the engines would be filled, and the scouring process would cease. Under such circumstances, it would, perhaps, be more desirable to construct a large reservoir, to receive the sluicing water, and, if steam power is considered desirable, that it should be auxiliary and pump out into the Thames at high-water, the more solid deposit from the catch-pools. The idea, "that the increase in the size of a sewer compensates for a loss of fall," sounds somewhat novel, and seems to require some explanation.

The Paper is accompanied by plans illustrative of the views of the Author.

Mr. RENDEL,—President,—directed attention to the peculiar recommendations of the Paper,—the separation of the surface drainage from the sewage, the employment of great flushing power derived from a point high up the Thames, and the use of alternate reservoirs for the sewage at a point low down on the shore of the river; these were important features when viewed in connection with the sewerage of the Metropolis, and demanded the best attention of the profession.

Mr. C. FOWLER said, that the system designed by Mr. Lindley, (M. Inst. C.E.,) for the sewerage of Hamburg, embraced the principal points of the plan described in the Paper. The most striking feature in the Hamburg system was the power of constantly flushing the sewers, and they were thus kept so clean, that it was rarely necessary to send any men into them, except for the purpose of making repairs. There was a syphon sewer passing under the canal, which was kept clean by flushing, with as much apparent facility as the sewers with a regular fall. Whether such a system was applicable to the Southwark district, must be carefully considered.

Mr. BIDDER, V.P., looked upon the professional labours of Mr. Lindley at Hamburg, with feelings of national pride; the works executed there under his direction, since the period of the great fire in that city, were excellently designed and carried out, and among them the system of sewerage was pre-eminently efficient and successful; and this success was the better appreciated, when compared with the former state of sewerage of the city, which was as bad as could be conceived.

Mr. C. Manby,—Secretary,—said he had recently been in correspondence with Mr. W. Lindley on the subject of the sewerage of Hamburg, and was enabled to give some particulars of the main features of the system.

The forms and dimensions of the sewers varied with their inclinations, and also with the quantities of sewage which they were designed to carry off. The steep sewers were cylindrical, from 15 inches to 24 inches in diameter. The fall of these tubular sewers varied from 1 in 15 to 1 in 150; no sewer of this class was flatter than 1 in 150, and about four, or five miles of such sewers had been constructed. For long main lines, where such rapid falls could not be obtained, oval sewers of larger dimensions were built, sufficiently large for men to pass through; being 4 feet 6 inches high, and 2 feet 3 inches wide. This class of sewers was not made with less inclination than 1 in 500 in the upland districts of the city, where the quantity of water to be obtained for flushing, was dependent upon the waterworks. In the marsh districts, however, where the water for flushing was obtained from the River Alster, sewers of this description were built as flat as 1 in 3,000. The marsh levels would not allow of greater fall, and the water power, derived from the River Alster, rendered the adoption of such flat sewers quite unobjectionable. Each house had its drain pipe discharging directly, (without any cesspool, or other place for accumulation,) into the sewers. Where there was fall enough, a cast-iron pipe of about 6 inches diameter was carried directly into the brick arm, or eye, built in the sewer to receive it; but where there was less fall, the brick drains of 12 inches, or 15 inches diameter received the soil pipes within the house, and then discharged the contents into the main sewer.

The larger classes of sewers followed each other in succession, as the number of smaller sewers were united and the quantity of water to be carried off, increased; the largest sewer used was 5 feet wide and 6 feet high; and during heavy storms of rain, the quantities of water delivered into it from all its branches, were so great, that upon two, or three occasions it had been filled almost to the soffit.

The whole of the upland sewers were so laid out as to act as catch-water drains, and thus to separate the upland waters from the marsh sewers. The necessity for this arrangement arose from the water in the Elbe remaining, at times, for twenty-four to thirty-six hours, above the cellars of the houses.

The whole of the sewers built for Hamburg, whether for the marsh, or for the upland districts, were so laid out, that the upper ends were connected either with the River Alster, which afforded a head of 13 feet of water, or with the canals which intersected the city, or with other higher-lying sewers; the latter forming reservoirs, supplied from the waterworks. In this manner there were not any dead ends, and all the sewers were thoroughly flushed from one end to the other. This arrangement had involved additional outlay for extra lengths of sewer, to form the connections with the water-heads, and for penstocks, and flushing-gates, to turn the stream in the direction required through the sewers; but the general result of this thorough system of flushing was most economical in working, and it was proved, that the cheapest means for getting rid of the matters discharged into the sewers, was to dilute them with large quantities of water, and then to flush them away.

It was intended, that there should be only two outlets for the sewage of Hamburg; the one for the upland waters, and the other for the lowland: both these outlets would discharge the sewage waters into the main stream of the River Elbe, at a point below the city and the harbour. This point was so selected, that steam engines might be placed to pump the sewage water over the lands of the adjoining district, when such a proceeding should be deemed advisable.

The main object of the system was to prevent all accumulations of filth within the sewers, keeping them clean, by repeated flushing from a head of water, and the experience of several years had shown, that this plan was both practicable and economical.

The animal and vegetable refuse being in this manner washed away before decomposition had taken place, poisonous gases were not evolved, and the atmosphere of the sewers, by the aid of a system of ventilation, was kept in an innoxious and healthy state.

It need scarcely be observed, that sewers with flat, or segmental inverts, required much larger quantities of water to scour them clean, than the proper egg-shaped or oval section;

indeed, as a rule, the sharper the invert, the less water was required to clean the sewer.

Mr. Simpson, V.P., corroborated the statement as to the efficiency of the system of sewerage at Hamburg; he had examined it carefully, and observed the extent of the flushing power: a large cast-iron ball put into the sewer dipping under the Alster, on the higher side, was forced out in the opposite direction by the head of water. This power of flushing had been very judiciously applied by the Engineer, Mr. Lindley, as a portion of the city was so situated as not to be susceptible of being drained by self-cleansing sewers. The construction of the sewers was very creditable to Mr. Munday, (Assoc. Inst. C.E.,) the contractor for the work.

He must contend, that for the sewerage of London, a system of catch-water drains was indispensable, and it would be found erroneous to allow the contents of the high-level sewers to run down to the lower levels, whence it would be requisite to pump them, at a vast expense, and at a great risk, during storms, or accidental stoppages of the machinery. The drainage of fen lands by steam power was not analogous, as the fen water-courses were so large as to form reservoirs, whence the pumps, or scoop wheels, lifted the water, in a given, but lengthened period of time; and even then, not so as to avoid such back-flooding as would be incompatible with good town drainage. If a comprehensive system of sewerage was so laid out, as to intercept and to keep up the high-level drainage throughout its course, delivering the sewage, by natural gravitation, at a sufficiently low point down the Thames, and only resorting to pumping power, where indispensable, for the lowest districts, there would not be any insurmountable difficulty in efficiently draining and sewering the Metropolis.

Mr. J. T. Harrison said, his object in expressing an opinion in this Paper, relative to the novelty and the necessity for explanation of the idea promulgated by Mr. Bazalgette in his Report, "that the increase in the size of a sewer compensates for a loss of fall," was to induce the attention of Members to the point. He believed the position might be maintained, to some extent, by examining more carefully the principles of sewerage. The object of sewers was to convey the refuse away from streets and houses to some point whence it could be allowed to fall into a stream, or where it could be used for fertilising purposes. Water was the diluting medium and the motive power, and the object was not fully attained, if any deposit occurred in the course of the sewage matter. In the construction, therefore, of a sewer, one of the chief points was to give to it such a form and inclination, that the ordinary flow of water through it should keep it clear from all deposit. The self-cleansing power of a sewer depending then upon the form, the inclination and the quantity of water passing through it, if the latter remained constant, whilst the size of the sewer was increased, and the inclination was reduced, he must contend, that the efficiency of the sewer would be diminished. This was a point to which he demurred in Mr. Bazalgette's Report, but which he believed to be susceptible of explanation. He would admit, that if a sewer was required occasionally to carry off a large quantity of water, an increase in its sectional area might compensate for the loss of fall;—that was, however, an extraordinary, rather than an ordinary use of sewers; also if the sewer was so situated as to be scoured by a sufficient head of water, which remained constant, then an increase of the sectional area would augment the velocity of the flow, and compensate for a loss of fall. In all ordinary cases of sewers, however, the position assumed in the Report, of the mere increase of size compensating for a loss of fall, did not hold good. Whenever the hydraulic mean depth was reduced, there was a loss of scouring power, and hence the intention in selecting the oval, or egg-shaped section, for large sewers. There might be peculiar circumstances connected with the sewers alluded to in the Report, which not being explained, might have induced erroneous conclusions, but the question viewed broadly, must, Mr. Harrison contended, assume the position he had taken. The object of his remarks was to show, that it was practicable to drain the southern district of the Metropolis with little, or no pumping, by a proper distribution of the sewers, and by the employment of the adequate scouring power of the head water, afforded by the Thames at high-tides, the main sewer discharging into reservoirs for depositing and filtering; so that when the sewage matter had been precipitated, filtered and chemically deodorized, the water would flow into a canal, connected at each end with the river in such a manner as to run off the contents, at the best period of the ebbing tide.

Mr. RENDEL,—President,—would ask the Members to devote their attention chiefly to the questions of sewerage by natural gravitation, or by the artificial means of pumping, taking into consideration the nature of the matter to be conveyed along the sewers, and with reference more particularly to the area to be operated upon in the metropolitan districts. He would invite Mr. McClean to state his views as to the question generally.

Mr. J. R. MCCLEAN said, that as the President had requested the expression of his opinion of the plans proposed in the Paper, for the sewerage of the Kent and Surrey district, and had also intimated, that the discussion need not be confined to that subject only, but might embrace the general question of the sewerage of the Metropolis, he would take advantage of the opportunity to bring the whole subject succinctly before the Meeting. In doing so he would refer to the principal plans and reports which had been partially approved by the Commissioners of Sewers.

