-houses was less than in ground crowded houses is that there is a free circulation of air in and around these artisans' dwellings which was impossible in the overcrowded ground houses. Referring to anthracite coal, he thought that better ventilation was produced by fires which produced flame than by using anthracite coal. With gas and anthracite coal one is liable to get carbonic-oxide back into the room, which is dangerous.

The vote of thanks to Dr. Poore for his paper was then put to the meeting, and carried with acclamation.

Dr. G. V. POORE (London) acknowledged the honour done him by the vote of thanks, and desired to express his sense of appreciation of the attention given him. He said that London should not be taken as an example by places which had a better chance, and referring to overcrowding said that with regard to air-borne contagia the danger of infection in the open air was slight, whereas under a common roof it was enormous. He said that he did not believe that the health of a city was improved by boulevards, as they only pushed everything on either side and created greater overcrowding under a common roof. Paris was a case in point. With regard to high buildings, he cited the case of the *Magazin du Louvre* in Paris, for when the epidemic of influenza prevailed 1,000 people in that place had it.

THE HOUSING OF THE WORKING CLASSES.*

By H. PERCY BOULNOIS, M. INST. C. E.

Read at the Sessional Meeting, March 8th, 1893.

"THE sins of the fathers shall be visited upon the children." The sins of the speculative builders of the past are being now visited on the ratepayers of to-day.

In most of the great towns of this country, owing to the rapid growth of their populations, habitations had to be provided; unfortunately, when the sudden rush took place from the agricultural to the urban districts, due to the discovery of steam power and the consequent centralisation of manufacturing industries, there were few, if any, laws regulating the erection of dwelling-houses, and, as a result, the greatest possible accommodation was provided on the least possible areas of building land; and as the more well-to-do citizens left their town houses, these were bought and converted into "rookeries" by the speculators of the day. In many towns, courts or alleys sprang up, with back-to-back houses facing these narrow courts. A typical court may be thus described:—

The area on which it is built has a frontage of 30 ft. towards a narrow street, and is about 60 ft. in depth; fronting and opening on to this narrow street are two three-storied houses, under the first floor of one of these houses is a passage or tunnel about 3 ft. wide and 5 or 6 ft. high, which gives access to the court behind, although in some cases this narrow passage is not covered in, but forms a narrow, trench-like opening between the gables of the two front houses. In the court are two rows of three-storied houses, facing each other at a distance of only 6 or 8 ft., their backs being built against other houses, which in their turn face against a similar court. The houses have 11 ft. frontage, and are 11 ft. deep, including walls, with staircases inside the living rooms, and the only ventilation being that which can be derived from the windows opening into the court, which is a mere well-hole. Some sixty or seventy persons will be found living in a court of this description, which is equivalent to a population of 1,680 persons to the acre!

Such and similar buildings were the outcome of an abnormal

* See Appendix A.

demand for cheap dwellings in towns and the dread of speculative builders, that legislation might put a stop to their harvest before they had had time to "make hay."

Another evil form of cheap dwelling is the mansion, or town house of a respectable kind converted into a tenement building or rookery. These are well known in London, and consist of large houses built close together, in which every room on every floor is let to a family, and even in some cases to more than one family in a room, where they have lived harmoniously till one of them took a lodger!

It is not necessary to dwell upon the horrors of such an abode, where the ordinary daily necessities of civilized life are absolutely inadequate and can only be used in common with the teeming population of such dens.

In order to grapple with the insanitary court property in Liverpool, of which a description has been given and models have been shown, the Corporation about thirty years ago obtained an Act of Parliament entitled "The Liverpool Sanitary Amendment Act, 1864,"* which empowers the Medical Officer of Health to present to the Grand Jury at Quarter Sessions a schedule of any houses that he may deem unhealthy in themselves, or any court, alley, or any premises unfit for human habitation, or in a condition, state, or situation, injurious, dangerous, or prejudicial to health. If the Grand Jury concur with this presentment, after hearing evidence on both sides, the owners must either sell to the Corporation for demolition, or themselves demolish their property, and the Corporation have to pay reasonable compensation.

Failing an agreement between the Corporation and the owners as to the purchase price or amount to be paid as compensation for demolition, an arbitrator is appointed by the Local Government Board, who decides the amounts to be paid. There is one point specially to be noted in connection with this Act, which was the first of the kind ever passed by the Legislature, and that is that there is no statutory obligation upon the Corporation to provide dwellings for the persons displaced by the demolition of insanitary property, as is invariably provided for in all other Acts dealing with this question.† The Corporation, however, have always endeavoured to sell the land, where suitable, as cheaply as possible, in order to encourage builders to erect healthy dwellings thereon available for the working classes. This has been done to some extent, but, owing to the necessity for leaving more area of open space and for other reasons,

* See Appendix B.

† See Appendix C.

the accommodation provided has not been in any way commensurate with the numbers of persons displaced. For instance, up to the present date about 3,500 insanitary houses have been demolished, and only 334 six and four-roomed houses have been erected by builders, and let at rentals varying from 5s. 6d. to 6s. 6d. per week, as against 2s. 6d. to 4s. per week rentals paid for the insanitary houses demolished. It may, however, be readily understood that the demolition of such houses as I have described to you is of far greater importance than the provision of dwellings upon equivalent areas.

In some cases, in order to avoid demolition, the Corporation caused to be prepared for the owners schemes for the conversion of their unhealthy properties into sanitary dwellings; and as these proposed conversions are extremely interesting, I have prepared diagrams to explain the details. (Copies of the diagrams will be found facing page 48.)

It was found, however, that the cost of alterations, and less accommodation provided, disinclined owners to take advantage of these proposals, and they preferred to be compensated in cash by the Corporation and divert the money into other channels. It is also found that the owners of this description of property have, as a rule, no means to carry out alterations; and a great deal of it is trust property, &c., which makes it difficult to deal with, short of sale and demolition.

Under the Act, which has been thus described to you, the Corporation of Liverpool have up to the present time spent £235,000 in the demolition of 3,500 houses, but still much remains to be accomplished.

The Corporation have also carried out a scheme under the Artisans' and Labourers' Dwellings Act, 1875. An area known as "Nash Grove" was scheduled by the then Medical Officer of Health as an "unhealthy area" in the year 1875, which comprised 22,487 superficial yards (nearly 5 acres), which cost the Corporation in compensation for trades, lands, buildings, &c., £67,000, and the number of persons displaced was 1,310 or £51 per head.

Many unsuccessful attempts followed to sell the site thus acquired for private individuals or companies to erect artisans dwellings thereon. The land was offered by auction on two occasions with a modest reserve which was not reached, and consequently in the year 1885 the then City Engineer prepared plans, &c., and eventually erected a fine block of artisans dwellings, of which the following description will, I think, be interesting. The buildings are known as Victoria Square, and they are bounded on every side by streets of 60, 45, and 30 ft. wide. The site contains 9,195 yards, of which 3,924 yards are

occupied by dwellings and 5,271 yards in the approaches, and a large open quadrangle in the centre paved with asphalt, which gives abundance of air and light space, and is an excellent playground for the children. The entire area occupied by the buildings was covered with a layer of concrete 9 ins. thick, and all the streets in the neighbourhood are paved with syenite setts upon concrete; the site is thus practically impervious, with the most beneficial sanitary results. The buildings are 5 storeys in height and divided by thick party walls into 13 separate "dwellings," each of 75 ft. frontage and 36 ft. in depth. These are placed facing the quadrangle, and thus admit of a free circulation of air around them.

There are 22 tenements in each "dwelling" approached by a separate entrance from the quadrangle, the arrangements of the rooms being as follows: On the ground, first, second, and third floors there are two tenements of three rooms and two of two rooms, whilst on the fourth floor there are four two-room tenements and two one-room tenements. There are 271 tenements in all, made up as follows:—

86	3-room tenements...	...	...	258	rooms.
164	2 " " " " " " " "	...	...	328	" "
21	1 " " " " " " " "	...	...	21	" "
	Superintendent's House...	...	...	4	" "

Total number of rooms 611

The three-room tenements are arranged as a living-room or kitchen, 13 ft. × 12 ft. 4 ins.; a large bed-room 15 ft. 3 ins. × 9 ft. 7 ins. (capable of being divided by a screen), a bed-room 13 ft. 8 ins. × 8 ft. 6 ins. The two-room tenements are arranged as a living-room or kitchen, 13 ft. × 12 ft. 4 ins., a bed-room 15 ft. 3 ins. × 9 ft. 7 ins. (capable of division as before). The one-room tenements are arranged as a living and bed-room combined, 12 ft. × 12 ft. All the rooms are 9 ft. in height.

The following table gives the floor space and cubical contents of the rooms of each tenement approximately:—

TENEMENTS.	LIVING-ROOM.		No. 1 BEDROOM.		No. 2 BEDROOM.		Total floor space.	Total cubical contents.
	Floor space.	Cubical contents.	Floor space.	Cubical contents.	Floor space.	Cubical contents.		
3-room tenements	160½	1443	146	1314	110½	994½	416	3751
2-room tenements	160½	1443	146	1314	...	...	306½	2757
1-room tenements	144	1296	...	...	...	...	144	1296

NOTE.—These measurements are exclusive of the sculleries, laundries, and other sanitary conveniences, of all of which the tenants have the free use.

Two water-closets are provided on each floor for the joint use of the four tenants. The dust and ashes on each floor are disposed of through ventilated shoots formed in the angle of the lobbies leading to the water-closets. A laundry is placed on each floor for the use of the four tenants, each tenant having the sole use on a fixed day, or portions of days. On each side of the laundry is provided a double stoneware glazed sink-trough with water laid on to each, thus giving a separate sink to each tenant. Gas is laid on to all the tenements, and the supply is under the control of the superintendent. The rents are as follows:—

Three-roomed dwelling on the ground, first, or second floors, 5s. 6d. per week, and a two-roomed dwelling, 4s. 3d. per week. On the third and fourth floors a three-roomed dwelling is 5s. per week, two-roomed dwelling 3s. 6d., and one room 2s. per week. The rent covers all charges, including rates, gas, and water.

The class of persons who occupy these dwellings is better than that which was displaced, as the following table of the occupations and wages of the tenants of a block taken at random will show:—

Occupation of Tenant	Wages per week.	Occupation of Tenant.	Wages per week.	Occupation of Tenant.	Wages per week.
Saddler	31s.	2 Millers.....	30s. & 28s.	Cooper	30s.
Coach Builder..	26s.	Printer	26s.	Carter	25s.
Weight-taker ..	25s.	Labourer ...	22s.	Labourer	20s.
Barman	20s.	Porter.....	20s.	Labourer	18s.
Sailor	20s.	Lamplighter.	19s.	Cooper	19s.
Labourer	18s.	Labourer ...	17s.	Porter	17s.
Charwoman ...	8s.	Charwoman .	5s.	Cigar Maker (female)	12s.

These persons are all of the real wage-earning class, whereas the majority of those displaced were no doubt of the class called the "submerged tenth," and there is every probability that the houses vacated by the persons now occupying the Victoria Square Dwellings have become occupied by the class of people displaced by the demolition of the condemned houses.

(Some drawings illustrative of the Victoria Square Dwellings were exhibited to illustrate this portion of the paper.)

The Corporation have also erected another block of buildings on the site of this formerly "unhealthy area," known as "The Juvenal Dwellings," which are only separated from the Victoria Square Dwellings by a street, 45 feet in width,

which runs between them. These dwellings are of the type of Labourers' Dwellings, and consist of one large block facing Cazneau Street, containing 50 tenements, with three blocks behind containing 50 tenements, making a total of 100 tenements and one shop. There are only one and two-room tenements and no three-room tenements in these blocks, and the rents are as follows:—4s. and 3s. 9d. per week for two-room tenements according to height of floors, and 2s. 6d. per week for one-room tenements, all inclusive of gas, taxes, &c. The roofs have been kept flat on which the washhouses were constructed. The block plan shows the respective positions of these buildings, with plans of the arrangements of the floors in the Juvenal Buildings.

