

BOMBAY MUNICIPAL CORPORATION.

PAPERS

REGARDING CERTAIN REMARKS

OF

MR. BALDWIN LATHAM

ON THE

BOMBAY DRAINAGE SYSTEM.

BOMBAY
PRINTED AT THE "TIMES OF INDIA" STEAM PRESS.

1899.

to Mr. Frederick Edgelow, for
 to the Hon'ble the
 Mr. Edgelow with them, able and ex
Extract from the Proceedings of the Corporation dated 1st of my inspections the
 of this solid matter were t
 Bombay sewers

Proposed by the Hon'ble Mr. Ranchodlal Chotalal copy of a
 C.I.E.—

No. 3252. "That the Municipal Commissioner be asked to inform the Corporation if he received from the Hon'ble Mr. Ranchodlal Chotalal copy of a letter, dated 21st January 1897, addressed to him by Mr. Baldwin Latham, and to lay it before the Corporation at its next adjourned meeting."

The motion was seconded by Dinsha E. Wacha, Esq., and carried.

Extract from the Proceedings of the Corporation dated the 4th August 1898.

Considered the following :—

No. 8850 of 1898-99.

BOMBAY, 9th July 1898.

TO THE MUNICIPAL SECRETARY.

SIR,—In reference to the Corporation Resolution No. 3252 of the 7th instant, I have the honour to state that receipt of a copy of the letter referred to cannot be traced in this office. I, however, forward a copy made from a copy in the possession of Mr. N. N. Wadia.—I have, &c.,

P. C. H. SNOW, Commissioner.

WESTMINSTER CHAMBERS,
 13, VICTORIA STREET,

WESTMINSTER, S. W., January 21st, 1897.

AHMEDABAD SEWERAGE.

DEAR SIR,—I beg to acknowledge the receipt of your letter No. 1597 of the 31st December 1896, and I take the opportunity of stating in reply to your communication that I am not at all sur-

prised to find
outbreak
drainage
Bombay
a reinvigoration

likely to attribute the
satisfactory state of the
doubt what has occurred in
lead to delay in providing
that City and in other places,

You are aware that I most carefully examined
the whole of the drainage of that City, and advised the
authorities with reference to the matter, when I discovered that the
system of sewerage which had been brought into operation was by
no means such a perfect system as ought to have been adopted in an
Indian City, and suggested remedies by preparing a new scheme for
the drainage of that City, the largest portion of which would have
been dealt with by direct gravitation.

The errors which have been perpetuated in the drainage of Bombay
have not arisen in the area which has been carried out at Ahmed-
abad; and the consequence is that while your sewers, according to your
own statement, are shown to be absolutely free from deposit, this is
not the case in the Bombay sewers.

I have appended to this letter a section which shows the mode
in which the main sewers of Bombay are constructed, and which
give the length and levels of the various portions of this main
sewer, from which it will be seen that, whatever the size of the
sewers, the sewers are all level upon their inverts; but as the velocity
of flow in a sewer does not depend upon the inclination of the invert
but upon the inclination of the surface of the sewage which is flowing
through the sewer, it will be seen that if a line be drawn from the
crown of the upper end of the main sewer to the crown of the lower
end of the main sewer, the actual fall on the surface does not conform
to the fall of the sewer, and is very considerably less than the average
inclination of the sewers in question, for the fall from one end of the
invert to the other as shown by these levels is 14.94 feet, while the
actual fall along the crown is only 10.69 feet. The consequence is
that if these sewers run full at any time, the velocity of flow through
them, especially through the small sewers of the upper parts of the
system, is actually less than is considered a sufficient velocity in
this country to make a self-cleansing sewer; but in India, as a very
much higher velocity is required for sewers to make them self-
cleansing than in this country, *it must be obvious that sewers so con-
structed cannot be self-cleansing.*

The average rate of the inclinations of the inverts of these main
sewers, shown upon the sketch appended, is 1 in 1488.55 feet, whereas
the average inclination from crown to crown is only 1 in 2080.25
feet; but the houses in Bombay have never been connected up to
the sewers, so that although the sewers are calculated to convey a
considerable volume of sewage, and if they could carry this volume
of sewage they would be more likely to be self-cleansing than they
are, yet owing to the sewage not being admitted to them, the
absolute velocity of flow in the sewers is so small that it is abso-

Frederick Edgelow,
 lately impossible for it to consent to the Shone forward to the point of outfall. Add to this do with them, at the time of my inspection of the sewers, after wrote to my agent and expense of separately collecting the solid excreta of the Municipality at certain points in Bombay, 186 tons of this solid matter were turned daily into the sewers. At the time of my inspections the total volume of sewage flowing through the Bombay sewers was under eight million gallons per day, and if all this solid excreta is mixed with the whole of the sewage of the 24 hours, it would add 364.5 grains to every gallon of sewage—a quantity which is about four times in excess of the normal solids in sewage in this country. Add to this however the solid matters washed in from open cut drains passing all kinds of garbage into the sewers, and there cannot be a shadow of doubt as to why the solids should accumulate in the sewers of Bombay to the extent which was shown at the time of my inspection, which is entirely due to having sewers of so large a size having so little fall and such volume flowing through them.

If the sewers were constructed on the same principles as the part of the city of Ahmedabad which has already been sewered, no accumulation could possibly arise, and there could be no difficulty or trouble in dealing with the sewage itself.

There can be little doubt that such sewers as have been allowed to exist in Bombay are more or less detrimental to health; and I was hopeful that the Municipality of Bombay would have acted upon the experience of those who devoted their attention to these matters, and not have taken matters so much into their own hands.