The first he should notice was the competition plan submitted by him in 1849, and pronounced by the Commissioners, to be "the best conceived and most practicable scheme submitted to them." The second was Capt. Vetch's plan, (since published by his permission,) which professed to be "the basis upon which the plans ultimately adopted by the Commissioners were founded." The third consisted of the plans and reports published by Mr. Frank Forster, the late eminent Engineer of the Commissioners of Sewers, whose lamented death at a period when he had only just completed the studies of the drainage of the Metropolis, must have been a severe loss to the Commissioners. And the fourth, embraced the published plans and reports of Mr. Bazalgette, their present able Engineer.

The competition scheme, (in 1849,) proposed the construction of works adapted to the existing system of sewers, for the purpose of intercepting the whole of the sewerage of the Metropolis, and discharging it into the River Thames, at a point below Greenwich and Blackwall, about seven miles from London Bridge, during ebb-tide, in such a manner as to prevent its returning to London Bridge, with the next flood-tide. Each sewer was to have sufficient fall to discharge its contents by gravitation, and without the assistance of pumps, or machinery of any description. An outfall sewer was to be provided on each side of the River Thames, of sufficient dimensions to contain the whole of the sewage, during the period intervening between the times of discharge, so as to prevent the water from being arrested in the existing sewers, and reversing the direction of the currents, which he conceived to be one of the greatest evils of the present system.

The main sewer, for the high-level district, commenced at Battle Bridge, King's Cross, and intercepted the River Fleet at that point, leaving its present channel available for carrying the flood water into the Thames, at Blackfriars Bridge, and, in case of accident to, or during the necessary repairs of the new sewer. It passed from Battle Bridge, under the Regent's Canal, and nearly parallel to it as far as the Victoria Park, which it traversed; and thence under the River Lea, falling into the Thames, below Blackwall. The outfall sewer between the River Lea and the Thames, to act as the reservoir sewer referred to, and to be capable of containing the estimated product of the sewers during eight hours.

The second-class sewers to fall into the main sewer, near Battle Bridge, after having intercepted the Ranelagh and King's Scholars' Pond Sewers and the whole of the sewerage of the district north of Piccadilly, Oxford Street and Holborn, and of those bounded on the west by the Edgeware Road, and on the east, by one of the streets parallel to the River Fleet.

Another second-class sewer to fall into the main sewer near the River Lea, having intercepted the Hyde Park Tunnel Sewer, the Regent Street Sewer, and the whole of the sewers north of Charing Cross and the Strand, and also of the City and Tower Hamlet Districts, above the influence of the highest tides.

The main sewer for the low-level district commenced with a junction with the King's Scholars' Pond Sewer, on the Westminster side of the Thames, and passed, by means of a wrought-iron culvert, under the bed of the river, to the Lambeth district, and thence through Kennington Oval and along the black ditch, under the Kent Road, the Surrey Canal, the River Ravensbourne and through Greenwich Park, to the Thames, at a point adjoining the Bugsby Marshes. The last two miles of this sewer to be capable of holding the estimated sewerage flowing into it during the whole time of the flood, and the first and last quarters of the ebb-tide.

A series of second-class sewers intercepted the sewerage on the west side of the King's Scholars' Pond Sewer, as far as the Kensington Canal, on the west, and on the east side, as far as Northumberland Gate, or, if required, as far as Tower Hill, and on the south side of the Thames, between the River Wandle and Kennington Oval.

Both the high and the low-level intercepting sewers, to be supplied with water from the existing sources, or from the Regent's Canal, or from the Thames by means of a conduit from Henley, and to be constructed so as to interfere very little with private property.

The portions of the sewers adjoining the Thames, were intended to form reservoirs of sewage, so constructed as to afford facilities either for pumping it up in a fluid state, or for operating upon it chemically, so that it could be conveyed in a solid state to the agricultural districts.

The plan designed by Captain Vetch, also proposed to discharge the sewage into the Thames, only during the period of ebb-tide, and at a distance of nine miles below London Bridge: this was, however, the only similarity between the designs, as Captain Vetch proposed to effect the object, not by the power of gravitation, but by steam power; in fact, he proposed to pump up the whole of the sewage and of the rain-fall of the Metropolis, (embracing a district of upwards of 50 square miles,) by a lift of 22 feet, and to force it through pipes, passing under the River Lea, into a reservoir sewer, on the east side of that river and terminating at Galleon's Reach, in the River Thames.

The plan proposed by Mr. Frank Forster, comprised portions of the two designs already described.

He adopted for the high level, the interception system, and provided for the discharge into the Thames of the sewerage of that district, by the power of gravitation alone, at Galleon's Reach, during the first three hours of ebb-tide.

For the low-level district, he designed a system of pumping somewhat similar to that proposed by Captain Vetch; the principal difference between the two plans for the north side of the Thames, being, that Captain Vetch proposed to have two pumping stations,—one at Blackfriars Bridge, with a lift of 31 feet, and the other at the River Lea, with a lift of 22 feet; whereas Mr. Forster proposed to continue the fall of the low-level sewer, as far as the River Lea, to a depth of 20 feet below low-water level, and to have one lift of 47 feet.

The plan proposed by Mr. Bazalgette for the north side of the Thames, was nearly similar to that proposed by Mr. Forster. Mr. Bazalgette also proposed an additional high-level sewer for intercepting the whole of the water from the brooks now flowing through London, and for discharging it either into the River Lea, or at some point beyond it. Mr. Forster had proposed to pass this water through the intercepting sewers, and to allow the flood water to escape, as shown in Mr. McClean's design, through the present outlets into the Thames.

After this brief outline of the plans, Mr. McClean thought it would not be difficult to demonstrate, that the system proposed by him was more in accordance with the following instructions of the Commissioners, than any of the other designs.

The resolution promulgated by the Commissioners was:— "That in effecting the drainage of this northern portion of the Metropolis, it is expedient to keep the River Thames, within the metropolitan districts, free from sewage at all times of the tide; to provide an escape, by means of intercepting drains, for so much of the sewage of the north side of the Thames, as admits of being so carried off, and so to construct the intercepting sewers, as to secure the largest amount of effective drainage, without having recourse to artificial means."

It was stated, in the preface to Captain Vetch's Report, (published by Professor Gordon,) that the plans approved of by the Commissioners, were based upon his scheme; but it was impossible to conceive any system more at variance with the above instructions than the scheme he promulgated, as it did not provide effective drainage for a single acre of the district, without having recourse to artificial means; and although a great portion of the district was 40 feet or 50 feet, above the level of high-water, the whole of the sewage of the Metropolis was to flow down to the level of low-water, and then to be pumped up, at considerable expense.

According to Mr. Forster's plan, the sewage matter of a large district would be carried off by gravitation; but in consequence of an alteration of the level of the main outfall, from the level proposed by Mr. McClean, for crossing under the River Lea, nearly the whole of the sewers of the City of London, including the high districts of Smithfield, St. Paul's, and the Bank, were placed on the low-level system, and the rain-fall and sewage matter of a district, 30 feet or 40 feet above high-water, was allowed to flow down to about 20 feet below low-water mark, from which depth it was to be pumped up by a lift of 47 feet.

In the Report of the Commissioners, on the competition plans, Mr. McClean's plan of crossing the Thames, by means of an iron culvert, was considered impracticable; he contended, however, that it was not so, and that an examination of the level would have shown, that there could not be any valid objection to the low-level system, as the fall at Greenwich, at the first quarter of the tide, was generally about between 7 feet and 8 feet below Trinity datum, and the highest level of the surface of the water in the King's Scholars' Pond Sewer would be 5 feet below Trinity datum.

At half-tide the level, at Greenwich, was 12 feet below Trinity datum, giving a fall of 1 foot per mile. At three-quarters' tide, the level was 16 feet below. The outfall sewer was proposed to contain the whole of the sewage matter accumulated during the flood-tide, and until it began to discharge at ebb-tide. There could be little doubt as to the practicability of this proposed south sewer, and if the Thames did not intervene, that system of carrying away from the north to the south side, the sewage matter of the low parts of the former district, would be adopted, and a bent culvert, even though traversing a river, could not form such a serious obstacle, as to prevent its construction. The same remarks applied to the Surrey and Kent district, out of which an outlet, such as he had described, ought first to be provided, for the natural drainage, and if there was any part of the district too low to be drained by it, pumping should only be resorted to for that district, for it would appear to be injudicious to pump up the rain-fall and the sewage matter of twenty square miles, when the sewerage and surface water of only a very small area required to be provided for by artificial means.

Mr. McClean was inclined to advocate the delivery of the sewage matter at a much greater distance down the Thames, or even to avoid that river entirely; but his plans would, he feared, be considered almost chimerical at present; the time would, however, arrive when, if the actual annual extension of building continued, some means must be adopted of disposing of the refuse of the Metropolis, without pouring it into the Thames, not only to the pollution of the stream, but to the serious detriment of all the waterside premises, and the injury of all the towns and villages along its banks.

Mr. HAYWOOD said, the Author of the Paper had accurately described the local peculiarities of the metropolitan district, situated on the southern side of the Thames, and the difficulties under which they laboured, but he did not appear to have suggested effectual means for remedying those evils.

In the Paper it was stated, that the chief requisites for this district were improved land drainage, the conveyance of the sewage from the houses, the discharge of the surface water, and the interception of the high-level water, each of which, in the opinion of the Author, should have separate provision made for it. The questions of improved land drainage and the details of the general district sewerage, he would dismiss for the present, and would confine himself to the main subject of the Paper, which was the means of providing for the interception of the sewage now flowing into the Thames, and generally affording an improved outfall for the sewers of the low-level portion of the district.