The population contained in the dwellings I have described are as follows:—

	Males.	Females.	Total.
Population of Victoria Square Dwellings...	485	501	986
" " Juvenal Dwellings ...	135	132	267
Totals ...	620	633	1253

The cost of the Victoria Square Buildings was about £58,000, that of the Juvenal Buildings £12,946, or a total of £70,946 for buildings, to which must be added the cost of the land, £67,000, making a total of £137,946 expended in carrying out these schemes. From this amount must, however, be deducted the sum of £2,797, the value of some surplus land which was sold to a builder, who erected fifty small four and five-room self-contained cottage dwellings thereon, which reduces the total cost to the sum of £135,149. The annual costs, consisting of maintenance, rates, taxes, gas, water, superintendent's salary, &c., amount to £1,300 per annum for the Victoria Dwellings, and £350 for the Juvenal Dwellings. The income from rents is £3,000 per annum from the Victoria Dwellings and £895 from the Juvenal Dwellings, thus leaving a net surplus of £2,245 per annum to meet the interest and sinking fund on the capital sum of £135,149, which it is evident is not sufficient for that purpose.

The Corporation however decided, and I think justly so, that the amount paid by them in compensation for the acquisition of the land, which averaged £3 per square yard, did not represent its commercial value when cleared of buildings, &c., and they have consequently assessed its value at £1 2s. 6d. per square yard, which reduces the cost to £25,298 instead of £67,000, its real cost; and taking it at this value, less the £2,797 received for the surplus land, the net return since the year 1888 has

been estimated to produce about $2\frac{1}{2}$ per cent. on the assumed capital expended.

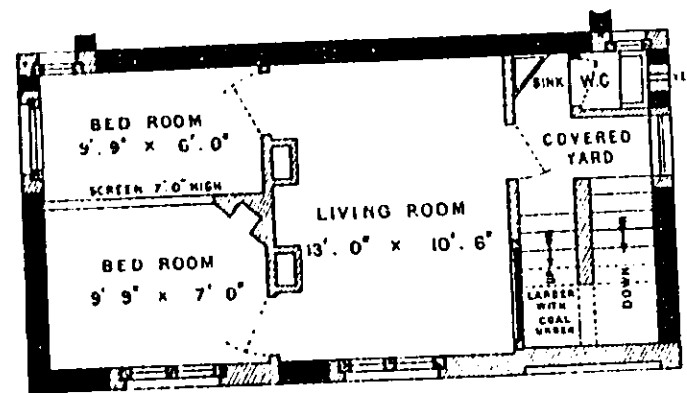
It is evident that in dealing with this question a considerable loss must necessarily fall upon the ratepayers, as it is impossible to acquire land already densely crowded with rent-producing buildings at any such price as would make it possible to erect remunerative dwellings thereon, and this fact should never be lost sight of in dealing with this highly important problem of the displacement and re-housing of the working classes on or near the sites of their old homes in towns or cities.

It will be seen from the figures that have been given that the loss to the ratepayers of Liverpool was £32 per head of the population of 1,310 displaced; and in London, where the operations of similar Acts have been enforced, as much as £60 per head has been lost, this loss representing part of the penalty which the thrifty taxpayer of to-day has to bear in endeavouring to remedy the mistakes of the past.

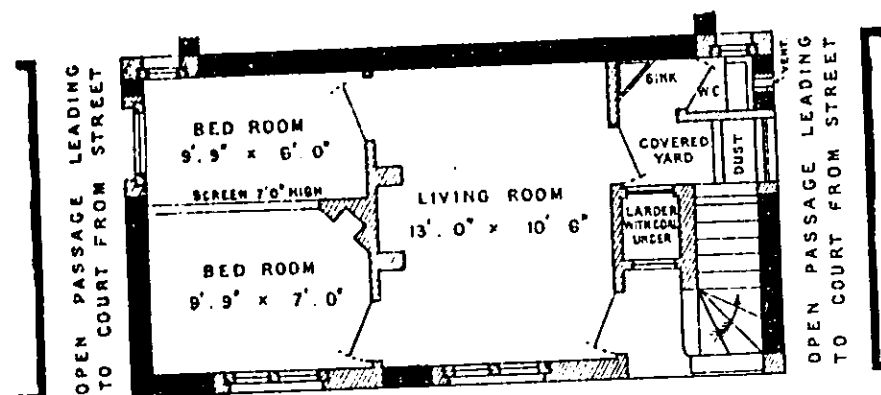
The problem that has thus been forced upon the present generation is of vast proportions, and has puzzled statesmen, politicians, philanthropists, political economists, and sanitarians for the last fifty years. It is a problem which affects the industrial, social, intellectual, and sanitary condition of the working classes, and the prosperity of the industry of the country. It resolves itself into how much rent can the wage-earning classes afford to pay, and can the small wage-earning class be properly housed without State or philanthropic interference? and how far is such interference or assistance justifiable without disastrously affecting that self-reliance, which is the mainstay and backbone of a community? and how far is such interference contrary to the laws of political economy, and detrimental to the progressive evolution of the race?

Even if help towards comfortable and sanitary dwellings for the "submerged tenth" and working classes is deemed advisable, the best methods for this accommodation have by no means yet been satisfactorily settled. If it is necessary to find accommodation for the working classes near their work, and to increase our cities vertically as well as horizontally, then I think the problem resolves itself into the following heads:—

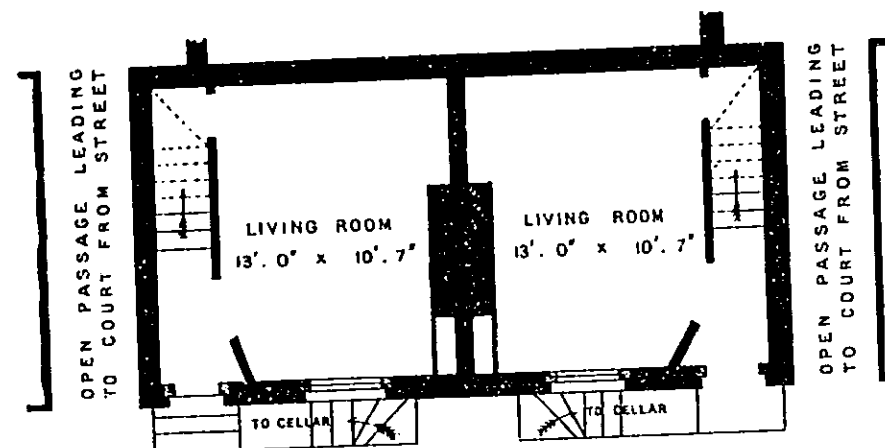
- (1) That the rental paid must be the lowest that is possible for the maximum of accommodation.
- (2) That the situation of the dwelling shall be convenient for the daily avocations of the occupiers.
- (3) That the dwellings shall be substantially and sanitarily constructed on healthy sites.



Upper Floor Plan.
(AS PROPOSED)



Ground Plan.
(AS PROPOSED)

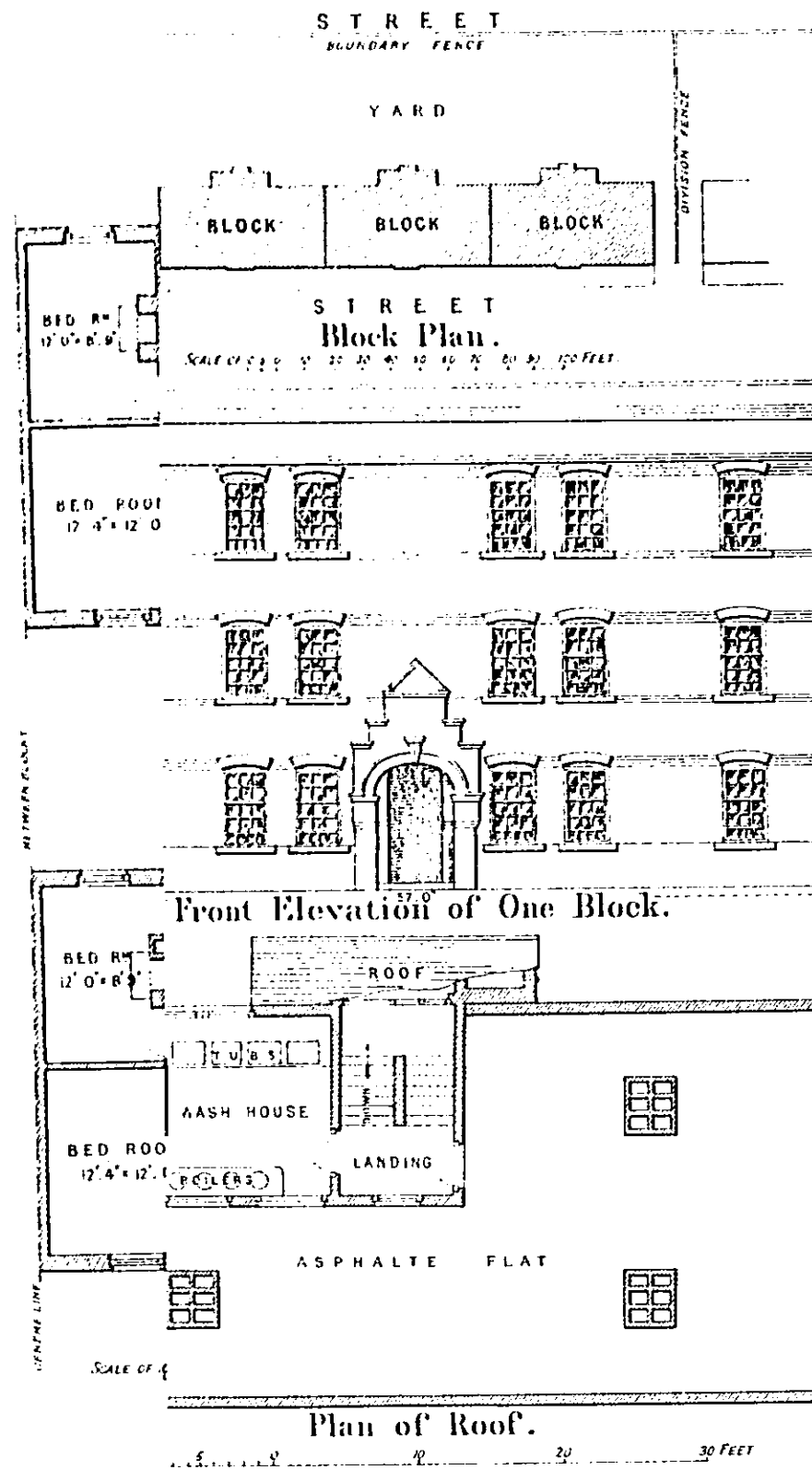


Ground Plan.
(AS EXISTING.)

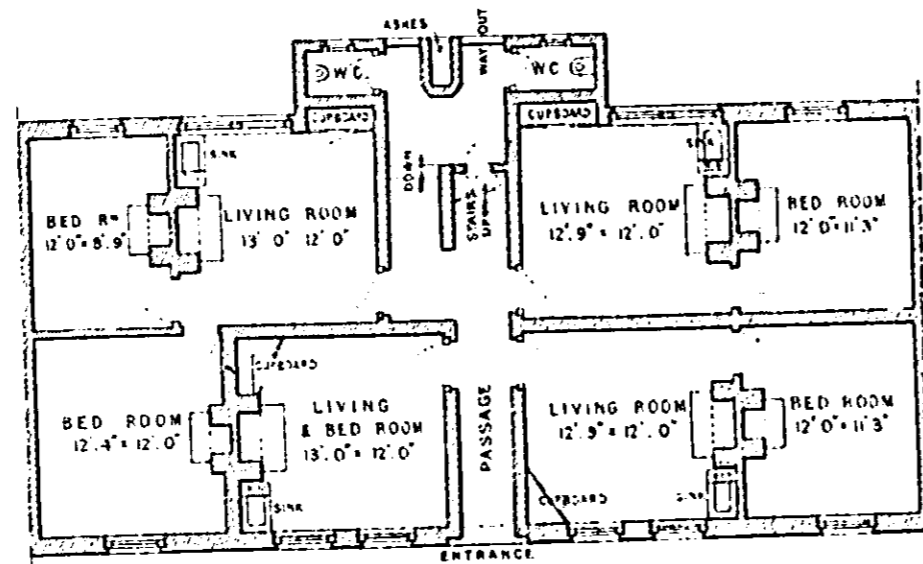
SCALE OF 1" = 20 FEET.