The delay arising from the question of house connections in Bombay is a matter which an experienced engineer would have successfully settled in five minutes, but things appear to be governed in Bombay more by sentiment than by actual knowledge or experience. What could possibly be more detrimental to Bombay than the position of its existing outfall and the large sewage lake which is allowed to exist on its western shore for so long a period? The proper place for the outfall for Bombay should clearly have been at the very southern extremity of the island. This at one time was looked upon by all parties as the proper place for the disposal of the sewage; but as time went on opinions changed, and ultimately an outfall was selected on the west of the island entirely through a misconception of the actual set of the tidal currents and the laws which are at work for disposing of sewage in tidal waters. At the present outfall on the western side the sewage is discharged at all stages of the tide, to be brought back by every flood upon the shore in the immediate neighbourhood, thus fouling the whole coast on the west side, or the side from which the prevailing winds blow that bring the fresh air for the invigoration of the inhabitants of the city. Knowing the strange infatuation which had taken hold on the authorities of Bombay with reference to this outfall on the western side, and the impossibility as it appeared

of carrying out a southern extremity of the district, I gave n western outfall only on the condition that the sewage discharged only on a limited time of the ebb tide, so that it could be effectually got rid of without polluting the western shore. I understand however that nothing has been done, and strange as it may appear in Bombay, they have adopted for a portion of their district the Shone System—a system by which the pure air of heaven is made use of for forcing out the foul sewage of the existing sewers, and this foul air is absolutely liberated within an eastern city. The fact of any Municipality or any person or persons, professional or otherwise, adopting and advocating the Shone System as a sanitary measure shows how little they can possibly know of what is sanitary especially in an eastern city like that of Bombay.

It is shown by the figures published in Rangoon in the various trials which have been made with the Shone System in that city, that where air of 26 and 27 lbs. pressure above the atmosphere is used, the actual volume of fresh air used was from 4.89 volumes to 5.73 volumes for each volume of sewage raised, so that for every million gallons of sewage raised by this plan in the city, over five million gallons of foul air are liberated in the atmosphere.

Still more singular is the fact that in Bombay they have discarded the original pumping engines, which gave an efficiency of 36 per cent., on account of their giving such a low duty in raising sewage, and have put up at great expense new pumping engines, yet while doing this on the one hand they have adopted the Shone system on the other hand, and I will undertake to guarantee that if an efficient and proper experiment were made as to the efficiency, namely, such as would be done with an ordinary pumping engine, as to the amount of sewage raised on the one hand and the power employed in doing it on the other hand, the efficiency of this Shone system would not exceed one-fourth of that of the engine which they have discarded.

I cannot conceive anything more deleterious to health than the large volumes of foul air which must be liberated under the Shone system within the place in which the sewage is produced; and in my judgment there would be nothing more likely to lead to the dissemination of the plague and such like diseases than the dispersion of this foul air.

In a previous letter I have already drawn your attention to the fact that the recent Government reports show how the health of Karachi has suffered since it has laid its new system of drainage on the Shone system; and the same thing occurred with regard to Rangoon, and so it will be to the end of the chapter; that this is a matter of which the Municipality of Bombay have full knowledge I must inform you that arrangements were being entered into between the Municipality of Bombay and myself for my acting as their Consulting Engineer, but upon the Municipal Commissioner, Mr. Acworth,

informing my agent, Mr. Frederick Edgelow, of Bombay, that I should be required to give my assent to the Shone system, I declined to have anything whatever to do with them, and the following is a quotation of a letter which I wrote to my agent at the time :-

“ If it is required by the Bombay Municipality that I should advise them to adopt the Shone system at Bombay, I should decline under any circumstances. No amount of remuneration would relieve my conscience in case of the advice so tendered. I should look upon myself as morally guilty of culpable homicide if I recommended any authority with my present knowledge to adopt the Shone system in any locality, much more so in an eastern country and in a City like Bombay; and if my appointment of Consulting Engineer to the Municipality of Bombay depended upon being able to recommend the Shone system, then there is an end to my engagement, as I decline, both upon moral and engineering grounds, to be a party to any such recommendation, for I know very well in the course of a limited period what the result would be, and the authorities would not bless the day when they commenced such an undertaking. ”

With reference to the plague, I have carefully studied the whole of the annals with reference to the outbreak of the plague in this country, as I have been engaged in making an investigation going back over 300 years, with reference to the sanitary conditions of this country, and studying the statistics with reference to the question of marriages, christenings, and burials in various districts extending over that long period until we have efficient registration in 1837. What is found with reference to the matter is that periods of drought, such as that which India has been passing through, are periods which are extremely susceptible to diseases of the fever type, and the same precautions which would be taken against typhus fever are those which should be taken against the bubonic plague. That it is an infectious disease imparted at short distances between persons but not at any great distance. It is obvious therefore that overcrowding should be prevented. Anything which tends to pollute the air should be avoided: all surfaces should be properly cleansed. The use of water for cleansing purposes cannot be overrated; the limewashing of the interior of foul houses at repeated intervals; the immediate disinfection, removal, and cleansing of foul linen and clothing of every description; sufficient food for the people, as in famine times these diseases are very much more prevalent and destructive than in other periods; and no doubt in this country the disappearance of the bubonic plague is largely due to the increase of green vegetables. No doubt the introduction of the potato has had a most marked influence in increasing the health standard of the country. All water-supply brought into a house, especially houses which are infected or exposed to foul air, should be boiled. Free and open ventilation should be admitted into every house. The rays of the sun, which are so destructive to germ life of a virulent type, should be allowed

to have free play. There is an old Italian proverb which is extremely true—"Let in the sun and you shut out the doctor." As I have already said, foul air is one of the most important agents to be guarded against in the dissemination of the plague. It therefore follows that a proper system of drainage with sewers having sufficiently rapid falls which will convey away in a limited time such polluted matters which, if allowed to remain in the precincts of the residences of the people, will produce foul air, is one of the greatest safeguards you can possibly have against the dissemination of disease, and to maintain the air in that pristine purity in which it is intended that man should breathe it. So I trust that you will not be discouraged by what has taken place in Bombay, but have the good resolution to carry out what is really a proper sanitary system of drainage and you will never regret it.