He entirely concurred in the propriety of intercepting, as much as possible, the upland waters by a high-level sewer delivering by gravitation; that being disposed of, the question of the treatment of the low-level district remained. A large portion of that district was 3 feet, or 4 feet below Trinity high-water mark, and this very portion was the most closely covered with houses, having basements at all levels, and it was for the improvement of their drainage and of the outfalls of the existing sewers, that some remedial works were needed. The existing area, therefore, with all its fixed conditions must be dealt with, and any scheme which did not improve them, however ingenious it was, and however it obviated difficulties which might attach to other schemes, if it did not answer its particular object and purpose, would be a fruitless work, and metropolitan rate-payers would not be satisfied with having to pay for such a scheme.

One of the first points to be attended to was the relief of the existing sewers, which were now closed, during a large portion of every tide, and which, when closed in times of rain, caused the flooding of the district. Now the invert of the proposed sewer would be, on an average, not more than 14 feet deep, and being 8 feet high, the crown would be only 6 feet below the surface of the ground, in some portions of the line; indeed, there would be scarcely any covering to the sewer, and it would be but little deeper than the existing main sewers of the district, which, therefore, could have no better fall given to them. Mr. Bazalgette and Mr. Haywood had recently estimated the daily discharge of sewage from that district, in dry weather, at about 3,000,000 cubic feet, and as one-half of that quantity was reckoned to be discharged in six hours, it would give about 4,100 cubic feet per minute. Now the sewer, which was only 8 feet in diameter, would, with the small fall assigned to it, only carry off about 3,200 cubic feet per minute, and to do even that would be quite full, and as the sewage would be running at a level far above many of the basements, it would certainly flood all the houses draining directly into the sewer, as well as force back the sewage up those main outfalls which it should be an especial object of such a scheme to relieve.

He did not think, therefore, that the tidal variations could be used for effectually draining the district, as sufficient depth could not be given to the sewer; for, as he had before observed, it was the duty of the Engineer to relieve the district of its existing evils, and it was, therefore, absolutely necessary to design the scheme in relation to the existing conditions of the surface, the houses, the drains, and the sewers. In a new district it might be possible to determine arbitrary levels, and it might be competent for some body, invested with sufficient governing powers, first, to lay the sewers of the district at suitable depths, and then, to dictate the levels of the basements of the premises, so as to enable them to be effectually drained; perhaps such a place as Battersea might be so treated, or any similar comparatively new quarter, but the district under consideration must be taken with all its fixed local features and disadvantages.

He thought it was not possible to give to any sewer, for this district, a sufficient fall, with such an outlet as the tides afforded, to render it self-cleansing; and even supposing that means were attempted to be taken to keep out improper substances, they never could be entirely excluded. A sewer 8 feet in diameter, with a fall of 3 inches per mile, would not give a velocity of more than about $\frac{3}{4}$ths of a mile per hour, which would not be sufficient to render the sewer self-cleansing, and as during the largest portion of the time the sewer would be quite full, and always nearly full, getting into it for cleansing, or repair would be impossible; neither did he think, that a sufficient flushing power could be obtained from the Thames, as even with a head of 15 feet of water, it would occupy four, or five hours to run a body of water through the 10 miles of sewer.

The flaps, or valves alluded to, for keeping the backwater out of the collateral sewers and drains, must be very numerous; self-acting tidal valves could not be depended upon, and the more numerous they were, the greater chances there would be of some becoming inoperative, and when that was the case, those districts, or dwellings, to guard which was the object of placing the valves, would be flooded;—a very slight impediment sufficed to prevent the proper action of hanging valves.

With regard to the question of separating the soil, or sewage water from the rain water, in the district in question, he did not think it was now practicable; and even if the house drainage of the district could be laid out afresh, he thought, that double sets of drains would ultimately lead to disappointment and confusion.

With regard to the question of laying down a separate system of permeable drains, to relieve the land from water, he considered, that brick sewers which would answer for the purpose of conveying away the sewage, would, at the same time, dry the land. Within the City of London there were 50 miles of sewers, most of them permeable and of brick, and they had the effect of reducing the water-level from 8 feet to 16 feet, over the whole area of the City.

Back drainage he did not think could be used advantageously in the Metropolis; there might be certain cases where such a system would be admissible; but he believed, that in the Metropolis generally, the introduction of back drainage, as a rule, would be an error.

With regard to that vexed question, the use of pipes for sewers; he did not object to their employment within certain limits, if they were properly applied and were of adequate capacity. They were well suited for house drains; but he did not think they could be effectively applied to a large extent as main sewers. The Author of the Paper thought they might be used for sewering the district, if improper substances could be kept out of them. Now that hypothetical 'if' would certainly make all the difference, but he did not believe any system that could be adopted, would prevent the intrusion of improper substances, not even if the system included the most inquisitorial inspection by officials;—much might doubtless be done by care, but to prevent the intrusion of improper substances, it would be necessary, that the inlet to every drain should be in perfect order. There were about three hundred thousand houses in the Metropolis, and assuming each to be drained, and each drain to have four inlets into it, there would be one million two hundred thousand inlets, all of which should be perfect; but he thought such a state never would be maintained, and just in proportion to their liability to casualties, would be the chance of introduction into the sewers of extraneous substances, which would involve the necessity of opening the pipe sewers for cleansing, or for examination,—and the cost of this was too well known for it to be necessary to do more than mention it.

There were many localities, both in the Metropolis and in the provinces, where pipe sewers had been laid, and where it was said they, hitherto, had not been stopped; but on the other hand, there were a great number of places where they had signally failed, and as might be seen from recent investigations, in the Metropolis their failures as self-cleansing sewers appeared to be the rule. Still he had no determined objection to the use of pipes for small sewers, and he was by no means fond of Procrustean rules upon the subject. He had laid down many pipe sewers in certain localities, and was still continuing to use them; but he believed, that for the Metropolis, until the casualties to which all sewers were subjected, could be removed, brick sewers large enough for men to enter, were the only main conduits that could be depended upon, and that they would eventually be found to be cheaper than any small pipes. In a system necessarily so complicated as the sewers and drains of a large city, everything should be done to simplify the general plan as much as possible, and he conceived that, generally speaking, one set of sewers and drains to carry off the sewage and storm waters, and, if possible, at the same time to drain the land, would be the best and most effective.

Mr. J. W. BAZALGETTE said, that there were many points of Mr. Harrison's plan with which he could not accord. One of the most prominent was the main sewer on the south side, which would constantly be found, during rainy seasons, to be so full as to back the waters up the collateral drains and to flood the basements, exactly in the same manner as now occurred during periods of high-tide. This sewer appeared to be designed with a depth of 2 feet 6 inches below datum at Battersea, and 5 feet 6 inches, at Greenwich; and to have a fall of only 3 feet in a distance of $9\frac{3}{4}$ miles, which he considered insufficient, especially as it would not admit of any fall for the cross drains into the main sewer. The maximum velocity due to its fall, would not exceed 67 feet per minute, or three quarters of a mile per hour; which, in a reservoir sewer, was not sufficient for scouring away deposit. It was found, that the Victoria-street sewer through which the sewage matter travelled at the rate of 2 miles per hour, required to be cleansed by manual labour, because it also was a tide-locked, or reservoir sewer. The discharge of the proposed sewer, when full, would be about 3,300 cubic feet per minute; now the present maximum flow of sewage matter in that district was about 2,000 cubic feet per minute, the sewer would, therefore, be two-thirds filled, and in addition, would be required to convey away the rain from the roofs and yards, which would more than fill it, even if its outlet were free at all times; and during storms the house drains would be choked, so that the basements would be flooded.

The proposed flushing power from the river would be found to be insufficient, as the velocity to be attained by flushing from high-water would vary with the head due to spring and neap-tides, from a mile and a quarter to a mile and three-quarters per hour. Now this would hardly keep a sewer clean even if constantly maintained, as it would not remove heavy accumulations of deposit; and this sewer would become an "elongated cesspool, or settling reservoir," as it would be closed by the tide during, at least, six hours each day.

Pumping must be resorted to for overcoming these difficulties, and if an artificial outfall must be provided, and it should, as had been suggested, at any time accidentally fail, the houses would still be no more subjected to floods than at present, and they would then be better protected by the addition of catch-water sewers than they now were.

If the sewage were discharged at low-water, at Greenwich Marshes, it would flow with the next flood up beyond Vauxhall Bridge, and would probably not get below London Bridge for a fortnight. This was demonstrated by the experiments on this subject made under the directions of the late Mr. Frank Forster.

On the 15th July a float was put into the centre of the river, opposite Barking Creek, two hours after high-water. At low-water it reached $11\frac{3}{4}$ miles below that point, and returned with the next flood-tide to 1 mile above it, having gone $11\frac{3}{4}$ miles that flood, it being then spring-tides. As the neaps came on, the float continued to work lower down at each succeeding high-water, and by the 24th July it was 13 miles below Barking Creek, at high-water, having gone down the river 14 miles during the falling off of spring-tides to neap-tides. As the floods again became stronger, it worked up the river, each succeeding tide, until the 29th July, when it again came to within 5 miles below Barking Creek at high-water, having worked up the river 9 miles from high-water neap-tides to high-water spring-tides; the excess of the ebbs over the floods being only 5 miles in fourteen days.

Another experiment was tried, at the same place, on the 6th August 1851, it being then lowest neaps, and the float being put down two hours after high-water, it worked up at each succeeding high-water till the top springs, on the 12th August, when it reached $6\frac{1}{4}$ miles above Barking Creek, at high-water. This result would have been the same as the last, assuming the float to have been put in at high-water. It then again worked down the river till the 20th August, being neaps, when at high-water it reached $9\frac{1}{2}$ miles below Barking Creek; being a distance of 16 miles during the falling of spring-tides to neap-tides. The excess of the ebbs over the floods would, in this case, have been about 7 miles in fourteen days.

The wind and other causes would vary the result; but it might be roughly assumed, that matter in suspension worked up the river about 1 mile a day as the spring-tides strengthened, and down the river 2 miles a day as they fell off.

Mr. PHILLIPS explained, that the bottom of the float was at a depth of 6 feet, whilst the top was only a few inches above the surface of the water.