PROPOSED CONVERSION OF FRONT HOUSES INTO
TENEMENTS. IN FLATS.

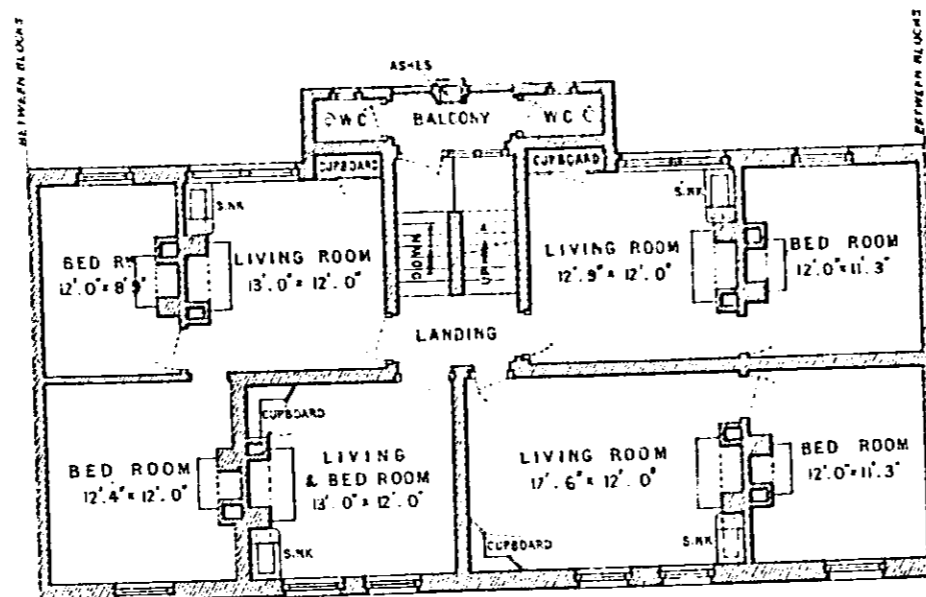
SUGGESTED PLAN FOR LABOURERS DWELLINGS.



SUGGESTED PLAN FOR LABOURERS DWELLINGS.



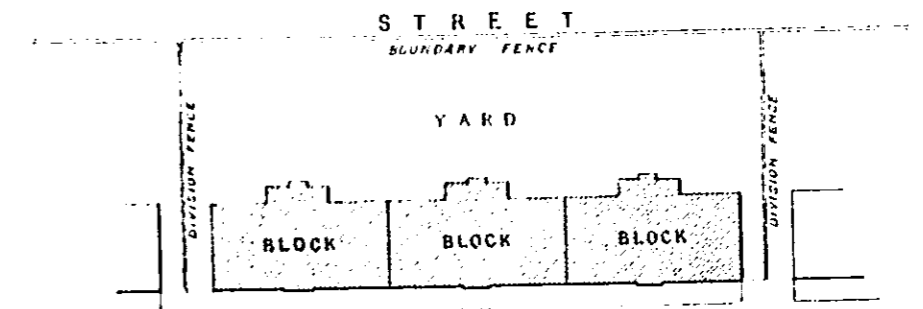
Ground Plan.



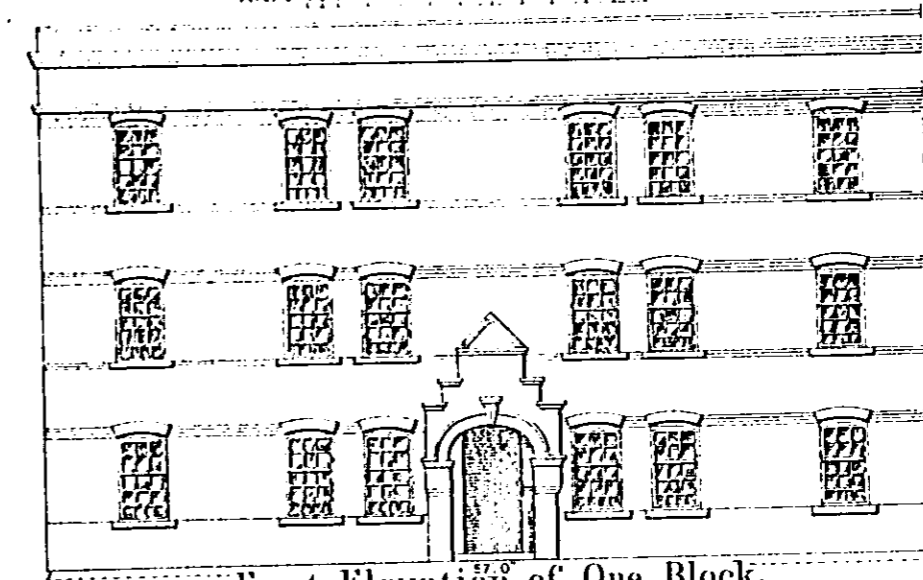
Plan of Upper Floors.

SCALE OF 10 5 0 10 20 30 FEET

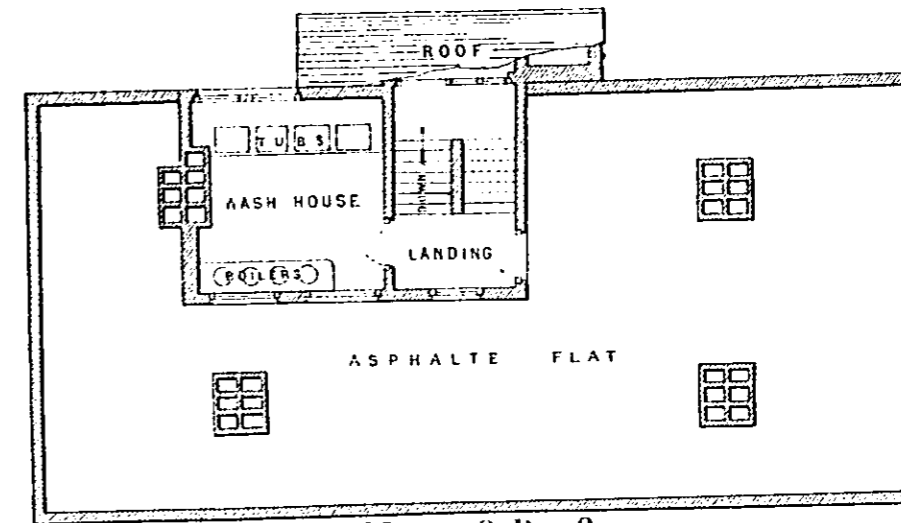
SUGGESTED PLAN FOR LABOURERS DWELLINGS.



Block Plan.
SCALE OF 10 5 0 10 20 30 FEET



Front Elevation of One Block.



Plan of Roof.

SCALE OF 10 5 0 10 20 30 FEET

- (4) That each dwelling in the block shall be to some extent isolated, and communion avoided as much as is possible under the circumstances.

An analysis of the above requirements show that in order to obtain low rentals, inexpensive materials and very little ornamentation must guide the design, and that the site must have been obtained at a low price. I have caused to be prepared some diagrams of a class of workmen's dwellings which are, I think, somewhat superior to the large high blocks of dwellings. With regard to convenience of site, this is of course a great difficulty; cost of land, possibility of securing a sufficient area, the value of the area for other purposes, such as manufactories, &c., have hitherto proved considerable obstacles, except where the local authority has been prepared to lose capital in the purchase of the land.

That the dwellings shall be substantially and sanitarily constructed is of primary importance,* when we consider the effect of massing human beings together in large numbers under the same roof for any considerable period of time; for unless very special precautions are adopted, these dwellings may gradually become saturated and soaked with human emanations, and in the event of an epidemic breaking out considerable difficulty would be experienced in checking it.

In the *Times* of the 15th November of last year, in an article on English Ports and Cholera, the following appeared:

"Probably more has been done in the way of slum improvements than in any other line of late years, but it is feared that we have in many cases only laid up worse trouble for the future, for the vast structures known as 'model' dwellings are often merely models of rotten construction and jerry building of the most shameless order. One of the most experienced sanitary inspectors in London, who has seen the old and the new in a poor district, and has now under his charge forty of these structures, each containing from 200 to 4,000 persons, observed to me the other day: 'In a few years these buildings will be the curse of London, they are worse than the old slums we had before them.'"

These are serious forebodings from a leading journal, and, if true, point to the fact that the solution of the proper housing of the working classes has not yet been reached.

Nearly all the legislation of the past upon this question has

* See Appendix D.

been with a view to replacing upon any area the population removed therefrom, the reasons for this obligation being, no doubt, the desire to incommode the population as little as possible, to avoid any great change in the rateable value of the area dealt with, the desire to study the interests of the small shop-keepers in the neighbourhood, and lastly, not to disturb or extinguish voters.

I think it is a matter well worthy of this meeting to discuss the question from the point of view as to whether it is a really sanitary measure to perpetuate crowded areas, even under better and more healthy circumstances; and if it would not be wiser to discourage this centralization of the population into towns and cities, and endeavour on the other hand to provide suitable, self-contained, and more interesting habitations for the real working classes in the suburbs, leaving the "submerged tenth" to be dealt with in Municipal or State common lodging-houses.*

If there is a necessity, as it appears there must be, for the ratepayers' pockets to contribute to this problem, if it is to be carried into partially successful operation, and if, as I have shown, this is to cost the capital sum of from £30 to £60 per head, could not this money be more usefully applied in making arrangements for the cheap carriage of the working man to his suburban cottage, which could be built far cheaper than in a city, and have also a garden and plenty of space around it? Cheap means of locomotion have grown rapidly in the immediate past, the merchant and the shopkeeper no longer live close to their work, why should the labouring classes? I would suggest that a *bonâ fide* working man should be carried by train, tram, or 'bus at State-aided fares; that he should live in a house on the hire-purchase-system, away from the squalid surroundings of even the most palatial block of artisans' dwellings, and by this means his personal self-interest and self-reliance would be strengthened instead of deteriorated as it is by such communism as he is forced into under the "block" system; and with the prospect in view of one day becoming a freeholder he would be more likely to become a peaceful, law-abiding citizen, with a real stake in the interests of his country. The law should be made to deal with insanitary dwellings, either as areas or any premises unfit for human habitation, in a summary manner. No one is allowed to sell poisonous food, no one should be allowed to let unhealthy dwellings; they should be condemned

* See Appendix G.

and demolished, or closed against the possibility of letting them as habitations unless the owners consented to alter them in accordance with modern sanitary requirements.

These views may be considered as utopian, but I believe they are the real solution of the problem, and they are shared by some of those who have given this question their careful consideration.*

Much has of necessity been omitted from this short lecture, as the time at my disposal naturally curtails many points which might be raised upon this debateable question, but I have added several Appendices, which may be useful for reference. I have omitted all reference to the latest legislation on the subject, and the effect of the Housing of the Working Classes Act, 1890 (53 & 54 Vic., Chap. 70), which has practically superseded the thirteen or more Acts which preceded it.† I have omitted all details of the necessary points to be considered in the proper arrangements for the construction of artisans' dwellings, and of their management after erection.‡

I have omitted any mention of the successful operations that have been carried out in many towns, London included, in connection with the establishment of Corporation Common Lodging Houses, which seems to be a wise, economical, and effectual solution of some portions of the problem,§ in which direction London and Glasgow have set good examples; and I have abstained from quoting any statistics of what has been done throughout the country towards the erection of model artisans' dwellings or otherwise.¶

In conclusion, let me summarise what I have endeavoured to convey by this paper:

- (1) The need for some action owing to the overcrowding of our urban districts, arising from special causes.
- (2) The magnitude and difficulties of the subject.
- (3) The impossibility of complying with the Acts, except at considerable loss to the ratepayers.
- (4) The action that has been taken in connection with the question by the Corporation of Liverpool.
- (5) A description of how that work has been carried out.
- (6) That if the "Block" system is right, then great care must be exercised as to healthiness of site and construction.