I was only more pleased to see that the year 1895 had shown in your district that the health had considerably improved as against the results occurring in other places to which I have before referred.

If I can give you any advice at any time with reference to the matter, pray do not hesitate to ask me as I shall be only too happy to do anything I can for you. I have only one desire—to see a proper sanitary system carried out in India; and I am sure if once a proper system is inaugurated that its benefits will become so manifest that there will be no hesitation on the part of the authorities adopting such sanitary system throughout the length and breadth of that land.—I have, &c.,

BALDWIN LATHAM.

The Hon'ble Rai Bahadur Ranchorlal Chotalal,
President of the Municipality,
Ahmedabad.

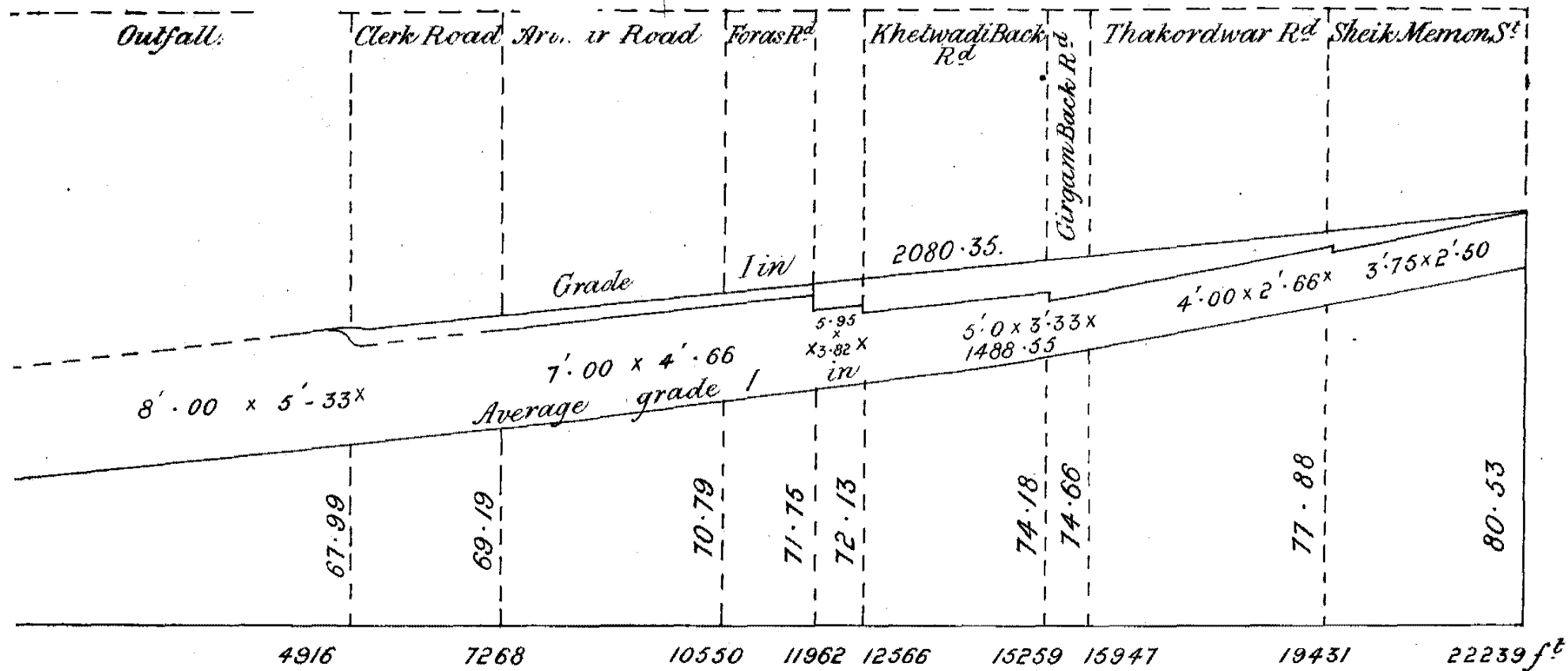
Proposed by the Hon'ble Mr. Pherozeshah M. Mehta,
C.I.E., seconded by Nanabhai N. Katrak, Esq.—

"That the letter to the Secretary, from the Commissioner, No. 4055. No. 8850, dated the 9th July 1898, forwarding with reference to the Corporation's Resolution, No. 3252, dated the 7th July 1898, copy of a letter from Mr. Baldwin Latham to the address of the Hon'ble Rai Bahadur Ranchorlal Chotalal, President of the Municipality, Ahmedabad, be recorded.

2. "That the Commissioner be requested to favour the Corporation, after consultation with the Executive Engineer, and the Deputy Executive Engineer, Drainage, with any observations he may wish to make on Mr. Latham's letter, and his opinion as to the defects in the Bombay drainage system pointed out by Mr. Latham."

Carried.

by Main Outfall Sewer.



(S^d) Baldwin Latham.

M. I. C. E.

13 Victoria Street

Westminster S. W.

London.

21-1-97.

No. 430^{ked} w¹⁹⁸⁻⁹⁹.MUNICIPAL COMMISSIONER'S OFFICE,
BOMBAY, 8th April 1899FROM W. L. HARVEY, Esq., I.C.S.,
Municipal Commissioner for the City of Bombay.

TO THE MUNICIPAL SECRETARY.

SIR,—With reference to the Corporation Resolution No. 4055 of the 4th August 1898, asking for my observations and opinion on Mr. Baldwin Latham's criticism of the Bombay drainage system, I have the honour to forward here with letters Nos. 12551 of the 26th November 1898 and D-7968 of the 16th September 1898, from the Executive Engineer and Special Drainage Engineer respectively, and to state that I concur generally in the remarks made by those officers.