Mr. SIMPSON, V.P., said, he did not think, that the result of these experiments could be implicitly received, as there were so many impediments to be considered in a crowded river like the Thames. He had tried experiments which gave very opposite results, but he hesitated to rely upon them.

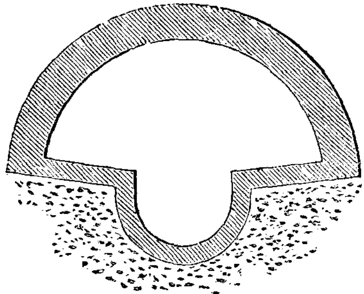
The separation of the house sewerage from the surface drainage would involve the construction of two entirely new sets of sewers for the whole of the Metropolis, and the re-construction of all the house drains falling into them;—this in itself would be found to be an enormous work, and when completed, three sets of sewers would have to be kept cleansed and repaired instead of one set. This could not be considered an economical system of drainage.

It had been so often asserted, that "pipe sewers were self-cleansing," and that large brick sewers accumulated deposit, that it was almost received as an axiom. Now this assertion was contrary to theory as well as fact. In properly-constructed oval, or egg-shaped sewers, the hydraulic mean depth was the same in the pipes as in the small sewers, for the ordinary flow of sewage, with the advantage, that in floods the sewer could convey away the surplus water, and the pipe drain could not do so. The sewers accumulated deposit almost only in the low and tide-locked districts where they were not large enough, whereas in the upper districts, some of them were, comparatively, very large, but having good falls, and they were always clean.

The alleged advantage of the smooth interior of the pipes was illusory, as their joints were more liable to occasional stoppages, than the joints of the brickwork; the interior of the latter did, however, practically, soon become covered with a slimy matter, and deposits rarely occurred, except where the sewers were too flat, too small, or insufficiently supplied with water.

He had known sewers succeed very well, which were constructed with sunk channels in the bottom to convey the normal flow of sewage, the upper part being capacious enough for carrying off the flood water, as shown in the section, Fig. 1.

Fig. 1.



As to the question of cost, it could be shown, that the statements of the comparative expense of the metropolitan and of the country drainage works, as published by authority, must be received with caution; the cases were not analogous, from the impossibility of comparing the ducts, made to convey sewage one mile, with those intended to convey the cumulative proceeds of many miles of dwellings. The mere difference of the cost of labour, between London and the country, would preclude comparison as to the expense of works; and the local difficulties of the earthwork, paving, &c., in large cities, must be taken into consideration. Besides which, the pipes could not, in cases of accidental stoppage, be so easily, or so cheaply examined and cleansed as the brick sewers, which were capable of admitting men to go up them; thus it was a safer system to construct large main sewers of brick and to restrict the use of pipes to branch and house drains.

Mr. HAWKSLEY stated, that he agreed so entirely with what had fallen from the previous speakers, as to the Paper, and on the subject of metropolitan drainage, that he had really little to add; but he nevertheless wished to draw attention to certain misstatements promulgated in recent blue-books, professing to have the sanction of Government authority, with respect to the comparatively excessive cost of the drainage works executed by the Metropolitan Commissioners. Comparisons were sought to be instituted where, in fact, no standard of comparison existed. In the five diminutive towns drained under the Public Health Act, the sewage in general, had not more than about a quarter of a mile to travel before it was out of the town; whilst in London, the sewage had travelled, in many cases, several miles through gradually-enlarging sewers, till at length, an enormous magnitude and a proportionate cost resulted. Besides this, in the country, pipe drains could be laid at little more than the cost of taking up and relaying the pavement in London. Then again, in the Metropolis the sewers had to be made at considerable depths, to drain deep cellars; very commonly the ground had to be strutted with timber throughout and at great expense; existing sewers, water-pipes and gas-pipes had to be stayed, propped, and suspended; buildings had to be shored up and many other costly precautions to be taken, not the least of which was that security of strength, the employment of which was necessary to prevent failure and consequent injury, by flooding and otherwise, to extensive districts. In some provincial towns many miles of brick sewer, 24 inches in diameter, had been laid down at the same, or even a less cost than a pot-pipe of only 12 inches diameter, say at from two shillings and sixpence to three shillings per foot lineal, and yet the same diameter of sewer would unavoidably cost three, four, or even five times as much in the Metropolis. The comparison was altogether unfair and delusive, and led to unsound inferences and impossible conclusions in favour of the Board of Health system of drainage. He had found, as a matter of theory, abundantly confirmed by the large experience of himself and others, that under similar circumstances, the cost of drainage per head of the number of population draining to one common outfall, varied nearly as the cube root of that number. For instance, if the drainage of a small town of ten thousand inhabitants having one main outfall, should cost ten shillings per head, then the drainage of a similarly-circumstanced town of eighty thousand inhabitants, having one main outfall, would cost twenty shillings per head,—the extra-mural part of the outfall being, in each case, separately considered. This gave the inferential cost of draining a town, (calling the population p), $= \frac{p^{\frac{4}{3}}}{43}$: and hence, if the north side of the Metropolis, containing a million and a half of people, were to be drained afresh to one common outfall, the inferential cost would be very nearly £4,000,000, exclusive of the extra cost of deep tunnelling for the intercepting sewer, and of outlying works. In those cases in which there were several outfalls, the expense would be proportionately smaller, and in such cases the inferential cost would be obtained by making separate calculations for each outfall, and then adding the whole together. Researches of this kind were invaluable, because they not only exposed and corrected the erroneous statements made in blue-books, but they afforded to the profession and to local authorities, the means of arriving at a fair anticipation of cost, before any surveys, drawings, or detailed estimates were entered upon; although, as all towns differed, in some degree, in their local circumstances, these could not be dispensed with after the execution of the work had been once resolved upon. A thoroughly-practised eye would, however, be able to detect differences for which the equally well-practised mind might make allowances, approximating very closely to ultimate facts. The cost of the drainage now spoken of, was the cost of that portion of the entire drainage which was usually undertaken by public authorities, and was exclusive of the cost of the so-called house drainage, the cost of which was generally defrayed by the owners of property.

Mr. Apsley Pellatt, M.P., said that, as an old inhabitant of the southern side of the Thames, he was well acquainted with the state of the sewerage, and of the general drainage of the district, and as one of the representatives of the Borough of Southwark, he was deeply interested in the proposed steps for ameliorating the condition of the valuable properties situated there. The plans brought forward by the Commissioners of Sewers had not apparently been sufficiently considered, and the expense was very great. How did they propose to deal with the outlet from the sewers to the river? The banks had been raised to protect the adjoining land from being flooded, and probably, as in the cases of the Po, the Adda, the Rhone, the Mississippi, and many other rivers, the alluvial matter brought down had raised the bed, so that parts of the adjoining district were almost below low-water mark. Any unforeseen accident, or want of attention to the trap-valves, or any stoppage of the pumping power, would cause the most serious casualties. In Lambeth, a great amelioration in the state of the ground had been produced, by the construction of many deep and large brick sewers. The land had been drained to such an extent, that as an instance, a well at Messrs. Maudslay's factory, in which, though only 18 feet deep, there had always been an abundant supply of water, was now perfectly dried up.

Mr. HAYWOOD remarked, that this statement of the comparative dryness of the soil of that portion of the Lambeth district, would show to some extent, the use of brick sewers as land drains; it certainly showed, that the ground was not sewage-logged in that part of the Metropolis, as had been recently stated.

Captain W. S. MOORSOM was of opinion, that the great desideratum was to extend the main sewers to spots so low down on both sides of the Thames, that gravitation should constantly deliver their contents down to the point of discharge. He believed that it would be necessary to extend them to full 10 miles below Greenwich, and if it were necessary to have tidal flap-valves at the outlets, they could be constructed so as to be almost unfailing in their action; he had many such valves under his control, and with only ordinary attention, there had never been any instance of their inefficiency.

Mr. HAYWOOD explained, that what he had intended to convey was, that the constant efficiency of a number of small valves could not be depended upon, and if not, those drains and sewers dependent upon them, would be filled with water, whenever they were inoperative, and the main sewer was either running full of sewage, or was being flushed. He did not mean to assert, that it was physically impossible to keep large tidal valves in generally good working condition, for there were metropolitan districts to some extent dependent upon such valves; but they required constant, indeed daily attention, and there were but few of them. A large quantity of valves could not be so attended to; their number and situation would preclude it; indeed, according to the plan under discussion, it would be almost impossible ever to get to the valves hanging in the large sewer, and if pipe sewers only were laid down for the district, no valves could be applied, at the outlets of the drains into them, and a whole line of sewer and drains might be flooded, by the inoperativeness of one valve, hanging out of the way of inspection, in the main sewer.

Mr. J. T. HARRISON explained, that he never contemplated putting valves to each house; they were only intended for the end of each cross drain which collected the sewage from the houses, and conveyed it into the main sewer. As to the depth of the main sewer, he had taken the map and section furnished by the Commissioners, and assuming them to be correct, he had worked from them. It was for the sake of argument, that he had assumed the area of the south district to be entirely free from houses; he did propose to use all those of the present sewers which were suitable for his design, and most of the others could be used for conveying away storm waters, which, if permitted to enter the main sewer would, in case of pumping being obligatory, occasion great expense and trouble, as the heaviest duty would have to be performed at sudden and irregular periods when the machinery might possibly not be prepared for it. It must be observed, that the current in the Victoria sewer was arrested at every tide, and during that period the deposit took place which required to be removed by manual labour; with a constant uninterrupted flow no deposit would occur.

Mr. Harrison had, in his plan, considered, that the time might come when the sewage matter would be advantageously employed either in a liquid form, for irrigation, or in a solid form for transportable manure; in the latter case, after the process of deodorizing, the fluid would easily pass over into the river at all times, unobjectionably. He agreed, that it was generally only the small sewers, in low ground, with insufficient fall, that did actually become stopped. He only proposed the use of pipe drains in situations where a rapid fall could be given, and for all the rest of the system he intended the sewers to be sufficiently large to enable men to go up them.