* See Appendix E.

‡ See Appendix D.

† See Appendix F.

§ See Appendix G.

¶ See Appendix H.

- (7) That it is impolitic and insanitary to try and replace on the same area the displaced population.
- (8) That if State interference is not mischievous it should be used in the direction of spreading and not centralising the population.
- (9) That the working man should be encouraged to become the owner of the house he occupies.
- (10) That the so-called "submerged tenth" should be provided for by State or Corporation Common Lodging-Houses.

I trust that this paper may add something to the already voluminous literature upon this interesting social and economic question.

APPENDIX A.

The Law attempts to define "Labouring Classes" as follows:

"For the purposes of this section the expression 'labouring class' includes mechanics, artisans, labourers, and others working for wages; hawkers, costermongers, persons not working for wages, but working at some trade or handicraft without employing others, except members of their own family; and persons other than domestic servants whose income does not exceed an average of thirty shillings a week, and the families of any such persons who may be residing with them" (Cheshire Fines Committee Act, 1893, Sec. 5).

APPENDIX B.

Particulars of the Liverpool Sanitary Amendment Act, 1864, and the subsequent Statutes amending that Act:—

The principal Act provides that if the Medical Officer of Health shall find that any court,* alley, or any premises is or are unfit for human habitation, or in a condition, state, or situation injurious, dangerous, or prejudicial to health, he shall report the same; and if four householders report to the Medical Officer of Health that disease exists in any court or alley, he is required to make an inspection. The report of the Medical Officer of Health is to be made in duplicate, and the principal Act requires that he shall deliver one report to the Town Clerk and the other to the Clerk of the Peace. An important

* The term "court" includes a street having an entrance of less than 40 feet in width.—Act of 1864, Section 3, as amended by the Provisional Order of 2nd May, 1879.

amendment was made in the principal Act by the following sections of the Liverpool Improvement Act, 1882:—

Sec. 78. A report by the Medical Officer of Health, under the Liverpool Sanitary Amendment Act, 1864, as to the condition of courts, alleys, and other premises need not be made and signed in duplicate, and a copy need not be delivered to the Clerk of the Peace unless the Corporation specially so direct.

Sec. 79. Where the Medical Officer of Health has made a report to the Corporation under the Liverpool Sanitary Amendment Act, 1864, the Corporation may from time to time (whether or not a copy of the report has been delivered to the Clerk of the Peace, or a presentment has been made under the said Act) acquire by agreement all or any of the premises included in such report, or any estate or interest therein or in any part thereof; and any premises, estate, or interest so acquired by the Corporation may be sold or otherwise dealt with, and disposed of in like manner as land and premises acquired by them under the Liverpool Sanitary Amendment Act, 1864, and Section 26 of that Act shall have effect accordingly. Any moneys which the Corporation are for the time being authorized to borrow or apply for the purposes of the Liverpool Sanitary Amendment Act, 1864, may be borrowed or applied by the Corporation for the execution of this Section.

Sec. 80. Nothing in this Act shall be construed so as to impair, or prejudicially affect, the procedure by way of presentment under the Liverpool Sanitary Amendment Act, 1864, in cases where the Medical Officer of Health, with the sanction of the Corporation, delivers a copy of any report under that Act to the Clerk of the Peace.

It will be observed that where any property mentioned in the Report of the Medical Officer can be acquired by agreement, no further preliminary steps need be taken by the Corporation after the delivery of the Medical Officer's Report. If, however, it is desired to take any property by means of compulsory purchase, the following steps have to be taken under the principal Act:—

- (1) A copy of the Report has to be sent to the Clerk of the Peace, and a copy to the owner of the premises, to

whom a notice has to be given that the Report will be taken into consideration by the Grand Jury at the next Sessions.

- (2) The Clerk of the Peace is required to lay the Report before the Grand Jury to make a presentment thereon, according to their view of the requirements of the case.
- (3) The Clerk of the Peace is then to send a copy of the presentment to the Town Clerk, whose duty it is to lay it before the next meeting of the Council.
- (4) The Council are required to forthwith order the City Engineer to proceed in the matter, and he is directed to survey the premises, and to prepare a plan and specification.
- (5) When the plan and specification have been prepared the City Engineer gives notice to the Town Clerk.
- (6) The Town Clerk is then required to forward a copy of the presentment to the owner of the premises, and to inform him when and where the plan and specification may be inspected.

The owner has the right of appeal against the presentment to the next Quarter Sessions, and that tribunal is empowered to make an order in the matter. The Act also provides for an appeal to the Queen's Bench. Within three calendar months after the service upon him of the notice the owner is required to signify in writing whether he is willing to effect the works, or whether he requires the Corporation to purchase the premises.

If the owner elects to effect the works and makes default, the Corporation are empowered to execute them and to reimburse themselves by the sale of the old materials and to recover the balance, if any, from the owner. If the presentment requires the total demolition of any premises the buildings are to be removed, and it is obligatory upon the Corporation to pay compensation, including the value of the buildings and the site thereof, unless the owner shall desire to retain the latter, in which case he will not be able to build upon it without the consent of the Council.

In cases of compulsory sale the steps prescribed in the Lands Clauses Act have to be taken.

APPENDIX C.

With regard to the provision to be made for re-housing the population displaced it is necessary for the scheme to "provide

for the accommodation of at least as many persons of the working class as may be displaced in the area with respect to which the scheme is proposed in suitable dwellings, which, unless there are any special reasons to the contrary, shall be situate within the limits of the same area, or in the vicinity thereof" (38 and 39 Vic., chap. 36, sec. 5).

It is true that some amendments to this Act partly repealed this clause, but although the legal compulsion of the provision of "suitable dwellings" did not remain so severe the moral obligations remained unaltered.

APPENDIX D.

A few points to be considered in connection with the erection of Blocks of Artisans' and Labourers' Dwellings.

- (1) Healthiness of site.
- (2) Open surroundings and wide impervious streets.
- (3) No possible stagnation of air.
- (4) Substantiality of buildings and best materials in construction, commensurate with economy.
- (5) Perfect plumbing and best sanitary appliances.
- (6) Prevention of spread of fire and facilities for escape.
- (7) No basements or cellars.
- (8) Each tenement to have only one door to landing.
- (9) Isolation of each tenement.
- (10) Perfect ventilation of each room.
- (11) Separate W.C.'s, sinks, &c., to each tenement.
- (12) Heating and lighting to be included, if possible, in rent.
- (13) Ample provision for washing and drying clothes.
- (14) Ample provision for quick removal of dust and other dry refuse.
- (15) Simplicity of cooking ranges.
- (16) Rules for prevention of overcrowding, sub-letting, &c.

(See also Appendix J.)

APPENDIX E.

WORKING MEN AND THEIR HOMES.

At a Political Conference held in Sheffield on December 13th, 1892, the Hon. C. Stuart-Wortley, M.P., in the chair, there being also present Mr. Akers Douglas, M.P., Sir E. Ashmead-Bartlett, Sir F. Dixon-Hartland, M.P., Sir F. Seager Hunt, M.P., Sir A. Rollit, M.P., and others;

Mr. T. Wrightson, M.P., moved—"That the time has come when Parliament may well afford facilities for the acquirement

by working men of their own homes." He said he wished to bring forward a plan by which the credit of the country could be utilised for the benefit of working men, by making available a large amount of cheap money for the purpose of building or purchasing dwelling houses for the working classes. His proposal was that municipalities and other local authorities should be empowered by Act of Parliament to borrow from the State certain moneys every year, in some reasonable proportion to their rateable value and their building requirements, and that they should lend the same to the *bona fide* working man who desired to purchase or build a dwelling house for his own occupation, and this on the easiest possible terms, which, without profit to the municipality, would cover the obligation to the State and the bare cost of administration.

Sir Albert Rollit, M.P., seconded the resolution, and expressed his sense of the value of our municipalities, pointing with pride to the fact that the Marquis of Bute had taken office as Mayor of Cardiff, and that Lord Tredegar had also taken an active and useful part in local administration. The proposal of Mr. Wrightson was on the lines of social and political development.

Whilst this paper was in course of preparation I find that a Bill, entitled "*A Bill to secure the provision of Cheap Trains in London*," will be brought before this Session of Parliament by Sir John Blundell Maple, Sir Algernon Borthwick, Mr. Bucknill, and others, which states in the Preamble that "having regard to the congested state of the population in the central and other parts of the administrative County of London, it is expedient to afford greater facilities for the residence of London Working Classes in the outer suburbs."

This Bill, if carried, would make it obligatory on every Railway Company, having a terminus in London, to issue, by all Workmen's trains arriving at that terminus in the morning before eight o'clock from any Station within twenty miles of the terminus, daily Return Tickets at fares not exceeding those specified in the following scale:—

Distance between Station and Terminus.	Maximum Return fare.
Not exceeding five miles... ..	2d.
Exceeding five miles and not exceeding ten ...	4d.
Exceeding ten miles and not exceeding fifteen...	6d.
Exceeding fifteen miles and not exceeding twenty	8d.

Such tickets are to be available for the return journey by any train departing from the terminus after five p.m. on the day of issue, and after twelve noon on Saturdays. There is a clause providing that the Board of Trade may interfere supposing the Company refuse or neglect, to comply with the order in the

manner provided in the "Cheap Trains Act, 1883." The Bill does not in any way propose that the fares should be State-aided, but it is suggested that the Railway Companies alone should bear the cost of the carriage of workmen to and from their work at reduced fares.

APPENDIX F.

HOUSING OF THE WORKING CLASSES ACT, 1890.

Before the Housing of the Working Classes Act, 1890 (53 and 54 Vic., chap. 70), came into force there were about a dozen Acts of Parliament of different dates dealing with this question, which were most confusing and complicated to understand and somewhat contradictory of each other. These have, fortunately, been repealed or amended, and the procedure has now been much simplified and extended, under which local authorities can close or demolish dwellings unfit for human habitation; and powers have been given for dealing with schemes on smaller scales than those contemplated by the old Acts, and the payment of compensation simplified and certain payments to occupiers, &c., authorised, and the law on the subject generally improved. For instance:—

- (1) Any area may be excluded, or lands may be included, as the exigencies of the case require.
- (2) Approaches may be widened or opened out for the purposes of ventilation and health.
- (3) Dwelling accommodation must be provided for the working classes displaced by the scheme.*
- (4) Proper sanitary arrangements must be provided.
- (5) The scheme must distinguish the lands taken compulsorily.
- (6) The scheme may be carried out by the freeholder under the superintendence and control of the Local Authority under certain conditions.

* Where a scheme comprises an area situate elsewhere than in the county or city of London, it shall, if the confirming authority so require (but it shall not otherwise be obligatory on the local authority so to frame their scheme), provide for the accommodation of such number of those persons of the working classes displaced in the area with respect to which the scheme is proposed, in suitable dwellings to be erected in such place or places either within or without the limits of the same area as the said authority, on a report made by the officer conducting the local inquiry, may require. (53 & 54 Vic. c. 70, sec. 11, sub-sec. 2.) A local authority may, for the purpose of providing accommodation for persons of the working classes displaced by any improvement scheme, appropriate any lands for the time being belonging to them which are suitable for the purpose, or may purchase by agreement any such further lands as may be convenient. (53 & 54 Vic. c. 70, sec. 32.)

- (7) Compensation for lands and interests to be based on the fair market value, due regard being had to:
- (a) Nature and condition of property.
 - (b) Probable duration of buildings.
 - (c) State of repair.
 - (d) No improvement made to the property after publication of scheme to be taken into account.
 - (e) Evidence to be allowable as to fictitious values of rents by reason of the property being used for illegal purposes, or overcrowded.
 - (f) That the houses are a nuisance or in a state of defective sanitation, or not in reasonably good repair.
 - (g) That the houses are unfit and not reasonably capable of being made fit for human habitation.
- (8) All rights of way and easements shall be extinguished on purchase of the lands, &c.