2. It would be unprofitable to discuss at length the situation of the sewage outfall for the southern portion of the Island. That question has been thoroughly threshed out and a conclusion has been arrived at, and it is only necessary to add that even under Mr. Latham's scheme for a high-level sewer from Parel to Colaba a great portion of the City would still have had to be dealt with on the sectional system by pumping.

3. It must undoubtedly be admitted that the want of sewage reservoirs on the foreshore is a serious defect in the present arrangements and one that will have to be remedied at some future time. The desirability of discharging the sewage on the ebb tide only has always been recognized, but the Corporation is not in a position to carry out the necessary works at the present time, in view of the still more urgent demands on its funds. It must be remembered also that the point of outfall is at a considerable distance from any thickly populated part of the City, and it is probable that a great part of the nuisance which is popularly supposed to emanate from it is really attributable to the katchra filling of the Flats and to the sewage in the storm water reservoir. The former will cease before the monsoon of this year and the latter will diminish year by year and finally disappear as the sewers are completed and houses connected, when the storm water drains will be used for their legitimate purposes only.

4. Mr. Latham calls special attention to the fact that the various portions of the main sewer running from Carnac Bridge to Love Grove have been joined invert to invert, and he arrives at the conclusion that the Bombay sewers cannot be self-cleansing. In this connection it is necessary to bring prominently to the notice of the Corporation that when he wrote his report in 1890 the main

Sewer.

never was in exist. conclusion seems to have forced itself on him. The emphasized then as interfering with the proper flow of ti. e were the great deposits of silt in the masonry sewers, and the e of the pumps at Love Grove to keep the sewage sufficiently low. d so assist in maintaining a proper fall in the sewers. It will be seen from page 54 of the "Sanitation of Bombay" that Mr. Latham was apparently of opinion that with sufficiently powerful pumps the level of the sewage might be kept parallel with that of the invert, and he is well aware that Worthington pumps giving a very high percentage of efficiency have been substituted for the old pumps. It is difficult therefore to understand on what grounds he has changed his opinion as to the sufficiency of the size or gradients of the masonry sewers since 1890. The greater part of the sewerage system of Bombay is provided with flush tanks not only at the heads of the sewers, but also at intermediate points, and a sum of Rs. 54,000 has been provided in the Budget of the current year for additional flush tanks on pipe sewers and tidal flaps on the ovoid sewers; special attention has been and is being given to the removal of silt and in many cases catchpits have been constructed at the junction of main and pipe sewers as an experimental measure which may hereafter be extended and the completion of the system of sewers and the connection of houses will be pressed on as rapidly as circumstances will permit. It will be impossible for many years to come to abolish altogether the practice of collecting solid excrement from privies and emptying it into the sewers at depôts, and any attempt to do so would be productive of worse nuisances than now accompanying its disposal. In some parts of the City, however, the removal of this matter direct to the sewers is feasible, and I am taking steps to secure this result. I need hardly say anything more on Mr. Latham's criticism of the system of sewers and their working. His information even as to the volume flowing through them is not up to date, and all his calculations and conclusions must be vitiated by his ignorance of their present condition. Add to this the facts that the position selected by him for the outfall was rejected, and that the Corporation has committed the deadly sin of adopting the Shone system, and we have all the preliminaries complete for a violent attack on the Corporation and all its works.

5. Turning next to the Shone system I forward herewith a letter from Mr. Shone to the Special Drainage Engineer, which I think it only fair to place before the Corporation that Mr. Shone's side of the question may be heard. I do not propose to waste time in attempting to hold the balance between the contending parties. Here again the matter is *res judicata* as far as the Corporation is concerned, and the Shone system is to be introduced in the Sectional districts of the southern portion of the Island. I may only add that I have been in communication with the Municipal Authorities of Rangoon and Karachi where the Shone system is worked, and they have nothing but praise for it.

In Colaba the system has worked well in 1898-99. The Secretary of the Rangoon Municipality informs me that 16' ventilating shafts have been provided, and that the smell from the exhaust air even when thus discharged at ground level is practically imperceptible.

6. I regret that this report should have been delayed, but after receipt of the Engineers' reports I considered it desirable to make the enquiries referred to in the last para. and to make myself better acquainted with the actual condition of the sewers before reporting on the matter.—I have, &c.,

W. L. HARVEY,
Municipal Commissioner.

No. 12551 of 1898-1899.

BOMBAY, 26th November 1898.

TO THE MUNICIPAL COMMISSIONER.

SIR,—I have the honour to forward herewith letter No. D-7968 of 16th September 1898 from the Deputy Executive Engineer, Drainage, and to report that that officer has so fully dealt with the subject that it is hardly necessary for me to say anything at length on it.

2. Mr. Baldwin Latham points out the following defects in the existing sewerage system of Bombay :—

- (a) That the several sections of the main sewer from Carnac Bunder to the Pumping Station at Love Grove are laid level upon their invert and not connected top with top as they should be ;
- (b) That the sewers are constructed of a capacity sufficient to carry the sewage of the whole city, but all the houses not having yet been connected with them, the full quantity of sewage is not discharged into them, with the result that the velocity of the flow of the sewage is small and the sewers are not therefore self-cleansing ;
- (c) That solid matters enter the sewers through temporary fair-weather connections ;
- (d) That the outfall should be at Colaba near the Prongs Light House and not at Worli as at present ; and
- (e) That the Shono system of sewerage is objectionable because it causes a large quantity of foul air to be liberated in the atmosphere.