Mr. C. MAY would assume, that not more than 4,000,000 cubic feet of sewage per day, required to be lifted a height of 30 feet in the south district; this quantity of pumping could be performed by 200 H. P., which working twenty hours per day would not cost more than £4,500 per annum. Why then should such an extra expense be incurred for a system of gravitation? He believed the time would come, when the sewage matter would be advantageously employed for agricultural purposes; although he admitted, that hitherto, with very few exceptions,

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all attempts to employ it advantageously had proved commercially unsuccessful.

Mr. Vignoles contended, that this assumption of the quantity to be pumped and of the power required, was not exact. The result of the rain-fall, (which was enormous,) from an area entirely covered by non-absorbent roofs, or pavements had not been taken into consideration. Now it was of vital importance to consider and provide for the irregular as well as the regular flow; and also as to the point of discharge down the river, which, though it might be arbitrarily determined by legislative enactment, should not be so placed as to become prejudicial to the estates, or town property adjoining. It was incumbent on the authorities to show how they would dispose of the products of the sewers, so as, whilst providing for the wants of the Metropolis, not to prejudice the towns lower down the river.

Mr. Simpson, V.P., referred to Mr. Bazalgette's Report, to show that he provided a force of 2,500 H. P. for raising the sewage matter a height of 30 feet. He questioned the accuracy of the statement of 4,000,000 cubic feet of sewage matter and the cost of only £4,500 for lifting it. On the contrary, he believed it would be found necessary to employ a very much greater power, and from long experience he felt authorised in stating, that in order to achieve regularity in lifting even a smaller quantity of fluid matter, it would be necessary to have duplicate engines to insure constant working, and even then, occasional stoppages for three, or four hours could not be prevented. The consequences of arresting the flow of sewage under a pumping system, might be very serious in the absence of reservoirs.

Mr. Bazalgette explained, that he did not intend to pump all the storm waters, and the sewers would be so arranged, that even if all the pumping power should be stopped accidentally, which could scarcely be anticipated, the ancient outlets would be available, to preserve the houses from injury by flooding, and the lower districts would be thus relieved from inundation by the influx of their storm waters, which now overgorge the tide-locked sewers at high-water. The upper parts of the district would be drained by the catch-water sewer.

Mr. Rendel,—President,—would have desired to observe more harmonious views, on a subject which really scarcely admitted of such discrepancy of opinion. It was not difficult to ascertain the quantity of sewage matter and rain-fall to be provided for in the low district, and the upper district could, it was admitted, be drained by catch-water sewers, which would act by gravitation. These points being established, it would be easy to calculate the power required for pumping up the sewage, whether combined with the storm waters, or not, as might be decided upon, and then it was merely a question of cost, what amount of engine power should be provided, and whether the whole of the low-district storm waters should be allowed to pass into the low sewers and be pumped up, or be directed off the surface into the Thames. The chief element in any system was simplicity, and the next was to obtain the object at the least cost. There could not be any doubt of the most efficient system, consisting of large main sewers, capable of admitting men for the purposes of inspection and repair, being ultimately the cheapest; gravitation should be used where the locality permitted it, and the quantity of pumping be reduced to the least possible amount.

Mr. J. T. Harrison said his object in writing the Paper had been to invite discussion, and it was his duty to place the subject before the Meeting, in as practical a form, and as clear a light as he could; his desire had been to elicit facts and practical opinions, and he was open to conviction upon any points wherein it could be shown, that he was in error. There appeared to be but one opinion, and that decidedly in favour of the high-level intercepting sewer. The real difficulty then was the low-level district. Was a natural system practicable, and if not, what were the difficulties of the artificial system and how must they be met?

According to Mr. Bazalgette's large plan, the level of the natural surface of this district, appeared generally to vary from 6 feet to 12 feet above Ordnance datum. The first question then was the quantity of sewage and rain-fall to be provided for. In the Paper the sewage matter only, was proposed to be disposed of by the system suggested; this was objected to, and the size of the proposed sewer was shown to be inadequate for the duty, which it was contended, that it must perform, but for which it had never been intended, viz., the conveyance of the combined sewage and rain-fall.

It became necessary then to meet the case as so altered. The advocates of deodorizing the sewage matter would, however, ask for the sewage as little diluted as possible. The present maximum flow of sewage was stated to be 2,000 cubic feet per minute, and the ultimate probable quantity, when the district was all built upon, was about 4,000 cubic feet per minute. One quarter of an inch of rain-fall in 24 hours, would give 5,000 cubic feet per minute, increasing the total to 9,000 cubic feet per minute. There might be, occasionally, a larger quantity, and it was questionable to what extent provision should be made for it; the above might be considered to be sufficient.

Then came the consideration of the size of the sewers, required to carry off this quantity of matter. The main sewer, was proposed to have its invert at the outfall, 6 feet below the Ordnance datum, and to rise uniformly 1 foot per mile, and at the lower end the sewer would be double; each sewer carrying the drainage of half the district, but being capable of connection at will. It must be observed, that the relative positions of the existing sewers and of the main outfall, were such, that all could drain into them. This design was then based on the assumption, that sewers with an inclination of 1 foot per mile, would suffice to intercept, and to convey away the contents of all the existing sewers; their direction being a matter of eventual careful investigation. Two parallel main sewers would be preferable to one single large sewer, as one of them would carry the ordinary sewage, and by turning all of it, periodically, into one sewer, the other might be cleansed and repaired at leisure. Only one sewer had been proposed in the Paper, on account of the cost, but two, or at all events, one of larger dimensions became necessary, when it was insisted on, that provision should be made for the rain water as well as for the sewage.

Each sewer was capable, when full, of discharging 4,500 cubic feet per minute, so that one of them, half full, would suffice upon emergencies, to carry the present actual maximum quantity of sewage only. A small increase in their diameters at comparatively little cost, would greatly augment their capabilities for discharging their contents, without necessarily diminishing their efficiency in other respects. Thus then, there could not be any doubt as to the capability of the sewers.

The velocity of the stream in the sewers, with the present maximum flow of sewage, would be about 1 foot 7 inches per second, or rather more than one mile per hour; and when the sewers were only half full, the velocity would be 1 foot 9 inches per second, or nearly one mile and a quarter per hour. It might, however, be argued, that this was not sufficient to cleanse the sewers. The objections raised against sluicing under pressure, though by no means existing to the extent contended, were sufficiently important, to show the desirableness of avoiding them. Now, Mr. Phillips stated, from observation and experiment, that he found it required a constant velocity of current through the sewers, equal to about $2\frac{1}{2}$ feet per second, or one mile and three-quarters per hour, to prevent soil from depositing within them. Captain Vetch stated, that a less velocity than $4\frac{1}{2}$ feet per second, or about three miles per hour, was not sufficient to insure sewers maintaining themselves free from deposit, and accumulations interfering with their action; and Mr. Bazalgette, in his plan recently laid before the Commissioners of Sewers, provided for an ordinary velocity of from one mile and a half to two miles per hour; which corresponded with Mr. Phillips' views. On the other hand, Professor Robison stated,[1] that a velocity of 6 inches per second would scour away usual deposit, and 1 foot per second would move fine gravel. Again, when asked by the Commissioners on the Health of Towns, "Do you find the flushing effectual in a horizontal line?" Mr. John Roe, replied, "Yes; we have a sewer building on a dead level, in consequence of the difficulty of the outlet; in that case we have placed a gate for 1,600 feet; and we are in hopes we shall do with a greater distance than that hereafter; but that is the greatest length we have had an opportunity of working on a horizontal direction."[2]

At Eton the main sewer was horizontal, and had a good supply of water constantly running through it; it was kept constantly clear of ordinary deposit, flushing being had recourse to only for removing road drift.

The proposed sewer would give a velocity, varying from one mile to one mile and a quarter per hour, and the quantity of water that could be brought to bear upon it, was unlimited.

[1] *Vide* Robison's Natural Philosophy, vol. ii., p. 465.

[2] *Vide* First Report of the Commissioners for Inquiring into the State of large Towns and Populous Districts, vol. ii., p. 167. London, 1844.

The point then to be considered, was, whether it was possible by the ordinary flow, with the addition of properly constructed flood-gates, placed at every half-mile, or mile, to keep this sewer clear from all deposit. This should no longer be a matter of opinion, but an ascertainable fact.

The two miles from the Ravensbourne to the reservoirs, might be flushed under pressure, without interfering with the Greenwich drainage, or impeding the drainage above; one of the sewers during the process, carrying all the sewage. There would then be no difficulty in thoroughly cleansing that length.

The main inland sewer was intended to be so placed, as that the cross sewers from the high land should have sufficient fall into it to keep them clean, and there was everywhere sufficient provision for a fall of 1 foot per mile in the sewers required to be constructed, and in many cases, probably a greater fall. The existing sewers, throughout Lambeth, &c., would require regulation and control, and probably, some comparatively inexpensive alterations would be necessary.

Wherever the cellars and basements now had the benefit of drainage, they would receive further advantages from the diminished liability to be flooded.

Objections had been raised to the discharge of the sewage into the Thames, at low-water. It was, however, proposed to be deodorized, and consequently, might be considered inoffensive; but the objection might be otherwise met, by establishing at the outfall, double, or duplicate reservoirs, each capable of containing the sewage matter brought down during $12\frac{1}{2}$ hours, without exceeding the height of 6 feet above low-water of spring-tides. These reservoirs would be filled alternately with sewage; for instance, at low-water, one would be filled to that level with river water, ready to receive the sewage; whilst the other would be filled from 2 feet to 6 feet above that level with the sewage matter, &c., conveyed into it during the preceding $12\frac{1}{2}$ hours. As the tide rose, the water would be admitted into this reservoir, the gates at the upper end being closed against its progress upwards. At the turn of the tide, the gates being thrown open, the water would be allowed to flow freely through, carrying with it the whole of the sewage matter. Assuming the maximum quantity of rain water and sewage to be 9,000 cubic feet per minute, then $9{,}000 \times 60 \times 12\frac{1}{2} =$

6,750,000 cubic feet for the capacity of each reservoir. The dimensions would then be 4,000 feet long, 280 feet wide, and 6 feet deep, for the sewage matter. In cases of continued heavy rain there would, probably, be no objection to discharging at low-water, in which case double the storage capacity might be secured, by both reservoirs being used simultaneously to receive the sewage.