These are all very important powers, and the third part of the Act consolidates the Labouring Classes Lodging-House Acts, 1851 and 1885, and empowers Urban Authorities to provide lodging-houses for the working classes, either by purchase or renting of land, or appropriating land belonging to the authority, or to convert any buildings into lodging-houses and fit them up, or to purchase or rent from other persons existing or future lodging-houses.

APPENDIX G.

A MUNICIPAL LODGING-HOUSE.*

"At the invitation of the London County Council, a number of ladies and gentlemen yesterday afternoon visited Parker Street, Drury Lane, where an experimental 'Municipal Lodging-house' has been erected by the Public Health and Housing Committee of the Council. The establishment has been prepared to accommodate 326 men with lodgings. They will be housed in separate compartments, which are 8 ft. high, 7 ft. long, and 4 ft. wide. The rooms are lit by electricity. The house also contains a large general room, a kitchen, a library, a shop for the sale of cheap provisions, and a lavatory fitted with baths. Among those present were Sir Walter de Souza, Lord Lingen, Lord Monkswell, Alderman Beachcroft, Commissary-General Downes, Colonel Probyn, Mr. John Burns, M.P., and Alderman Fleming Williams. As Chairman of the Public Health and

* Extract from *The Times*, January 26th, 1893.

Housing Committee, Alderman Beachcroft explained that in 1890 the Housing of the Working Classes Committee of the last Council made an enquiry into the common lodging-house accommodation in London. They found that there were some 900 of these houses, accommodating over 30,000 persons. The members of the Committee inspected many of the worst of these houses, as well as some of the best, and as to the worst he could only say that no words could adequately depict the misery of them. Subsequently the Committee visited seven lodging-houses in Glasgow, started by the Municipality, which were not only remunerative, but had in no way interfered with private enterprise. As a result of the investigations of the Committee, they recommended the Council to erect a model lodging-house on the Parker Street site, and the Council approved the proposal. The work of erecting the building was put out to tender, and the cost had been kept within the amount of the contract—£14,300. The furnishing had cost £1,250, and with the addition of £3,700, the value of the site, and £1,100 for architects' commission, a total of £20,350 was reached. To secure a return of 3 per cent. on this, and such a sinking fund as would ordinarily be required to replace the cost of building in 80 years, a yearly gross income of £2,450 was required. To meet this the Council had fixed the charge for a bed at 5d. a night. He concluded by defending the erection of the house, and traversing the objections which had been raised against it."

An important experiment carried out by the Glasgow Corporation has been the providing of common lodging-houses. The first experiment was made in 1870, when the Corporation opened the Drygate and East Russell Street lodging-houses; and, even in the first year, these establishments, which were on a small scale, were financially successful, the expenditure at Drygate being £181, and the revenue, £341; and at East Russell Street the expenditure was £88, and the income £163. The Corporation increased the number of their common lodging-houses, and now have seven large establishments, the latest one being opened in 1879. The large lodging-house for men, that in Clyde Street (Calton), has been opened since 1878, is a large well-built stone building, which cost about £14,000. There is a large dining-hall, and abundant accommodation in the adjoining kitchen for cooking. Each inmate is allowed the use of cooking utensils, and cooks his own food. There is a large recreation room. Each man can have the use of a small locker by depositing sixpence for the key; and the sixpence is given back on his returning the key. There is accommodation for 350 lodgers, who, in addition to comfortable, clean beds, have the use of the recreation and dining halls, the kitchen range and

cooking utensils, and facilities for washing their clothes, &c., all for the charge of 3½d. per night, or, if they wish to indulge in the luxury of an extra sheet on their bed, the charge is 4½d. per night. Each lodger has his own enclosed sleeping closet, in which is fitted up a spring wire mattress, covered with a hair mattress. The lodgers are not allowed to go up into the sleeping rooms during the daytime. The Superintendent of the Clyde Street establishment estimated the "floating" lodgers at thirty to fifty per day, nearly all the remainder being men who have no family ties or friends, and live almost constantly in the house.

A shop is fitted up at each establishment and carried on by the Superintendent, who takes the profits as part of his remuneration. All articles of food are sold in these shops at ordinary trade prices; but lodgers may, if they prefer it, purchase their food outside. A Superintendent informed the deputation that a man can live in the lodging-houses at a cost of 4s. to 5s. a week.

One of the seven lodging-houses—the one in East Russell Street—is set apart for females. The charge is 3d. per night, and 1½d. per night for a child occupying the same bed as the mother. One woman, who was in the house with three children, was charged 5d. per night, all of them sleeping in one bed-closet. A great many women lodging in the house support themselves by needle and other work, which they do in the hall, and then go out and sell it.

The Corporation Committee are considering the advisability of building a lodging-house for the accommodation of married couples.

The success of the Corporation lodging-houses has been so great that private enterprise has now taken up the work on similar lines.

The cost of the seven lodging-houses has been about £85,000.

The following is a return of the total revenue and expenditure of each lodging-house from the year of opening up to May 31st, 1890:—

	Opened.	Revenue.	Expenditure.
Drygate	1870	£26,578	£16,524
Greendyke Street	1876	£20,363	£12,151
Portugal Street	1878	£19,691	£11,163
Clyde Street	1878	£18,175	£10,854
North Woodside Road	1878	£18,186	£11,582
Hyde Park Street	1879	£18,180	£11,577
East Russell Street (Females)	1870	£6,744	£5,492

APPENDIX II.

From a return made in January, 1893, by the Borough Engineer of Sunderland, from questions that he had addressed to forty-eight towns, it would appear that in reply to the query "Have you under this or any other Act acquired and demolished property of an insanitary character?" only five towns seem to have taken advantage of the Acts, though a great many replied that schemes were before their Corporations with a view to adoption. Where advantage had been taken of the Acts and artisans' or workmen's dwellings erected, it would appear that the return on the total outlay was not very encouraging. The rents charged varied apparently from 2s. to 6s. 6d.

APPENDIX J.

CORPORATION OF LIVERPOOL. LABOURERS' DWELLINGS.

Rules to be observed by the tenants, in order to secure their mutual comfort.

1. Rents will become due every Monday morning, and be payable in advance, if demanded. One week's notice to quit must be given to, or by, any tenant before leaving, such notice to be given to or by the Superintendent before 12 o'clock, and on a Monday only.

2. A deposit of five shillings will be required from each tenant, which will be held as security for the repair of cracked or broken glass, loss of keys, &c., and be returned at the expiration of the tenancy, subject to any deductions for such repairs as have not been executed or of rent due, and to the terms of Rule No. 17. The decision of the Corporation Surveyor as to the amount of the deduction to be final and conclusive.

3. Cracked or broken panes of glass must be immediately repaired by the tenants. The chimneys in use will be swept, when considered necessary by the Superintendent, free of charge to the tenants, to whom intimation will be given twelve hours previous.

4. No tenant will be permitted to underlet or take in lodgers without obtaining the previous sanction of the Corporation, or to keep a shop of any kind.

5. Care must be taken that no cotton waste, cotton, or anything likely to choke the water-closet is put therein.

6. Ashes and dry refuse only to be thrown into the dust shafts. Tenants are earnestly requested to observe this regulation, which is necessary to preserve the healthiness and comfort of their dwellings. Anything likely to create an obstruction or bad smell must be put aside for the scavenger's cart, which will call daily. All liquid refuse to be thrown down the water-closet or the sink, according to the nature of the fluid.

7. Intimation must be given to the Superintendent in cases of fever or other infectious or contagious disease, and the tenant must

also agree to allow any case of infectious disease occurring in his rooms to be removed to a Hospital.

8. The Liverpool Gas Fittings Company, Limited, shall be at liberty, by their agents or workmen, from time to time, to enter any dwelling, at all reasonable hours of the day, so as to examine and, if necessary, repair the Automatic Gas Meters fixed therein, and to collect the pence deposited in such Automatic Meter.*

9. The central playground being provided exclusively for the use of the tenants, children will not be allowed to play on the stairs, in the passages, or in the laundries.

10. Passage floors, landings, stairs, closets, and laundry to be swept each morning before Ten o'clock; washed and stoned every Saturday, not later than Ten o'clock at night. The tenant at the top of each staircase, whose turn it is, shall commence to sweep, wash, &c., as far as the next floor, the tenant in turn on that floor shall do the same to the next, and so on to the basement. The tenants on each floor taking the work in turns, commencing with the one inhabiting the dwelling with the highest number. Where a dwelling or dwellings on a floor are unoccupied, the whole of the tenants using that part of the staircase to undertake the vacant duty among them. Should there be any dispute as to the cleaning or sweeping required, or as to the tenant whose turn it may be, the matter shall be referred to the Superintendent to decide, whose decision shall be final. Tenants who, in the opinion of the Superintendent, are, by age, sickness, or infirmity, unable to do their proportion of washing, cleaning, &c., may be excused, and their work must be done by the other tenants.

11. Washing must only be done in the laundry; tenants will not be permitted to use the laundries for the washing of any clothes but their own. All clothes must be dried in the laundry, and no clothes must be hung out or laid out to dry. Each tenant will be allowed to use the laundry for one day in each week in rotation, and should any dispute arise as to the day for washing, the matter shall be settled by the Superintendent. After the washing is finished the tenant shall clean up the laundry, and dry the washing boiler—this is always to be kept dry when not in use.

12. No dog shall be allowed to be kept on the premises.

13. Tenants are not allowed to paper, paint, or drive nails into the walls or woodwork, without the consent of the Superintendent.

14. No business notice or sign to be exhibited or affixed to any portion of the premises without the consent of the Superintendent.

15. The Superintendent is not permitted to accept any gratuity whatever.

16. The Corporation to be at liberty, by their agents or workmen, to enter and inspect the state of repair or cleanliness of any dwelling at all reasonable hours of the day, and to execute any repairs thereon, and to inspect and test the Gas Meters therein.

* This is not necessary where the lighting is included in the rent.

17. Tenants who, in the opinion of the Corporation Surveyor, shall neglect to observe these rules, misuse or improperly occupy any of these dwellings, or cause or create any discomfort or inconvenience to their neighbours, shall be subject to immediate ejection at the expiration of forty-eight hours' notice in writing, and to the forfeiture of the deposit, without remedy of any kind on account of such ejection and forfeiture, and the Corporation shall not be liable to any claim by such tenant for damage arising from such ejection and forfeiture.

For the mutual benefit of tenants, they are severally requested to see to the carrying out of the above regulations.

N.B.—Receipts for rents will only be recognised, which are given on special Rent Books.

Form of Application for Dwellings.

Name

Occupation

Present address

Number of Rooms required in house

Whether married or single

Number of children residing with parents

Ages of boys

Ages of girls

Do you agree to abide by the Rules?

Name of person to whom applicant refers

Applicant's signature.....

Date.....

Sir THOMAS CRAWFORD (London) said he was sure that everyone had listened with very great pleasure to the paper, and invited remarks or questions upon the subject.

Mr. RAPHSON (London) asked what would become of the inhabitants of insanitary dwellings while these were being demolished?

Mr. KERSHAW (London) asked whether the drains in the Victoria Square Buildings were constructed in terraces, or whether each house was drained separately?

Mr. BEACHCROFT (London County Council) said he had listened with interest to the paper. There was one thing the author had

omitted to refer to, viz., the great difficulty of clearing areas and re-housing the population so disturbed. He asked how in future, slums that were destroyed, were to be prevented from reappearing? It was no use clearing away the present slums if fresh ones were allowed to spring up in their place. He thought that as long as London was hampered by the want of a proper Bye-Law-Making Authority, so long would this bad state of things continue. He was convinced that unless the municipality insisted that the frontage of houses should be at least twenty feet from the roadway, matters would not be improved. He advocated the London County Council prescribing how houses should be built. He agreed with the lecturer as to cheap fares on trams, trains, &c. In places where insanitary houses were demolished, there was only room for about half the people unhoused, which of course necessitated some portion of them going farther afield; and to facilitate this there should be cheap fares, not only in London but in the country at large.