3. As regards (a) it may be pointed out that the principle of joining sewer top to top was not considered of special importance twenty years ago, when the sewers of Bombay were commenced. This is fully borne out as pointed out by Mr. Smith by the diagrams given in Mr. Baldwin Latham's book on Sanitary Engineering and in Mr. Robert Rawlinson's book of suggestions for the sewerage of cities. As pointed out by Mr. Smith it is necessary to join the sewers top to top only when they run full bore, which is seldom the case with our sewers during the greater part of the year.

4. As regards (b) it may be stated that a considerable advance is made in the work of house-connections since the inspection of the sewerage works of this City by Mr. Latham, and this is clear from the fact that while "the total volume of sewage flowing through the Bombay sewers was under eight million gallons per day" when inspected by Mr. Latham, this quantity is now actually from 25 million gallons to 34 million gallons per day as stated by Mr. Smith.

5. The temporary connections referred to in item (c) are very few, and care is taken to prevent, as far as possible, the admission of solid matters through them into the sewers. The number of these connections will go on decreasing as the house-connection work progresses, and they will be entirely done away with when all the houses in the City are connected with the sewers.

6. The question of diverting the outfall from Love Grove to Colaba referred to in item (d) was discussed by an independent Committee appointed by Government, and they came to the conclusion that it was not necessary to divert the outfall as recommended by Mr. Latham. I am not prepared to say that an outfall at Colaba would not be a far better course to adopt, but it is too late now to consider that question. It would no doubt be an improvement upon the existing outfall at Love Grove if the sewerage were stored in tanks and discharged into the sea at ebb-tide as recommended by Mr. Latham. This would, however, entail the execution of costly works, and the matter might be considered when the financial condition of the Municipality improves.

7. As regards point (e), Mr. Smith has fully discussed the question in paras. 22 to 38 of his report. It is a well-known fact that Mr. Latham is an advocate of the system in which water under pressure is utilized for lifting up sewage, and Mr. Shone is an advocate of the system invented by him in which air under pressure is utilized to do that work. Both these gentlemen are therefore rivals, and the statements made by any one of them against the other must be taken with a great deal of caution.—I have, &c.,

M. C. MURZBAN,

Executive Engineer.

No. D-7968 of 1898-99.

BOMBAY, 16th September 1898.

TO THE EXECUTIVE ENGINEER.

Re Letter, dated Westminster, 21st January 1897, addressed by Mr. Baldwin Latham to the President of the Ahmedaba Municipality.

SIR,—I have the honour to observe that that letter, as far as it concerns Bombay, should not in my opinion be taken too seriously, for it appears to me from a general consideration of the letter that the main purport is not so much to reform the sewerage of Bombay as to encourage the Municipality of Ahmedabad in proceeding farther along the course traced for them by Mr. Latham, and to warn them of the possible consequences of straying from that course.

2. The new scheme which Mr. Latham prepared for the drainage of Bombay consisted of a high-level sewer from above Government House, Parel to Colaba, with an outfall at the latter place, but this would not have materially increased the area that could be dealt with by other means than the Sectional System, and his scheme involved the retention of the Love Grove Pumping Station for lifting and forcing the sewage from that Station to the head of the proposed sewer at Parel.

3. This new scheme was carefully considered by a very competent and influential Committee appointed by the Government of Bombay, and that Government, after receiving the report of the Committee, issued a Resolution, dated 15th September 1891, in the following terms:—

“The Governor-in-Council, looking to the prohibitive cost of constructing the outfall so far out as the Prongs Light House, a measure which would be necessary to ensure the safety of the troops and the public resident at Colaba, cannot but consider that it would be unreasonable to ask the Municipality to place it there, while the objections urged by the Committee against its location in the site proposed by Mr. Latham * * * are such as to render that position undesirable * * *. Having regard to the facts that Mr. Baldwin Latham himself considered the Worlee site as the second best for the purpose, and that the Committee give weighty reasons for regarding it as, in all circumstances, the best site, the Governor-in-Council is pleased to approve of the recommendation that Worlee should be the place selected for the outfall of the drainage of Bombay.”

4. Mr. Latham's proposal of a new high-level sewer therefore necessarily fell to the ground.

5. I quite agree with Mr. Latham that sewers of different sizes should as a rule connect together top with top, and as Special Drainage Engineer, I have generally adopted the principle in my designs, though there is no special virtue in that principle unless it is intended or expected that the drain shall or will run full. If otherwise, it is not objectionable to so join sewers that the water line or surface of the water in the smaller sewer shall not be lower than the water line in the larger sewer.

6. The regulation of joining sewers top to top is, however, a comparatively recent principle of sanitation, and was not recognized as one of general importance and application twenty years ago when the sewers of Bombay were commenced.

7. Mr. Baldwin Latham himself, even in the second and latest edition of his "Sanitary Engineering," published in 1878, shows in his Plate IV three sewers joining together with the inverts of the two smaller drains level with the invert of the larger drain.

8. In the same book, Figure 59 shows a drain which on page 283 is described as a "pipe-sewer or house-drain" joining an ovoid sewer half-way between the invert and the springing of the latter.

9. I have also now before me a book of suggestions and typical plans for the sewerage of cities revised to 1878 issued by the highest sanitary authority in England, the Local Government Board, and signed by no less a personage than Robert Rawlinson.

10. In this book the principle of joining sewers top with top is nowhere shown or advocated, but on the contrary sewers are shown connecting in some cases invert to invert, in other cases centre to centre, and in the cases of bell-mouth junctions springing to springing.

11. All the bell-mouth junctions in Bombay were constructed on this last-mentioned principle (so that the sewers do not all join invert to invert), though in one case the branch sewer was afterwards cut down (not by my orders) to the level of the larger sewer.

12. Mr. Latham shows the worst possible effect of sewers joined invert to invert in that he assumes for the purpose of his illustration that the sewers run full, a condition very seldom obtaining in Bombay.