Taking a general view of the existing system, and the causes of its being objectionable, it appeared, that the district was chiefly flooded by the hill waters, which would be remedied by a high-level intercepting sewer. The increased number of sewers would also diminish this source of inconvenience. Again, the district was subject to flooding, from the sewers being water-locked for so long a period during each tide. This objection would be entirely removed, by the proposed reservoirs permitting a continuous flow at all times of the tide. The present sewers were cleansed by hand-labour, and the short period between the tides when this could be done, rendered it generally difficult, and in some cases, impossible. The existing sewers might, moreover, be inspected, flushed, or hand-cleaned, at all times of the tide, under the system proposed.

It would not suffice merely to negative a natural system of gravitation; the apparent superior advantages of an artificial system should be clearly developed and demonstrated. The chief advantage claimed, appeared to be, that its effect would be the same as if the whole district were raised 20 feet; now, this very decided superiority was not by any means so apparent, without further explanation. Another advantage claimed, was that from the greater fall, less water would be required to flush the sewers: this might be satisfactory to the advocates for utilizing the sewage matter, by deodorizing, but was not so much in the interest of the inhabitants as having thoroughly cleansed sewers.

Assuming, as in the other case, that the sewers would yield 9,000 cubic feet of matter per minute, and supposing the reservoir, on the Commissioners' plan, to be discharged during two hours before and two hours after high-water, there remained eight hours and a half during which the district must depend on pumping; which gave 4,590,000 cubic feet of matter, and taking the depth at 20 feet, there would be an area of 470 feet square, filled with sewage, close to Greenwich. As this was to be discharged at high-water into the Deptford Creek, the bottom of the reservoir must be about the level of high-water mark, and the sewage be pumped up 50 feet, instead of 30 feet; or the reservoirs must be shallower, and thus expose a larger area to evaporate mephitic vapours.

The low-level intercepting sewers were proposed to pass almost entirely through suburban districts, which would, consequently, be materially benefited by the adoption of the pumping system, provision being made against accidents, by consolidating the ground, and providing for the drainage of cellars and basements, in the houses to be constructed; whilst the present populous district was not so improved. At the same time, from its present greater rateable value, it would have to bear the chief burden of the improvements, unless the whole work was executed under a Government loan, the principal and interest being paid off by rates in a certain number of years. Thus, as the improved district was built upon, it would pay its proportion of the cost.

Mr. Harrison repeated, that he still believed pumping to be very undesirable, though it might be practicable, and that the cost of flushing the sewers thoroughly, from the unlimited supply of water easily applicable to the district, would be decidedly less than that of pumping. He fully admitted a flushing system not to be the most desirable, and therefore, it was to be avoided, if possible; but the question in this case, was merely a choice between two evils,—the pumping and the flushing systems. Besides, it would appear, that a large and most important district, now closely built upon, must, under any circumstances, be cleansed by flushing. Assuming the maximum quantity of sewage and rain-fall to be 9,000 cubic feet per minute, equal to 567,000 lbs., to be raised 50 feet in one minute, 860 H.P. would be required for the maximum ordinary duty; and, as a matter of proper precaution, about double this power was provided for in the plan laid before the Commissioners of Sewers, by Mr. Bazalgette. The possibility of affecting the ordinary sewerage of the district by pumping, could not be doubted; what was questioned, was the expediency of having recourse to pumping, if it were possible to effect the object by natural gravitation, a system, which would not, like pumping, be liable, on a sudden considerable fall of rain, to derangement and inefficiency.

Mr. C. Fowler said, the two main points to be considered, were the means of relieving the town district of the River Thames from the pollution it now suffered under, by the admission into it of the products of the sewers, and the best method of diverting the sewerage, so as to render the matter available for agricultural purposes. It appeared, that either by a chemical process of deodorizing, and precipitating the solid matter, or by pumping up the contents of the sewers in a highly diluted state, to be distributed over land, according to a system of irrigation, the sewage could be advantageously employed. It had been stated by the late Mr. James Smith (Deanston), and others, that the value of the sewage, when properly applied, was equal to one pound sterling per annum, for each inhabitant of a large city; if such was the fact, it was incumbent on the Commissioners of Sewers to take measures for adequately employing so valuable a product, as was stated to be done at the Clipstone meadows, near Mansfield,—on some land near Edinburgh,—and at Harvey's Distillery Farm, near Glasgow. It appeared that, in these cases, the local circumstances were favourable, as he did not find it anywhere stated, that in any position it had been proved to be worth while to establish steam power solely for pumping up liquid sewage, to be used as dressing for land. If, however, it was, as asserted, indispensable that steam power should be employed for pumping the sewage from the low districts, why could not it be lifted into the upper districts, and be thence distributed into the agricultural districts, where it could be advantageously employed? There would not be more difficulty in that, than in supplying the houses with water for domestic use, throughout the Metropolis. It would be, in effect, a reciprocal operation, analogous to that carried on in the human body, through the arteries and veins, by the propulsion of the heart. Thus the water being pumped into the town, and becoming charged with organic matter, would be pumped back into the country, to fulfil its proper purpose of reproduction. In both instances, Nature would work by a principle of circulation to support and sustain life, in perpetual succession. He was convinced, that the time would arrive when this economical employment of the sewage must occur.

Mr. G. DONALDSON remarked, that at the level at which the invert of the proposed sewer was fixed, there would scarcely be sufficient power to flush the sewer from Battersea to Greenwich. He agreed in the opinion, that if it were practicable to obtain sufficient fall, for a system of drainage by gravitation, it would be most advantageous; but he was sceptical as to the possibility of it, and he feared, that pumping must be had recourse to, if the cellars and basements of the low portions of the district were to be kept free from flooding, as otherwise, the sewer would be full at each tide.

Mr. BIDDER, V.P., said, it appeared to be admitted, that the northern district could be drained by gravitation, through an extension of the existing system of sewers; if that was correct, the only serious difficulty was the treatment of the south district, a low marshy spot, covered with building, not advantageously distributed either as to level, or arrangement, and intersected by sewers, constructed at various periods, and with more, or less skill, so that there was not much unity of design. Such as they were, however, these sewers must, as far as possible, be used, and as the public demanded, that the Thames should be relieved from further pollution, it would be necessary to extend the main outfall far down the river, and at that point the sewage must probably be raised by machinery, as otherwise, sufficient fall would scarcely be obtained from the lower parts; the higher parts of the district being at the same time provided for by catch-drains. It appeared to be indispensable to employ steam power for draining the low district, and for this, supposing the sewage alone to amount to 4,000 cubic feet per minute, to be lifted 30 feet, there would be required about 250 H.P., and if the storm water was added, the additional fluid to be lifted, would at the utmost, be only such as to require 2,000 effective H.P., which was a force not unfrequently found on board large steamers, where there was not any difficulty in keeping the engines at work night and day, for very long periods, without having duplicate power; there need not, therefore, be any fear on that head; the only question was the cost. In his opinion, the low-level sewage should be lifted by steam power, say at Deptford Creek, into the sewers conveying the high-level sewage into the reservoirs proposed by Mr. Harrison, and thence should be delivered into the river, without any deodorizing, at the first turn of the tide from high-water, so as to preclude the possibility of any pollution of the stream above the outfall of the sewage.

As to the argument in favour of profitably pumping the sewage into the country, in a liquid form, because the Water Companies could by such means profitably supply water for domestic purposes, there was not any analogy between the circumstances, and the comparative value of the rental of agricultural land, and of the same area covered with buildings, would show, that no parallel could exist between the water supply to houses, and that of pumping liquid manure for agricultural purposes; all the schemes for that purpose had hitherto, with very few exceptions, and those in special localities, proved lamentable failures. As to the value of the products of the sewers, Mr. Bidder would rather pay £10 per ton for guano, than have deodorized sewage manure, even if it only cost the labour of carting to his land.

Mr. HAWKSLEY hoped, that the facts elicited by the discussion, would be found serviceable, in determining the ultimate system to be adopted, and that special care would be taken to avoid the fallacies which he contended had been promulgated in some of the documents emanating, "by authority," from the General Board of Health; particularly in the "Minutes of information, collected with reference to works for the removal of soil water, or drainage of dwelling-houses, public edifices, etc." (1852.) The errors, both of theory and practice, contained in those documents, were too numerous to be pointed out incidentally, during one Meeting of the Institution, as they set at nought all the received laws of hydraulics, the formulæ of Du Buat and of other experimenters of acknowledged scientific skill, and even the 'Principia' of Newton, and only substituted fallacies for those rules which had hitherto formed the basis of the best practice. The tendency of such publications was very mischievous, and it was incumbent on practical Engineers to furnish an antidote, by a careful examination of the published statements and an exposition of the errors; this, if not undertaken by any other Member, he promised to endeavour to prepare for a future session. These mischievous blue-books had been circulated through the Post-office, to the extent, it was stated, of one hundred and seventy thousand copies, promulgating the most erroneous doctrines, which had already produced corresponding pernicious effects, and the antidote, in the shape of recognized truths, should be equally extensively administered. The fact was, that the pipe drains, wherever substituted for brick main sewers, and laid according to the rules of the Board of Health, had proved to be of very inefficient capacity, and failures constantly occurred, although they were, as much as possible, concealed from the public.