Mr. BLASHILL (Architect, London County Council) said he concurred in nearly all the author had said. He remembered being consulted as to Cross' Act years ago, and he thought then that the obligation to re-house the population on the site of the demolition was fatal to the Act. With regard to the query as to what was done with the people while the alterations were being made, of course they spread into the surrounding neighbourhood, and hardly ever came back at all. He had known people who had been compensated for removal from one insanitary site, purposely go to another in order to get compensation again. He had known this happen three times, making it almost a trade. The result of making improvements is that the class of people removed does not come back to the same spot. He entirely concurred in the opinion that the population should be spread out more. The wealthy and commercial classes had left the central districts which they used to inhabit of old, and the poor people only lived there for the sake of the charity they could get. He thought the real way to settle the matter was to do it kindly, and not to un-house unnecessarily, and also not to promise to take the people back. With regard to fares, he thought that no State-aided fares were wanted, but that the fares would reduce themselves in time, as they had done in the past. He said he could now ride for a penny, a distance which used to cost fourpence or sixpence, and the same sort of thing would continue. He differed from the lecturer as to the advisability of the working man owning his own house. He thought it was better to move at will if necessary, and not be fixed to a certain spot.

Mr. T. GORNIOT (London) said he was a working man, and knew where the shoe pinched. He thought the working man should be distributed over a larger area, which would give him an opportunity to carry out his tastes. He entirely concurred with the lecturer as to the necessity for cheap fares, and thought that no profit ought to

be made out of the working man. Regarding trains, if you did not start early, you had to pay the full fare. He thought that the cheap trains ought to be made to run at times more suitable to the working man. With regard to the benefits the working man would derive from going further out, he thought that unless he had sufficient time he would not be able to enjoy the benefits. As an example he took the building trade, which he said entailed very laborious work. One had to get up at 4.30 a.m. so as to begin work at 6 o'clock, and and then work nine hours till 5 o'clock, making it 7 o'clock or later before one could get home, thus leaving the builder no time to avail himself of the benefits which it is said he would derive from going further afield. He was strongly of opinion that the hours of labour should be shortened.

Dr. E. WILLOUGHBY (London) said that the objection to the working classes going into the country was that they would go outside of the municipality of London, and into districts where there was no proper building supervision. As an example he took the case of Tottenham, where there were thousands of jerry-built houses, and land quite undrained. Tottenham is outside the metropolis, and cannot enforce building supervision. This state of affairs generates the germs of slums. He thought the block system of houses was too exclusive in tone to be suitable for the class for whom it was intended, viz., the working man. The system, however, possessed the advantage of dryness of site and ventilation of drains, but he thought that blocks ought in future to be built under strict supervision. He said that some existing blocks were worse than the houses they had superseded. He knew of blocks where the stairs were not open, where the soil-pipes were inside, where the closets were in the lobby in the middle of the house, where no light whatever could get to them. Very often the cistern containing the drinking water was in the closet itself; in some cases the dust shoots had sliding doors opening into the living rooms, the effluvia from them being very bad, and the cause of many diseases.

Mr. BOULNOIS (Liverpool) in reply said: firstly, as to what would become of the people unhoused, they would of course disappear from that spot and go elsewhere. Secondly, with regard to drainage of the Victoria Buildings, this is done by means of soil pipes which are outside, as are the closets, as shown in the plan of the Victoria Square dwellings, Liverpool. He was pleased at the concurrence expressed with his views generally. He regretted the state of things at Tottenham, and could not understand how there could be no bye-laws and no inspectors there. He thought that London must be administered in a very much worse manner than the provinces. Such a state of things as pointed out by some previous speakers, would be impossible in large provincial towns such as Liverpool, Manchester, and Glasgow. Regarding the line of frontage and having this set back, he pointed out that this was a very expensive matter indeed, as the authorities

would have to pay heavy compensation if they had all re-built houses set back twenty feet from centre of roadway. Regarding insanitary property and compensation, he thought such property should be made unsaleable by law. He was obliged to Mr. Gorniot for having spoken as a working man, and with regard to the difficulty for working men to go any distance away on account of their hours; he was of opinion that the hours were too long for good labour. Work before breakfast for instance was, he said, of no value whatever and should be dispensed with.

Sir THOMAS CRAWFORD (London) said he had very great pleasure in proposing a hearty vote of thanks to Mr. Bouhuois for the very interesting paper he had favoured the meeting with. The paper had been shown to be interesting by the number of speakers it had brought forth. He said he had seen a good deal of working men in some of the poorest districts of Deptford and Greenwich. He had found that men and women who are willing to work (he would not deal with the submerged tenth) find a difficulty as to how to manage with families in block buildings, staircases being dangerous and inconvenient where children were concerned. The working man liked the independence of a cottage; and he thought that insanitary cottages might be replaced by sanitary cottages. He agreed with the lecturer that every inhabited house should be made habitable, and that landlords should be compelled to make houses sanitary.

SOME GENERAL NOTES ON THE WORKING OF LONDON MAIN DRAINAGE SYSTEM.

By W. SANTO CRIMP, M.Inst.C.E., District Engineer,
London County Council.

Read at a Sessional Meeting, April 12th, 1893.

WHEN asked to read a paper at a Sessional meeting of the Institute on "Experiments in the London Sewers" the author felt that the title was an impossible one, because although he had made numerous observations of various kinds in the main sewers of the metropolis, the general results, obtained under various conditions and at different times, are without that continuity so desirable in placing on record observations, which would possibly by some few persons be regarded as authoritative.

The subject of "Main Drainage," again, is almost threadbare, and although the author would perhaps be enabled to place a few new facts before the meeting later on, he could not hope to add much to the knowledge of his audience. Engineers, again, are so accustomed to deal with dry facts and figures that they become as a body singularly unimaginative, and their writings are therefore as a rule devoid of that piquant interest for the general public which alone secures popularity, and consequently a widely-spread interest in the subject discussed. If, however, a popular novelist writes an article for the papers on some really difficult problem of engineering, attention is at once arrested, and our novelist becomes a first-rate authority, even although his facts be all wrong. Such a case recently came under the author's notice with regard to the sanitation of a northern suburb, and a writer of really delightful works of fiction, who has done much in the cause of humanity, allowed his splendid imagination to play him a trick when dealing with a subject of great difficulty, and with regard to which experts are by no means agreed.

In this paper the works on the north of the Thames will be more particularly referred to, because in the first place they are under the immediate charge of the author, and he is therefore familiar with their details, and in the second place the general

principles of the works are the same on both sides of the river, the main difference being one of population, since about three million persons contribute to the sewage works of the north side as against about one half that number to those on the south.

With regard to the subject matter of this paper, the popular writer would probably say that the most noticeable result of the working of the London main drainage system is the pouring into the atmosphere of a nauseating vapour, by means of the sewer ventilator, and it must be admitted that in this direction there are some grounds for complaint. It is however most gratifying to the sanitarian to know that both the County Council and the various District Boards of Works and the Vestries, are gradually but surely converting the old defective sewers under their respective charges into effective and self-cleansing ones. It is perhaps scarcely necessary to urge that no system of sewers can approach perfection, unless the sewers rapidly discharge all the liquid and solid matters that may enter them. The first step therefore towards lessening the offensiveness of sewer-air is to properly construct the inverts of the sewers and to employ judicious flushing where necessary. All street ventilators in unpaved roads—and in wide roads these are not necessarily objectionable—should be provided with dirt boxes in order to prevent the detritus from the surface of macadamised roads falling into the sewers and forming dams, which cause evil-smelling deposits to accumulate. In narrow roads, and in those districts in which there is little vehicular traffic and pedestrians use the roadway as much as the footways, ventilators carried up as high as possible by means of some convenient object, are most desirable, and this system is being gradually extended in London as well as in other towns.

With regard to the general question of sewer ventilation, the author's observations in the London sewers, coupled with constant inquiries among the sewer-flushers, confirm all he had said elsewhere as to the effect of the wind in causing movements of sewer-air. He had even observed cases in which large volumes of hot liquid poured into the sewers from breweries had caused a great rise in the temperature of the sewer-air without producing more than a local disturbance; there had merely been a sudden discharge of sewer-air through the nearest ventilators, but the effects have been quite local; and he is satisfied that in sewers the wind is by far the most powerful agent producing movements of sewer-air, and therefore the only one that need be recognized. Sometimes the currents are upwards, sometimes downwards, and in foggy or calm weather there is little or no movement other than that due to displace-

ment by reason of the varying sewage-flow. The wind therefore is the agent which might be easily made to ventilate sewers when it is necessary to do so.

Before leaving this part of the subject he could inform the meeting that the Main Drainage Committee of the London County Council are most anxious to throw all the light they can upon this most troublesome problem, and with that view a well-known scientist, Mr. Parry Laws, has, at the request of the Committee, made a number of experiments on the composition of sewer-air both from the chemical and biological points of view; and, although these have not been completed, it has, up to the present, not been demonstrated that pathological organisms are present in sewer-air. They certainly do not abound as persons with highly-developed powers of imagination assert; indeed, when the sewage has been caused to fall into the sewers from a height, in order to produce splashing, the germs—if present—succeeded in eluding the learned professor with a care most remarkable in so small and undeveloped an organism. Still, the author does not wish to convey the impression that he thinks sewer-air harmless.

We may next consider the working of the Main Drainage System from the sewage removal point of view, and as the system conveys both rainfall and sewage, it would at first appear to be difficult to indicate to what extent the system performs its functions as a sewerage one. The meeting will remember that in the great inquiries into London drainage that have been made by Royal and other Commissions, that a mass of information is given with regard to rainfall, and its effect in causing storm discharges. Recently, however, the Chief Engineer to the Council, Mr. Binnie, reported upon this question, and as the author assisted him in obtaining the materials for the report, he could shortly give the general results of the inquiry. Instead of looking at the question from the older points of view, it was decided to ascertain what proportion of the sewage was delivered at the outfalls and what escaped at the storm-overflows. It was not difficult to attain this object, since each storm-overflow is in charge of a man who keeps a record of the time during which it is in operation. In the result it was found that about ninety-six per cent. of the sewage is delivered at the outfall works, the remainder escaping at the storm-overflows. But in addition to the sewage conveyed to the outfalls, a very large proportion of the street washings due to rainfall are also so disposed of, to the great advantage of the river, so that on the whole the separate system, if adopted in the case of London, would not appear to be as satisfactory as the existing one. At the same time, it is only right to add that

the conditions affecting the Main Drainage System have been much improved since the works have been under the charge of the London County Council.

It is somewhat remarkable that the late Board of Works—under whose régime some of the finest and most enduring engineering works of the age were constructed—should have allowed the machinery at the principal pumping stations to have fallen into a state of disrepair, which resulted in a great waste of fuel and the ineffective working of the main low-level outfall sewers. This latter state was productive of serious evils on the north side, as the low-level sewer was allowed to remain always sur-charged, thus bringing the storm-overflows connected with it into operation nearly with the occurrence of every shower of rain, and also preventing the subsidiary sewers at the East End, and also at Westminster, from performing their functions properly. The late Mr. Gordon, however, when Chief Engineer, gave instructions to have the sewer pumped down, which was accomplished with some difficulty, as the pumps were worn out. New pumps have, however, been now provided at Abbey Mills, and are in course of construction at Crossness, and on the north side, as well as on the south, the low-level sewer is always kept pumped down, to the great advantage of the ratepayers, since the coal consumption at Abbey Mills is only $8\frac{1}{2}$ cwt. per million gallons pumped, to be reduced to about 6 cwt. when the engines are compounded—a contract for which has been let, as against $12\frac{1}{4}$ cwt. before the new pumps were provided, whilst from the sanitary point of view, the greatly lessened storm-discharges into the river in the midst of the metropolis is most gratifying. The meeting will remember that, acting under the advice of their Chief Engineer and Sir Benjamin Baker, the County Council are contemplating extensions of the Main Drainage System, rendered necessary by the growth of population, which will probably cost upwards of two millions sterling. A part of the suggested extensions in connection with the drainage of the East End is already in hand.