13. Although in "The Sanitation of Bombay" it may be gathered by inference from Mr. Latham's remarks regarding the connection of the Marine Lines sewer with the Queen's Road sewer that sewers should join top to top, yet in no part of that book is the principle definitely laid down nor is it stated that the omission of that principle constitutes a radical defect in the sewers of Bombay.

14. On the other hand, Mr. Latham states that all the main sewers have been properly designed with reference to their size and

gradient, and attributes their deficiency in self-cleansing properties to their being unfairly treated in that they "are robbed for a considerable portion of their length of the sewage that should flow into them which, if admitted, would keep them in comparatively good order."

15. I fully concur with Mr. Latham in this opinion, and the obvious remedy for the present state of affairs is to proceed with the house drainage connections as rapidly as possible.

16. The Municipal Commissioner is aware from letters addressed to him, notably letter No. S.D. 2277, dated 5th September 1896, that the Special Drainage Engineer proposes that the sewage now passing through the Queen's Road sewer should be raised at two points, viz., (a) the Marine Lines station of the B. B. & C. I. Railway, and (b) the junction of Churni Road and Khetwadi Back Road.

17. Until, however, the provision of the new air compressing machinery at Love Grove has farther advanced, it would be premature to bring up the subject for final disposal.

18. In the meantime new and more powerful engines have been provided at Love Grove and a considerable advance has been made in house drainage connections (that advance being still continued), and therefore there is an appreciable improvement upon the conditions prevailing at the time Mr. Latham was in Bombay.

19. The quantity of water pumped at Love Grove is now very much more than eight million gallons per diem, it being actually from 25 millions to 34 millions a day.

20. It is useless to consider the question of locating the sewage outfall at the southern extremity of the Island, that is, at Colaba point, because after a careful consideration of Mr. Latham's proposals Government declined, as I have above pointed out, to allow an outfall to be established at that place, and the objections have since been reiterated on the occasion of further references made to Government on the subject.

21. The Love Grove outfall would doubtless be much improved by the construction of reservoirs on the foreshore which would admit of the sewage being discharged only during a certain period of the ebb-tide, and I hope that arrangement will be carried out at some future time.

22. The Shone system was not adopted in Bombay until after the most deliberate consideration and after satisfactory experience of its working at Colaba.

23. The uncomplimentary remarks which Mr. Latham applies to every one who advocates and adopts the Shone system lose much of their poignancy when we consider how many eminent personages and important Municipal authorities come under their ban.

24. If we are erring we are doing so in very excellent company, and I believe I shall not be far wrong if I venture to say that the only eminent opposer of the Shone system at the present time is Mr. Baldwin Latham, since the ranks of the opponents have been deserted by Mr. James Mansergh, who is only second to Mr. Latham if not his equal as a Sanitary Engineer.

25. For the sewerage of our Sectional Districts, *i.e.*, those that could not be drained by gravitation to Love Grove, we had only two alternatives, one being the Latham-Davy Hydraulic Pumping system and the other the Shone Pneumatic Ejector system, the former working with water at a pressure of from 700 to 800 lbs. per square inch, and the latter with air at a pressure of from 20 to 30 lbs. per square inch.

26. Mr. J. C. Pottinger, Sanitary Engineer to the Government of Bombay, in comparing the two systems, says: "The first cost of the Pneumatic (system) as well as its working expenses is less than that of the Hydraulic (system). Lighter and smaller pipes with far less pressure can be used, a speed of 60 feet per second is admissible with air, but 3 feet is the limit for water; and there is no shock with the former, whilst there is considerable shock with the latter. Although the exhaust water of the hydraulic system flushes the sewers, it takes up space in them and costs money; whilst the sudden discharge of the Ejector acts as a flush and the exhaust air ventilates the sewers without either of these objections."

27. He says further: "The unanimity of the responsible authorities in the different places and under widely different conditions is most significant; as is also the fact that wherever the (Shone Pneumatic) system has been tentatively adopted, its use has invariably been subsequently extended as at Eastbourne, Southampton, Warrington, &c., for the reason given, *viz.*, economy in first cost, and in working, simplicity, adaptability and prevention of all smells or nuisances."

28. In my opinion the Latham-Davey system would be particularly unsuited to Bombay on account of the gritty character of the sewage, which causes considerable wear and tear even in the large pumps at Love Grove, and would be still more detrimental to the pumps of the Latham-Davey system which take the place of the Ejectors in the Shone system.

29. As regards the working of the Sectional districts, the comparison must be between only the Latham-Davey system and the Shone system, and it is entirely unfair to compare either of these systems with the working of an ordinary pumping engine such as we have at Love Grove.

30. In those two Sectional systems the power is transmitted from a central station, and there must be loss in such transmission, while in an ordinary pumping station, such as that at Love Grove the power is applied directly.

31. I have never been able to detect anything offensive in the exhaust air discharged from the Ejectors at Colaba, and even if it were as foul, as Mr. Latham assumes it to be, the quantity of air should not be compared with the quantity of sewage, but with the quantity of air ready to dilute it immediately on its discharge.

32. At Colaba the exhaust air, after having performed its work in the Ejectors, passes through very high shafts before being liberated into the atmosphere.

33. Mr. Doig, Sanitary Engineer to Government, in reporting on the Shone system at Rangoon, says there was practically no smell from the exhaust air from the Ejectors, although the exhaust air in that city is discharged through gratings on the surface of the roads.

34. With regard to the effect of the Shone system on the health of Rangoon, I beg to append two letters, one dated 23rd August 1895 from Mr. Baldwin Latham to the President, Rangoon Municipality, and the other dated 22nd January 1896 from the Secretary, Rangoon Municipality, to Mr. Baldwin Latham, and I beg to draw particular attention to the following paragraph in the latter letter :—

“Your public statements as to the increasing unhealthiness of Rangoon due to the introduction of the Shone system will probably not do any particular harm to Rangoon, but they are incorrect and might possibly prejudice people against both Rangoon and against a drainage system which has been proved to be most admirably suited to the place.”