With respect to the several proposals for the drainage of the southern district of the Metropolis, there could not be any doubt of the gravitation system being preferable, if it were practicable, which, however, he contended had not yet been satisfactorily demonstrated. The governing level was that of low-water of neap-tides, and if regulated by that, the proposed sewer would not be deep enough to drain the lower portions of the district; in fact, by the time there was an accumulation in the reservoir to a height of 4 feet above the low-tide level, the sewage matter would be ponded back for 6 miles up the main sewer, and there would not any longer be any practical fall. Recourse must then be had to machinery, for lifting the sewage to a higher level at Deptford, to enable it to run away to a point much further down the river. There were valuable suggestions in the Paper, but much more consideration was required, before giving adhesion to either of the proposed plans.

Mr. HAWKSHAW considered it a loss of time to enter into a discussion relative to the formulæ furnished by the Government Commissioners: it was better to allow them quietly to fall to the ground through their own worthlessness, and both the blue-books and their dogmas would soon be forgotten.

As to the question of deodorization, its proposers seemed to be unaware of the magnitude of the subject. They would have to dispose of 3,000,000 cubic yards of sewage per day, inclusive of rain-fall, and any system with that obligation would most probably fail; and although it was certainly possible to separate the solid matter from the rain-fall, it could not be profitably effected.

Either system of drainage for the south side of the metropolis could be made effectual, by providing sufficient reservoir space for the sewage, at such a level as would afford the requisite fall. But, to include the rain-fall, the necessary reservoir space would be nine times that required for the ordinary sewage alone, and the steam power employed to pump it must also be nine times greater. The main question to be decided was the relative expense of the different systems proposed.

Mr. Simpson,—President,—said, that the drainage of Lambeth and of the district south of the Thames was a problem involving considerable difficulty, and admitting of great diversity of opinion, but during the discussion, many parts of the projects that appeared feasible, had been proved to be inadmissible, whilst others seemingly objectionable had, on examination, shown certain advantages. He thought, however, that both Mr. Harrison's scheme of natural drainage and the artificial system proposed by Mr. Bazalgette possessed defects; one of the greatest being, that neither of them would be capable of carrying off, to a sufficient extent, the larger rain-falls which, though not frequent, were liable at any time to occur.

The subject would be much simplified, if the maximum duty to be performed by the sewers was settled before-hand. In his opinion, any system which might be adopted must fulfil two conditions:—

1st. The high-level sewer must, beyond all doubt, be capable of carrying off the drainage of the upper district, independently of the lower district.

2nd. The low-level sewers should be large enough to receive and carry off the greatest rain-fall, under the most unfavourable circumstances of tide, without a possibility of any part of the district being flooded.

There was no diversity of opinion as to the first condition; but the high-level sewer proposed by Mr. Bazalgette appeared to be insufficient, inasmuch as the maximum amount of rainfall seemed to be under-rated. For instance, on the 25th of July, 1852, 2 inches of rain fell in eight hours at Greenwich, and on the 14th of July, 1853, the rain-fall recorded at Lewisham and corroborated by observations at Greenwich, was 2·8 inches in seventeen successive hours, which, over 12 square miles, would give 76,000 cubic feet per minute. Now the high-level sewer projected by Mr. Bazalgette would only accommodate 46,000 cubic feet per minute; consequently, in such a rain as that above-mentioned, 30,000 cubic feet per minute would not be provided for, and would flow down to the lower district, to the interruption of the proper drainage of that part. Again, with regard to the low-level drainage scheme of Mr. Bazalgette, its utmost capabilities were stated to be 21,400 cubic feet per minute, with a corresponding pumping power, or rather, means for raising the sewage. In the above storm, therefore, there would be 54,600 cubic feet per minute to provide for in the present sewers, a quantity which it could be shown they were not capable of storing.

It was, of course, out of the question to convey any very extraordinary rain-falls to a distance; this could not be done within reasonable, or convenient limits of expense: but Mr. Harrison, in his scheme, proposed only to deal with 9,000 cubic feet per minute, or at most, by using both reservoirs in cases of emergency, 18,000 cubic feet per minute. His plan would, therefore, as at present designed, be quite insufficient to meet the second requirement. He also proposed, during heavy storms, to throw open all the existing outlets and to allow the water to take its natural course into the river, but if the heavy rain should occur at, or about the time of high-water, this would obviously be inadmissible, as all the lower districts would be flooded.

These considerations naturally led to the question of the storage room of the present sewers. Mr. Bazalgette proposed that extraordinary rain-falls should be accumulated in the present sewers: but this, of course, must depend on their quantity and duration. Mr. Simpson was inclined to believe, however, from the following circumstances, that the capacity of the sewers for storage had been greatly over-estimated, and would prove fallacious, if trusted to in cases of emergency.

It was a well-known fact, that at times during almost every wet season, the present sewers were found insufficient, and great complaints were made of premises being overflowed. Such being the case, there was no doubt, that an ordinary winter rain was sufficient to produce this effect, since the extraordinary rains were by no means so frequent as the cases of the sewers being surcharged. Now a heavy ordinary winter's rain was one-third of an inch per day, and supposing it to continue at the same rate for eight consecutive hours, during which the sewers were tide-locked, their capacity, if they were capable of storing such rain, would be, taking 24 square miles of area drained, 18,585,600 cubic feet, or at the rate of 38,700 cubic feet per minute. But in the continuous rain above recorded, the quantity required to be stored would have been, as before stated, 54,000 cubic feet per minute; there was no doubt, therefore, that the present sewers were not of sufficient capacity for such a purpose. The storage room of the present sewers would be equally available for Mr. Harrison's or Mr. Bazalgette's scheme, but they would not be sufficiently large for either.

Taking one-third of an inch per day as a large ordinary rain-fall, it would be found, from the observations recorded in Howard's 'Climate of London,' that during ten years, from 1820 to 1829 inclusive, there were only one hundred and eighty-three days on which the rain exceeded this depth, but taking the winter months only, viz., November, December, January, and February, there were only sixty days during the above period, on which it exceeded one-third of an inch, or six days, on the average, per winter.

Mr. Harrison's project appeared, at first sight, to possess many advantages, as regarded the proposed site of discharge and the system of reservoirs to deliver the sewage matter by a natural process into the river, from and after high-water, and in being independent of artificial, or mechanical means and all the casualties attending their employment; but it also appeared, that the level of the main sewer and reservoir was not such as would accommodate all the existing sewers, and if such was really the case, it must be considered a vital objection to the plan.

With regard to the pumping scheme;—it appeared, from the facts already mentioned, that, assuming the storage room of the present sewers to be 38,000 cubic feet per minute, (which, however, was in excess, because this quantity would surcharge them), there still remained during extraordinary storms, 38,000 cubic feet per minute of sewage to be pumped, and the power required to raise this quantity 30 feet was nearly 2,200 H.P. A strong objection to this scheme was the site proposed for the establishment of engines, reservoirs, etc., at Greenwich, because, if once fixed there, at the great cost which would necessarily be incurred, it was obviously out of the question to contemplate any further extension to the eastward, which would involve the removal of all the works. Again, if there was any intention of filtering and deodorizing the sewage matter, or any prospect of such a plan being permanently adopted, it would be unwise to expend large sums of money on high reservoirs and large power to discharge the sewage at, or about high-water, when, if purified, there would, probably, remain little objection to discharging it into the river at all times of the tide. The question of deodorizing, or disinfecting was one which required serious consideration, and according to his present knowledge, he was not satisfied, that it was practicable, on account of its large volume, to deal satisfactorily, in that way, with the sewage of London.

Whatever plan of drainage was adopted for the south of London, it must be not only proper and sufficient for the present, but be capable of meeting all future requirements, and of lasting through a long course of years. In taking this view of the subject, he could not but be impressed with the very decided advantage which a natural system of drainage would possess over an artificial one. The great annual expenditure would be avoided, the continual wear and tear of engines, &c., requiring the whole to be renewed twice, if not three times, in a century, would be superseded, and all the casualties attending pumping machinery, one of which might be mentioned, the possibility of the whole being stopped for want of coals, (a catastrophe nearly happening to some of the gas-works during the late storms,) would be avoided; and they were more than sufficient to raise very grave apprehensions as to the successful working of any artificial system of drainage.

He considered, that the discussion had been of great utility and importance, although no definite and perfect plan of drainage appeared yet to have been proposed. It had elicited many facts, it had exposed the intricacy and difficulty of the whole question, and it would conduce to the perfection of whatever scheme might be hereafter adopted. In conclusion, he admitted, that from the apparent difficulties of applying a natural system of drainage, pumping might prove to be necessary, but from the objections to it, he thought every scheme should be canvassed, and all other means exhausted before it was resorted to.

He had been furnished by Mr. Glaisher with the following Table of the instances of the fall of rain, at the Royal Observatory, Greenwich, amounting to, or exceeding 0·5 inch within twenty-four hours, during the years 1851, 1852, and 1853:—

INSTANCES of the Fall of Rain within Twenty-four hours.

Year, Month, and Day.	Amount fallen in 24 hours.	Duration of Fall.	Rate per Hour.	REMARKS.
1851.	Inches.	Hours.		
March 15	1·45			
April 20	0·70			
,, 22	0·55			
July 23	1·44	..	..	At times, 0·25 inch fell in 10 minutes.
,, 24	0·54			
Aug. 17	1·71	..	..	At times, it fell at the rate of 0·5 inch per hour.
1852.				
Jan. 13	0·91			
May 26	0·56			
June 9	1·36	17	..	At times, it fell at the rate of 0·15 per hour.
,, 10	0·99	18		
,, 19	0·52			
July 25	1·99	8	..	½ an inch fell within a quarter of an hour.
Aug. 12	0·55			
,, 15	0·84			
,, 19	0·50			
Sept. 8	0·97			
,, 18	0·70	..	..	¼ of an inch fell within a quarter of an hour.
,, 28	0·94	24	0·04	
Oct. 4	0·75			
,, 25	0·92			
Nov. 12	0·80			
,, 26	0·85			
1853.				
March 14	0·50			
April 25	0·80			
May 3	0·50	13	0·04	
June 13	1·15	17	0·07	
July 8	0·63			
,, 14	2·63	18	0·15	At times, it fell at the rate of 0·3 per hour.
,, 28	1·11			
Aug. 23	0·89	11	0·08	
Oct. 12	0·58			
,, 19	0·59			
,, 27	1·05			

Mr. BIDDER, V.P., noticed the published results of an experiment, on a large scale, made at Alnwick, under the direction of an Engineer of the Board of Health, so recently as December 16th, 1853. The line of earthenware pipe was 770 yards in length, 18 inches in diameter, lying at an inclination of 1 in 400, with a square culvert, 20 inches by 20 inches, leading from a flushing chamber, and stop-gate, adjoining the weir from the river.