We may next briefly consider the manner in which the sewage is disposed of. As is well known, the gigantic precipitation works at Barking and at Crossness are the outcome of the inquiry of the last Royal Commission on Metropolitan Sewage Discharge, and form part of the recommendations of the Commission. As the works are alike in principle, those of the north side will only be described. The dry weather sewage flow at Barking varies from about 85 million gallons per diem to about 115 million, the mean being about 105 million. During periods of heavy rainfall the rate of flow is for a time much

increased. The outfall sewers have always been said to be capable of discharging 33,000 cubic feet per minute, their capacity being calculated by the well-known formula of Eytelwein; but recently means for gauging the effluent have been provided, and discharges of about 45,000 cubic feet per minute in rainy weather have been registered, and there is strong evidence that the sewers have, in the past, discharged even larger volumes, and the author thinks that Kutter's formula gives the true discharge within a small percentage; at any rate, the formula as simplified by Mr. Henry Law, M.Inst.C.E., may be safely used when further modified as in the following form:

$$V = \frac{180 r \sqrt{s}}{0.70 + \sqrt{r}} \text{ where}$$

V = velocity in feet per second.

r = hydraulic mean depth.

s = sine of slope.

The co-efficients have been slightly modified by the author, and the results appear to be quite satisfactory, as far as the northern outfall is concerned. The calculated discharging capacity of the northern outfall sewer by the formula mentioned is as follows:—

Eytelwein.....	34,800 c.f. m.
Kutter (modified)	46,800 „ „
Kutter	50,340 „ „

With regard to the sewage outfall works at Barking, the works as constructed by the late Metropolitan Board of Works consist of thirteen settling tanks for precipitation purposes, each tank is thirty feet wide and the length varies from 860 feet to 1,210 feet. These tanks hold collectively about twenty million gallons or about two and three-quarter hours sewage flow during the period of maximum discharge, after making allowance for those out of work for cleansing operations. There are in addition, works of an extensive and very complicated character for dealing with the sludge, consisting of settling tanks, sludge stores, and pumping machinery. There is as well the old storage reservoir, built when the outfall works were first constructed, and this now acts as an effluent water-store to some extent, so that the bulk of the effluent is discharged upon the ebb-tide.

According to the Joint Report of the Chief Engineer, Mr. Binnie, and Sir Benjamin Baker, the works at Barking, including two sludge steamers, cost £525,000, and those at Crossness about £330,000; while since the date of the report three more steamers

have been procured. But further works and extensions, not of a very expensive character, are contemplated; and when the works on both sides are complete, it will no doubt be found that they have, with the five sludge steamers, cost about one million sterling.

With regard to the general design of the Barking Works, although there are in existence very many successful examples of settling tanks which are worked upon the continuous system, those at the outfalls were designed for working on the intermittent principle. This involved effluent-water disposal arrangements of an extensive and complicated nature, and generally of an ineffective character, since it was found in practice at Barking that a very large proportion of the sludge escaped with the effluent. It was the author's duty, in conjunction with Mr. Binnie, to find a remedy, and after carefully, and indeed anxiously, considering the matter, it was decided to recommend the Council to alter the system to the continuous one, and after obtaining the approval of the Council, the necessary structural alterations were carried out at a cost of about £2,500. The sewage was forthwith treated upon the continuous principle, and the sludge produced and sent to sea from Barking immediately rose from about 8,000 tons per week to about 23,000 tons for the same period, whilst the working expenses were very materially reduced, and the effluent does not now contain more suspended matter than is found in that of other successful works of a like nature. The Crossness Works were also re-arranged, and now are worked upon the same lines as those at Barking. The chemical treatment is that recommended by Mr. Dibdin, the Council's chemist, and consists in the addition to each gallon of sewage of from four to five grains of lime in solution, and about one grain of protosulphate of iron also in solution. As before stated, clarification is very successfully performed. The total estimated cost of dealing with both the sewage and the sludge during the current financial year is about £110,000, or about 30s. per million gallons.

The sludge produced at the two outfalls during the current year will, at the present rate of production, amount to about two million tons, or say two-and-a-half million cubic yards, which would cover 500 acres to a depth of about three feet, or the whole of Victoria Park to a depth of six feet, Battersea Park to a depth of seven feet six inches, or Hyde Park to a depth of two feet, whilst if the sewage from which the sludge is obtained were placed upon the sludge in Victoria Park, it would form a mass about 1,100 feet in height. This vast mass of polluting matter will be transported to the Barrow Deep, some fifty miles below the outfalls, by means of five

sludge steamers, each of a carrying capacity of 1,000 tons, or 1,300 cubic yards, at a cost of about 3d. per cubic yard, a most gratifying result from both the sanitary and the ratepayers' point of view, for as regards the former, there is no gainsaying the fact that the river Thames is less polluted at this moment than it has been during this century. Whether finality has been reached the author will not venture to prophesy; the Thames alone can answer that question, as it will assuredly do on the conjunction of a hot summer with a small flow of upland water. Then, and then alone, will the true effect of the present operations be demonstrated.

If further treatment should be found necessary, then either land treatment, or filters so-called—which it may be remarked are not filters in the ordinary sense of the term, but rather nitrifiers, or the removal of the outfall works to a point lower down the river will probably be resorted to.

In concluding these remarks upon the treatment of the London sewage, reference must be made to the criticisms which have in the past been freely indulged in as regards the method of sewage treatment adopted. It is now proved that the treatment results in the separation of nearly all the suspended matters, and the lessening of the dissolved organic impurity by about 15 per cent., therefore it is argued by some that the treatment is insufficient. But the condition of the Thames has vastly improved, and the foreshores adjoining the outfalls are clean and inoffensive, whereas they were, before the sewage was clarified, in a most abominable condition, and it may well be asked why such an apparently slight improvement in the effluent from the chemical point of view should be productive of such excellent results. The author ventures to think that the explanation must be sought in a study of the action of micro-organisms. It is well known among biologists that ferments are mainly of two kinds, the aerobic, living in the presence of oxygen, and the anaerobic which do not need oxygen in order to perform their functions.

The following experiment of John Tyndall's is a beautiful illustration of the great difference between these two classes of organisms, he says: "A drop of liquid containing those small organisms is placed upon glass, and on the top is placed a circle of exceedingly thin glass—for, to magnify them sufficiently, it is necessary that the object glass of the microscope should come very close to the organisms. Round the edge of the circular plate of glass the liquid is in contact with the air, and incessantly absorbs it, including the oxygen. Here, if the drop be charged with bacteria, we have a zone of very lively ones; but through this living zone, greedy of oxygen and appropriating it,

the vivifying gas cannot penetrate to the centre of the film. In the middle, therefore, the bacteria die, while their peripheral colleagues continue active. If a bubble of air chance to be enclosed in the film, round it the bacteria will pirouette and wobble until its oxygen has been absorbed, after which all their motions cease. Precisely the reverse of all this occurs with the vibrios of butyric acid. In their case it is the peripheral organisms that are first killed, the central ones remaining vigorous while ringed by a zone of dead. Pasteur, moreover, filled two vessels with a liquid containing these vibrios; through one vessel he led air, and killed its vibrios in half an hour; through the other he led carbonic acid, and after three hours found the vibrios fully active. It was while observing these differences of deportment fifteen years ago that the thought of life without air, and its bearing upon the theory of fermentation, flashed upon the mind of this admirable investigator.*

The bearing of this experiment upon the pollution of rivers is obvious. If the suspended matters in sewage are not removed, they are deposited in the bed of the river, where the oxygen, dissolved in the river-water, is merely brought into contact with its surface and cannot penetrate its mass; hence the organic matters in the mud or sludge are broken up by putrefactive ferments, which produce sulphuretted hydrogen and other evil-smelling compounds, whilst on the other hand, if the sewage is clarified before being discharged into a river the dissolved organic impurities in the effluent are disseminated in the river-water, which, if sufficient oxygen be present, teems with ferments which break up the organic matters into inoffensive minerals and gases. The author ventures to give this explanation in connection with the fact that the Thames is in a vastly better condition than would appear to be possible if the question were discussed purely from the chemist's point of view. If further confirmation of the views advanced by the author were needed, it may be found in the Report by the State Board of Health of Massachusetts, 1890, where, at page 553, the results of observations on the water of lakes and ponds at different depths are given, and it is clearly demonstrated that when mud at the bottom of deep lakes contains organic impurities, the lower layer of water becomes very foul. "Water drawn from near the bottom of such lakes contains, besides much ammonia, usually a large amount of offensive gases such as sulphuretted and carburetted hydrogen, while dissolved oxygen is completely absent. In foul water of this character the varieties of animal and vegetable life which

* "The Floating Matter of the Air," John Tyndall, 1883.

we find in the water nearer the surface are almost, if not entirely, absent, and bacteria are abundant."

In conclusion, the author would like to remark that in his opinion the solution of the huge problem of London sewage disposal will be accomplished by land treatment, or with the aid of those minute organisms which nature has provided in countless numbers, in order to perform her work in her own, as yet perhaps, mysterious manner. Organic matter must be broken up and rendered harmless, nature provides the means if man will employ them intelligently and aid her in her work; and although we stand as it were but upon the threshold of this new science, it will be conceded that already our views upon the subject have been broadened, and we have been enabled to break away from many of the traditions handed down to us by some of the pioneers of sanitary science.

Sir ROBERT RAWLINSON, K.C.B. (Chairman), said he would confine himself at the moment to proposing a hearty vote of thanks to Mr. Santo Crimp for his most instructive paper. The vote was thereupon responded to enthusiastically.

Mr. HENRY LAW, M.Inst.C.E. (London), said he had been acquainted with the subject of the metropolitan sewage for many years. He called attention to the enquiry held some time since, by order of the Home Secretary, before Sir Charles Hartley, Sir Frederick Bramwell, and Sir Douglas Galton, as to the alleged creation of shoals in the Thames at Woolwich, Barking, and Crossness, in consequence of the discharge of the metropolitan sewage at Barking and Crossness; the result of that enquiry, as expressed in the award of the Arbitrators, proved that the shoals in question were caused by the dredging operations which had been carried out by the Thames Conservators for the improvement of the navigation. At the later enquiry which took place before the Commission on Metropolitan Sewage Discharge, of which Lord Bramwell was Chairman, although much evidence was given as to the polluted state of the river, it was shown that the riverside population was more healthy than those people who lived further away from the river. His own view was that there was no such pollution as to warrant the expense of carrying the sewage down to the sea. He thought the present method best and most economical. The argument that the existing system of throwing the sludge into the sea was a waste of valuable material, reminded him of the case of the copper slag at Swansea, which, containing a large per centage of iron, an attempt was made some years since to reduce the iron, but the expense of doing so was found to be greater than obtaining the metal in the usual way from the ore. No doubt sewage sludge

contained fertilizing properties, but in most cases it cost more than it was worth to make use of it.

Sir ROBERT RAWLINSON reminded the meeting that he had held an enquiry, the result of which showed that the banks of the Thames were much mudded up by the discharge of the settling tanks.

Lieut.-Col. JONES (Carshalton) referred to two papers similar to Mr. Santo Crimp's, which had been read at the Institution of Civil Engineers. He contrasted the two and found one practical and the other theoretical. He did not think the Thames was by any means pure, and he agreed with the Medical Officer of Health for the Port of London in the opinion expressed in his report of October last. He attributed the recent improvement greatly to the more general use of destructors and to the pumping mills. He thought the statement that the transport of sludge cost 4d. per ton was rather startling. He would have liked to have had more information regarding the overflow.

Major LAMOROCK FLOWER (London) referred to the abuse of storm overflows into the Thames and Lee. On one occasion he had seen the storm outlet into the Lee at Old Ford turn the head of a barge, and he had known the water raised as much as six inches by the outflow of sewage during a storm. He thought the outlet might be carried elsewhere, or the sewage treated chemically. The London County Council had looked into this matter but had never done anything, although he had been informed that for eight days last year the sewage had been treated chemically, but the river was worse instead of better after the treatment. There was at the present time an epidemic of small-pox raging, which he attributed entirely to the conditions produced by abuse of the storm-outlet. He considered it a great pity that the pumping machinery at Abbey Mills had been allowed to get out of order. The whole subject required time for experiment, but he did not think the best way of overcoming the difficulty was to take the sludge out to sea; if at another place which he might name they took their sludge out to sea, they would wish they had never been born.