35. As regards the effect of the Shone system upon the health of Karachi, I have made enquiries of the Engineer and Secretary, and I am informed that the health of Karachi has not deteriorated since, or because of, the introduction of the Shone system.

36. Mr. Acworth, when Municipal Commissioner, having received most favourable reports of the working of the Shone system, and knowing that a sectional system must be adopted for certain parts of Bombay, came to the conclusion that the Shone system was the best.

37. I cannot find, however, from the records that Mr. Acworth made any stipulation regarding the Shone system in his negotiations with Mr. Latham with a view to his acting as Consulting Engineer to the Bombay Municipality, but it may be seen from Mr. Acworth's letter to the Municipal Secretary, No. 9908, dated 10th August 1893, that during the course of those negotiations Mr. Edgelow (Mr. Latham's agent) produced a letter from Mr. Latham in which he declined to serve a Municipality which had anything to say to the Shone system of sewerage.

38. It must be remembered that this occurrence took place a long time after the departure of Mr. Latham from India and the publication of his book on the Sanitation of Bombay.

39. Mr. Latham's remarks upon the production and dissemination of plague and the means of combating the disease are extremely interesting, but I presume it is not expected that I should discuss those points in this report.—I have, &c.,

JAMES W. SMITH, M.I.C.E.,
Dy. Executive Engineer, Drainage.

Dated August 23rd, 1895.

From BALDWIN LATHAM, Esq.,
Civil Engineer,
To THE PRESIDENT, Rangoon Municipality.

DEAR SIR,—I am very much indebted to you for having forwarded me the report of the Medical Officer of Rangoon for the year 1893. I regret that I have not had any time to look through it until recently, when my attention has been directed to the subject of the sanitation of Rangoon, and in going through it I find that some error has evidently crept into it; for instance, in Table 12, as I was very desirous of knowing what was the relative state of health of the different districts, in adding up the total of the columns for 1888, 1890, and 1891, I found that the number of deaths at the foot of the column does not agree with those inserted in the column itself. Evidently there is some discrepancy, especially as it would appear that for the district called Tanway there must be some misprint or error.

In looking into all the figures which refer to Rangoon, I am very much impressed with the extraordinary change which appears to have taken place in the health of the district since the Shone system has been in operation, and that, if the 5 years before, from 1885 to 1889, are compared with the 5 years subsequently, 1890 to 1894, there appears to be a most extraordinary increase in the death-rate, such increase, however, not occurring in any of the towns of Lower Burma or in Burma itself, shewing that, in spite of the lavish expenditure on the Shone system introduced into this district, it has been anything but of a beneficial character.

I am quite aware of the statement which has been made with regard to the improvement since 1890 in this district, but unfortunately a district in which a new system has been introduced cannot be compared with itself. If compared with itself, it must be with some period of years when not under the influence of the special system in operation.

If the populations of the districts are properly interpolated according to the late Dr. Farr's method, as adopted by the Registrar-General of England, and in other cases, it would be at once seen that in the 5 years, before the Shone system came into operation in Rangoon, compared with the 5 years subsequently there has been an

increase in the death-rate of nearly 10 per thousand in the latter 5 years, which of course I attribute, as I have pointed out, to the pernicious effects of the Shone system in diffusing foul air into the district in which it is in operation.

The same thing has occurred in the only other district in England in which the Shone system has been entirely adopted, namely, at Henley-on-Thames, that is, comparing the years subsequent to its adoption with the years previous, there has been also an increase in the death-rate in this district.

You cannot bring air under high pressure into contact with sewage without liberating into the atmosphere an enormous amount of sewage or fecalized air which is the most detrimental to health of all forms of pollution, and a very slight test made by charging the sewage with some chemical compound easily detected in the air, such as lithia, and then testing the air escaping from the ejectors by spectrum analysis, will shew at once how the sewage air is diffused into the atmosphere by the Shone Ejectors, and this sewage air escapes in very considerably larger volumes than the sewage itself which is removed from the district, and this sewage air, distributed at numerous points throughout your district, is scattered by the winds of heaven in various directions to exert its pernicious effects upon the health of the population. Moreover, the combination of air for raising water in which the same pipes are used which may be directly in connection with those foul ejectors is not a system to be commended when it appears that the ejectors at times are not under pressure, so that there is a means of getting direct access of sewage air to the water-supply.

What I really wanted was, not the reports of the Medical Officer of Health, a single copy of which has been forwarded to me, but the annual reports of the Municipality itself which give quite sufficient information upon the question of the health of Rangoon, and also the statistics which are not contained in the Medical Officer of Health's report, but I should very much like to know which are the districts in which it is alleged that the actual Shone system is in operation, as the Tables I, VII and XII do not shew which districts are in the town proper and have the Shone system or which have got a pipe water-supply, all of which are points of very considerable importance.

Of course, from a study of the various reports I personally know that certain districts are within the suburbs, but as to what are the districts which the Municipality themselves take into consideration no information is given, although they make statements in the reports as to relative differences in the health of the districts.

If you wish to know the actual state of health of Rangoon at any time, it may be readily found out from a method which I introduced some years ago, of proportional mortality, which is very fully described in the *Times of India* of the 11th of May of the present year. For example, the population of Rangoon in the census

year of 1891, in the middle of the year, if properly interpolated, is 181,862, which would give a death-rate of 36·78 per 1,000 in that year. Now, if the births are divided by the deaths in any year and the result is multiplied by 93·62 and taken from the tabular number applicable to Rangoon of 73·55, it will give the proportional death-rate in any year, that is, the death-rate proportional to the death-rate in 1891.