In the first experiment, the sluice was only sufficiently elevated to fill the pipe, when the results were :—

Velocity = 3·581 feet per second, or 2·441 miles per hour.
Discharge = 2,367·78 gallons per minute, or 3,409,603 gallons per day of twenty-four hours.
Depth at delivery end = $12\frac{1}{2}$ inches.

In the second experiment, the sluice was entirely taken out, causing the water to accumulate to a depth of 13 inches above the top of the pipe, when the results were:—

Velocity = 3·915 feet per second, or 2·67 miles per hour.
Discharge = 2,588·04 gallons per minute, or 3,726,777 gallons per day of twenty-four hours.
Depth at delivery end = 15 inches.

The second experiment gave the most decided results, the water being 13 inches above the top of the upper end of the pipe, and 3 inches below at the lower end, and allowing for the hydraulic height due to the velocity, a working inclination was given of about 1 in 340. Assuming, therefore, in accordance with the received rules, the resistance to be as the square of the velocity, and, as a corollary, the velocity in pipes being, *cæteris paribus*, as the square root of the mean hydraulic height,—*i. e.*, as the square root of the diameter of circular pipes,—the velocity stated being about 235 feet per minute, and the real inclination being about 1 in 340, these data would give for a pipe 6 inches in diameter, at an inclination of 1 in 100, a velocity of 255 feet per minute.

According to the blue-books, the velocity stated from the original experiments of the Board of Health, at an inclination of 1 in 100, would be 325 feet per minute. The results of this experiment, in fact, coincided much nearer with those given by the formula, even as stated in the blue-book, than with the results of the pretended experiments therein.

For a similar pipe, with an inclination of 1 in 800, the velocity would be 88 feet per minute instead of 240 feet per minute, the formula giving a velocity of 75 feet per minute.

He, therefore, contended, that, whilst the recent experiments at Alnwick confirmed the accuracy of the results of the formula, they as clearly demonstrated the inaccuracy of the experiments, and the erroneous deductions stated in the blue-book, which could not, consequently, be received as authority.

Mr. HAYWOOD observed, that Mr. Beardmore's Tables closely accorded with the results obtained by Eytelwein's formulæ, which were repudiated in the blue-book.

Mr. HAWKSLEY hoped, that the remarks which had been made on the experiments published in the blue-books emanating from the Board of Health, would not be considered to have a personal application; on the contrary, he was convinced, that if the authors of the blue-books had consulted one of the Engineers of the Board, the necessity for making those remarks would not have existed.

He observed, with respect to the statement of the experiments recently made at Alnwick, on the quantity of water discharged through a pot-pipe 18 inches in diameter;—that while, on the one hand, the results of the experiment sufficiently confirmed the accuracy of the formulæ of Du Buat, Eytelwein, Smeaton, Prony, and other investigators, and as decidedly contradicted the results published in the blue-books emanating from the Board of Health, these results, nevertheless, differed too considerably from other consistent conclusions to be fully relied upon. It was, therefore, desirable, that this experiment should not be taken as a datum, upon which to found any hydraulic law, for the determination of the quantity of water which might be transmitted through tubes. For this purpose, indeed, the cited experiment must be deemed unsatisfactory; because pot-pipes were never of uniform, or exact diameter,—inclinations were always more, or less vaguely stated,—joints were seldom sound,—and when the discharge was into free space, the differential level was rarely satisfactorily afforded. Moreover, this experiment itself was, in some respects, contradicted by very carefully conducted experiments, made by Monsieur Couplet, at Versailles, on a pipe 18 inches in diameter, the results of which were extremely consistent with the mathematical determinations successfully resorted to by all practical Hydraulic Engineers.

The experiment by Monsieur Couplet was made on a pipe 43,200 inches in length and 18 inches in diameter, the motive head was 14.5 inches, (all French measures), and the calculated velocity was $40\frac{1}{2}$ inches, while the observed velocity was $39\frac{1}{6}$ inches, differing from the velocity calculated from established formulæ, only about 3 per cent.

Mr. Errington remarked, that it was not desirable, that centralized authorities should continue to exercise that undue influence they possessed, as it was uniformly found, that they did mischief by the dissemination of errors, apparently under Government influence, and by the consequent hindrance of scientific and practical improvements.

Mr. Simpson,—President,—observed, that the experiments at Alnwick were made with pot-pipes, and must be taken only for what they were worth. Mistakes in hydraulic experiments often resulted from the want of sufficient knowledge of the proper method of taking the measurements, and want of skill in noticing the results.

Mr. C. Manby,—Secretary,—directed attention to a paper by a well-known authority on the subject of the application of liquid manures, in which it was stated, that Irrigation by liquid manure was first employed with completeness and success by Mr. Telford, of Ayr, on a small farm of forty acres near that town; but that small establishment was in quite an exceptional condition. The proprietor had the means of selling every pound of butter and quart of milk he could produce, in the neighbouring town, at the highest price.

Competent judges who had examined the much-talked-of farm of Mr. Kennedy, at Myremill, did not believe that it was remunerative—that is to say, that a tenant farmer could not have made the outlay which Mr. Kennedy had incurred, as an amusement, to carry out liquid manure irrigation.

The most complete arrangement for carrying out the system, was at the farm of Mr. Littledale, at Liscard, opposite Liverpool. There the buildings and machinery had avowedly been erected as an experiment, without regard to expense. There, too, was so good a retail market, that the cream and any quantity of butter could be sold at high prices.

Wherever a conjunction of circumstances should bring together a dairy farm close to a town, where every pound of produce could be sold at outside prices, and where coal was cheap, there it might answer to set a steam-engine to work to irrigate the turnips, swedes, mangolds, carrots, Italian ryegrass, lucerne, &c., on which the cows and pigs were to be fed.

But as liquid manure applied to corn crops was unprofitable, because it grew too much straw and not enough ear, and as it must, from its nature, be used as fast as the tanks became full, it followed that on a farm conducted on the ordinary four-course shift, a system of manure irrigation would generally be worked at a loss. It would be applicable to only a portion of the farm, would have sometimes to stand still, and be sometimes worked at a loss.

Farmers were, therefore, confirmed in the conclusion, that liquid manure irrigation was not a panacea for revolutionising the present system of farming, but merely an expedient which could only be profitably applied under the exceptional circumstances of a dairy farm, under garden culture, close to a town market.

It seemed more probable that it would answer the purposes of market gardeners, to take to the pump, steam-engine and hose.

A simple, less novel, and more profitable mode of treating liquid manure was employed by two farmers, one in Lincolnshire and another in Bedfordshire. Their stables, cowhouses, pigsties, and manure heaps, were drained into receptacles, into which were thrown, from day to day, enough of the fine ashes from the steam-engine, to absorb the daily produce of liquid; when ashes were not to be obtained in sufficient quantity, loam well sifted was employed, care being taken that enough was thrown into the pit to completely absorb the liquid.

The result of the mixture was a stimulating manure, which could be either drilled in, or ploughed for any crop, but especially for woolcrops. Now, with farm buildings well spouted to carry off the rain, proper drains for the farm steadings, and proper pits for manure, any one might economise the liquid manure produced on the establishment, and by adding to it the soap-suds, dish-washings, and other wash of their house might produce valuable dressing.

In arranging farms and farm buildings the continuous principle should always be kept in view. In modern factories the processes were always progressive, never backwards and forwards. Dirty rags went on from room to room in a straight line, being washed, torn, and bleached, until they emerged in a sheet of paper. And so the American pig entered the slaughterhouse and emerged in the shape of pickled pork in barrel, pig-skin, bristles, &c. But too many farms straggled in two parts of a parish, while the farm buildings were so arranged that half the labourers' time was lost in passing and repassing the same place. Farm produce might be good, middling, and bad; but it showed no signs of its origin. The wheat, the mutton, the butter, the cheese, from the most advanced farmer, raised in the most scientific manner, bore little, or no outward sign of its origin. Hence improvement in agriculture was slow. Norfolk under Coke, Bedfordshire under the wise landlordship of Francis Duke of Bedford, the Lincolnshire wolds stimulated by the Yarborough family, made great strides in agriculture, while others, close to great markets, remained ignorant of the first rudiments of rational agriculture. For instance, in the counties round London, Surrey, Kent, Bucks, and Herts, hedges, gates, farm buildings, bad drainage, and rude cultivation were to be found in discreditable profusion.

Competent judges of agriculture—not theorists, but practical farmers, believed that the mere extension of the system practised during the last ten years in the best farming counties of England and Scotland, to all the other districts, would more than double the food-producing powers of the kingdom.

Guano supply demanded attention, but few facts to be depended on were promulgated relative to it, especially as to the comparative value of deodorized sewage and Peruvian guano. An eminent agriculturist, farming nearly two thousand acres of land, had publicly stated, that, at its present price, it was the cheapest manure sold; and he should be very happy to contract for the next ten years to take thirty tons a-year, at nine guineas a ton.

December 13, 1853.

JAMES MEADOWS RENDEL, President,
in the Chair.

The discussion upon the Paper, No. 901, "On the Drainage of the District, South of the Thames," by Mr. J. T. HARRISON, being renewed, was extended to such a length, as to preclude the reading of any other communication.