Mr. R. W. PEREGRINE BIRCH, M.Inst.C.E. (London), said he was pleased to hear that there was an improvement in the state of the river. He had assisted the Corporation in proving the bad state of the river, in consequence of which the new works had been erected. With regard to Mr. Crimp's belief that a hot summer and a small flow of upland water would demonstrate the efficiency or otherwise of the present system of sewage disposal, he had had occasion to ascertain the fact that if the sewage were taken twenty miles farther down, it would do more good in the way of dilution than if the flow over Teddington Weir were increased six or seven times. Referring to the chemical treatment of sewage, he said chemists should study

what was the particular condition of sewage that made it yield to chemical treatment. It was clearly shown, by the experiments made by Mr. Dibdin, that there was more difference between the effect of the same treatment on two different samples of sewage, than there was between the effects of the mildest and the strongest treatments of any given sample.

Dr. G. V. POORE (London) said he thought they were coming to some solution of the matter now that people were beginning to see that the purification of the river was a biological and not an engineering question. Referring to the state of the Thames, he said that at the time of the building of the new London Bridge the old water-works were in existence, and up to the beginning of the century the Thames was pure enough at London Bridge for the water to be distributed to the inhabitants. He had no doubt that the impurity of the Thames was due to the great increase in population and to the fatal invention of water-closets. It was very important that villages should not be allowed to copy London. He said that the nitrogenous matter in the sewers was worthless, as nobody knew what town sewage was composed of, and it could not be depended upon. One of the first things to be done was to make large manufacturers dispose of their own waste products. He had no doubt that excremental matters were of great use if taken in their dry state, and if this could be done it would greatly assist the crops and give work to the unemployed.

Mr. A. F. ANDRESEN (Hampstead) advocated the system of drainage devised by Dr. A. Carpenter as opposed to the present London system. He thought the proper way was to give the sewage to the land, and said it should be distributed in different directions over the country. Personally he thought the state of things at Barking was intolerable, and thought that the example of Berlin should be taken, and Dr. Carpenter's system looked into.

Mr. ROGERS FIELD, M.Inst.C.E. (London), welcomed the fact that the County Council and the District Boards of Works were changing the present defective sewers into self-cleansing ones, which he regarded as a great reform. There were undoubtedly a large number of bad sewers in London. There was one point in the paper he thought rather misleading: it was the statement that the present precipitation works were the outcome of the inquiry of the Royal Commission. This might be taken to mean that in carrying out these works the County Council were carrying out the recommendations of the Commission, whereas this was not quite true. The Commission recommended this step as a preliminary means only, and went on to say that the liquid was not sufficiently free to be permanently discharged into the river, and should be further treated and sent on the land. They considered there was sufficient land for the purpose north of the river, but not on the south, so that the liquid must either be carried over to the north or else out to sea. The Commission distinctly said that it was only a preliminary means,

and that as a permanent measure it must be taken to the land. He thought Mr. Santo Crimp could not have meant to convey this rather misleading impression, as his subsequent remarks led one to believe that he regarded land treatment as the ultimate means of the solution of the problem. With reference to Mr. Crimp's observations about microbes, he thought that glaring pollution no doubt came more from sedimentary matter than from that in solution, but all the best authorities, both in England and abroad, agreed that chemical treatment could not be compared with land treatment as regards the removal of matters in solution. The circumstances mentioned by Mr. Crimp, as to the low level sewer on the north side always remaining surcharged on account of the pumping machinery having fallen into disrepair, was a remarkable one, and had no doubt tended to cause the storm-overflows frequently to come into action.

Mr. G. WESTON (Surveyor to the Vestry of Paddington) stated that he quite endorsed what Mr. Santo Crimp said with respect to the necessity of parishes systematically repairing the invert of old sewers and improving their gradients. Some sewers in Paddington had been down for many years, consequently their invert in places were sunk which caused elongated cesspools to be formed, and the sewage was unable to freely flow away, and when this occurred near ventilating shafts, caused unpleasant smells to be experienced in the streets, especially during hot and dry weather. He was instructed to examine the sewers, and report to his Vestry in March, 1890, on this matter, and since that date they had been repairing and improving the defective sewers in the parish with beneficial results at an expenditure of £5,000 per annum, and this was to continue annually until the sewers needing repair were completed.

Mr. RUODES (Past Chairman of Main Drainage Committee, L.C.C.) believed that the treatment and disposal of sewage must depend on the conditions under which it is produced. He referred to Mr. Baldwin Latham's differentiated treatment. Mr. Latham had carried out the agricultural treatment, and was regarded as its apostle; but in places where that system was inapplicable he got rid of it in the cheapest way. He instanced Margate, where the sewage was carried into the sea, this system having been designed by Mr. Latham. Referring to London sewage, he said that on the advent of the County Council, he was elected Chairman of its first Main Drainage Committee, and with the assistance of the committee had had to deal with the problem in different stages. They had to take up the works at Crossness and Barking in a very imperfect state, and deemed it advisable in improving Barking to stay their hands at Crossness, in order to see the result of the experiment at the former works, for it was unlikely they would prove to be designed (from want of working experience) on the best lines. They found out, *inter alia*, that the *intermittent* system of dealing with the sewage was a mistake and led to much expense and trouble; and the result of the experiment at Barking was that the *continuous* system was substituted and

had proved a marked success. With regard to the condition of the river, he said that in the time of the Metropolitan Board of Works raw sewage was always being emitted, and, in consequence, made the river one huge precipitation tank. Therefore, although the sludge was now withdrawn, this evil work would require considerable time to be made good. The condition of the river was for a time made worse by the alterations, but now one had only to go and see, to be assured of the immense improvement in the river. Everyone was of opinion that the success of the present system had been proved. He thought that the Royal Commission's recommendation of the existing system as a "*temporary measure*" did not prove that it might not succeed as a permanent one. He asked whether anyone could reasonably doubt that the improvement on the north, would be followed on the south, and he thought that the system would bear us out for years to come. Yet he believed in progress, and would not say that he might not in future be induced to review his opinion, although at present he thought we had a system on which we could depend.

Mr. LEWIS ANGELL (Borough Engineer, West Ham) referred to the advisability of the sewage arrangements of greater London, the most populous part of which he represented, being taken over by the London County Council. With regard to the sewage overflows in the Lee, he could not see that the inactivity of the pumping machinery at Abbey Mills had any bearing on the question, as they only served to raise the sewage from the low level, and had no connection with the high level overflows.

Sir ROBERT RAWLINSON (Chairman) said that there could be no greater question for Londoners than that of sewage disposal. There was no doubt that the lower reaches of the Thames were polluted, and that in times of rain the upper reaches were also much polluted by the outfalls. A great deal had been said about the origin and construction of the London sewers and their defects; but it must be borne in mind that the population had greatly increased from that time, and that engineers had had nothing to guide them by way of experiments in providing for rainfall from so large an area. Standing at the beginning of the Sanitary movement, he had had to learn everything for himself, and had found that to provide adequately for rain, one would have to make the sewers very much larger than was necessary to carry away the excreta. He believed that Mr. Hugh Mackay, under his direction as Chief Engineer, had carried out the first system of self-cleansing sewers in Carlisle, where all sewage was removed from the city within twelve hours. To have done this for London would have been a miracle, as there were no experiments on smaller scales to serve as guides. He said the Fleet Ditch ought never to have been covered and made a sewer, as it drained an area of about 4,000 acres, and in dealing with a corresponding area, he had found the flow vary from 300,000 to 90,000,000 gallons a day. This would explain the enormous volume of water

that had to be provided for in the Fleet Ditch, in addition to the sewage let into it on both sides. This was a question which was considered now, but was not thought of years ago. Regarding the difficulties of dealing with rainfall he instanced India, where twelve inches of rain had been known to fall in twenty-four hours, and pointed to the enormous volumes which at times fell in Australia. How could such great volumes of water be dealt with in sewers? With regard to India, he would prefer to confine himself to dealing with the waste water from houses. Turning to the question of sewage, he said it contained all the ingredients from a large population, and was undoubtedly rich in manurial character. All chemicals that were used, in his opinion, polluted the sewage, and clarified sewage became stinking in spite of the clarification. Mr. Crimp had indicated that the sewage must eventually go to the land, and therefore he thought it a great pity so much money was to be wasted on the costly barges now in construction. He said that at the mouth of the Thames there was a splendid area of sand over which, if turned by conduits, the sewage might be allowed to run. Contracts might be made with farmers to take sewage for irrigation purposes, and he thought that if it could be obtained, farmers would pay a good price for it. In his opinion statesmen had made a great mistake when they took the dues off coal and wine, as coal had not been made any cheaper, and poor people had not consumed wine, and the dues might now have paid for the necessary outfall sewage works.

Mr. SANTO CRIMP (London County Council) said, in reply to the discussion, that his task was a light one, because Mr. Rhodes had answered many of the questions. With regard to the storm-overflows at Old Ford, these were placed upon a navigable canal, with a very slight current, and the effect was to convert the canal into a settling tank when the overflows were in operation. The arrangement was therefore not a good one. Of course the pumping down at Abbey Mills only affected the storm-overflows on the low level system, and not those at Old Ford. With regard to Col. Jones's remarks, they had experienced some trouble in pumping sludge through mains, some 900 feet in length, and he thought it would be rather risky to attempt to pump it as far as Canvey. One speaker had referred to the Berlin farms, no doubt these were interesting, but so far from sewage farming being played out in this country, we had at Birmingham the sewage of 600,000 persons applied to the land; at Nottingham, 213,000; at Leicester, 180,000; and nearer home, about 80,000 at Beddington, and 30,000 at Wimbledon, and sewage farms in this country were constantly being extended. With regard to London, the question was a very large one, but they had in Essex land that was unmanured and uncultivated, they had sewage that was unutilized, they had labour that was unemployed, and if the liquid and the labour could be employed upon the land without placing a burden upon the shoulders of the ratepayers, he thought it was a consummation devoutly to be wished.

LECTURES ON THE SANITATION OF INDUSTRIES AND OCCUPATIONS.

OCCUPATION AND MORTALITY.

By ARTHUR NEWSHOLME, M.D.Lond., M.R.C.P., D.P.H.

Medical Officer of Health, Brighton.

READ NOVEMBER 2ND, 1893.

THE lecture which I have the honour to give is introductory to a course of six lectures, to be given by various specialists, which, although they cannot, of course, cover the whole range of the sanitation of industries and occupations, will, it is hoped, give a practical insight into some of the more important problems connected with this subject.

The importance of the subject.—A moment's reflection will show the enormous influence of a man's occupation on his health. At least one-third of each working day is spent under the conditions implied in this occupation, and it may therefore be credited with this proportion of the total influence exerted by the circumstances of life on health. The influence exerted by occupation is however much greater than this. Conditions of overcrowding are more deleterious during active work than when lying quietly in bed. Overcrowding implies an atmosphere loaded with the products of respiration, which are when re-breathed a fertile source of disease. Dr. E. Smith found that if the air inspired lying down be represented by unity, the amount inspired when standing erect is 1.33; when on a treadmill, lifting 196 lbs. through 1920 ft. per hour, 4.40; and when walking four miles an hour, 5. Not only is more air inspired during active work, but there is a corresponding increase in the amount of carbonic acid eliminated by the lungs. Thus during rest 13.11 grains of CO₂ are expired per minute; on a treadmill, under the conditions named above, 57.68 grains per minute. If, as in ill-ventilated warehouses and shops, the carbonic acid resulting from respiration is not quickly got rid of, the substance of the muscles becomes loaded with carbonic acid and their activity diminished. For this reason, if for no other, it would be economical for large employers of labour to provide an abundant supply of fresh air for their workpeople.

Conditions of overcrowding in insanitary factories and workshops are aided by the effects of inhalation of dust and