With 6,950 deaths in 1894 and 3,102 births, the proportion of births to deaths is 4,463, and the proportional mortality is therefore 31·76 per thousand, which is a less death-rate than if we assumed the population since 1891 as increasing in the same ratio as it had previously to 1891, and which shows that in all probability the population has increased faster than it had done previously to 1891, and the district is certainly healthier than it was in that particular year, 1891, as the proportion of births to deaths is larger, and the health of a district might just as well be ascertained from the proportion of births to deaths as in any other way.

The only report of the Municipality of Rangoon which is in my possession is that for the year 1889-90. I should very much like to see the subsequent reports, but I have had access to the various reports made by the Municipal Commissioner of Burma and other documents which are in this country at the India Office.—Yours faithfully,

BALDWIN LATHAM.

(True Copy.)

W. LENAINE,

Head Clerk, Rangoon Municipality.

No. 2029-568.

DATED RANGOON, *the 22nd of January, 1895.*

From

THE SECRETARY, RANGOON MUNICIPALITY.

To

BALDWIN LATHAM, Esq.

SIR,—I am directed to acknowledge the receipt of your letters, dated the 23rd August last, regarding the death-rate of Rangoon, more especially in connection with the effect of the Shone system of drainage which has been adopted for a portion of the Municipality. Your letter has not been answered until now, as it was thought desirable to include the figures for 1895 so that my reply might furnish you with the latest information.

2. It is noticed that from the information at your command, and in the last paragraph of your letter, you state that you have no Municipal reports subsequent to that of 1889-90, you have concluded

that the death-rate of Rangoon has considerably increased, and which you say "of course I attribute to the pernicious effects of the Shone system in diffusing foul air into the district in which it is in operation," and you add that the same thing has happened in the only other districts in England in which the Shone system has been adopted. I am to point out that as regards the districts alluded to in England this Municipality is not concerned, but as regards Rangoon both your facts and the conclusions arrived at by you from them are erroneous. This is probably due to your want of local knowledge of both the Shone drainage system here, its area of adoption and its effects and working, and also of certain facts connected with the registration of vital statistics.

3. As regards registration of births and deaths, no proper system was introduced until 1889-90. Previous to that year registration was left to a large extent to the Police, who simply kept registers and recorded births and deaths when reported to them; they were not in any way obliged to see to registration in their districts and were in no way interested as to omissions to register or as to the correctness of the returns. The slight knowledge that you may have of Indian cities will make it patent to you how imperfect registration must have been under such a system. The system employed since 1889-90 is entirely under Municipal control, and, as regards deaths, no doubt results in fairly accurate registration. Registration of births is very defective; not only here but throughout India, probably, and this is due to local causes which it would, perhaps, be difficult for you to understand thoroughly without a knowledge of the customs of the races inhabiting India, and their explanation would be tedious and not without difficulty. However, it is the death-rate which interests you, and the birth-rate has only been alluded to to point out that Dr. Farr's method of arriving at the death-rate, or the method of your own for the same purpose, would be useless in Rangoon, as would any method that included a calculation based partly on the number of births registered.

4. The presumed population of Rangoon for ten years from 1891 has been fixed by the Census Commissioner, and the following table gives the death-rate since 1890 in the district of Rangoon in which the Shone sewage system has been adopted entirely, based on the Census Commissioner's figures. :—

						Death-rate.
1890	...	...	...	...	...	32·91
1891	...	...	...	...	...	31·24
1892	...	...	..	...	...	25·16
1893	..	...	...	...	...	26·31
1894	...	...	...	...	...	26·95
1895	...	...	...	...	...	21·23

The sewage works were formally opened by His Royal Highness Prince Albert Victor on the 23rd December, 1889, but the works were not really completed until April 1890. During 1890 and

1891 the Municipal Committee had to use every endeavour to get house-owners to make drainage connections, and in 1891 obtained power from the Legislature to compel owners to connect houses. The result is apparent in the returns. It may be noted that the death-rate in 1895 for the districts outside of those shown in the above table was 31·32.

5. I am to add that the Municipal Authorities are perfectly satisfied with the Shone system as applied to Rangoon, both from an engineering and a sanitary point of view. It is to be regretted that from want of correct information, which could easily have been obtained from this office, that you should have arrived at conclusions that are at complete variance with the facts, and it is still more to be regretted that you should have made your conclusions public. Your public statements as to the increasing unhealthiness of Rangoon due to the introduction of the Shone system will, probably, not do any particular harm to Rangoon, but, as they are incorrect, and might possibly prejudice people against both Rangoon and against a drainage system which has been proved to be most admirably suited to the place, the President trusts that, now you are fully possessed of the facts, you will make a point of correcting the statements you have made.

A copy of this letter has been forwarded to Mr. Isaac Shone, together with a copy of your letter to which it is a reply.—I have, &c.,

(Sd.) J. SHORT,
Secretary, Rangoon Municipality.

(True Copy.)

W. LENAINE,
Head Clerk, Rangoon Municipality.

47, VICTORIA STREET, WESTMINSTER,
LONDON, S.W., 9th September 1898.

The Bombay Drainage.

DEAR SIR,—Whilst away from London on a holiday, I received from my partner, Mr. Ault, your letter to him, dated the 8th ultimo, forwarding a printed copy of Mr. Baldwin Latham's letter addressed to the President of the Ahmedabad Municipality so long ago as the 21st January 1897, but which you state had only just come to the knowledge of the Bombay Corporation.

2. I may state that both Mr. Ault and myself had already seen extracts from Mr. Latham's letter referred to, as they appeared in one of the columns of the *Times of India* on the 30th July last under the heading "Mr. Baldwin Latham on the Drainage of Bombay"; and both of us thought it was strange, having regard

to the importance of the subject-matters of the letter, the gentleman to whom it was addressed did not at once on its receipt, now nearly two years ago, forward it to the Bombay Municipality, if he believed that Mr. Latham seriously meant all he stated in his letter to him of the 21st January 1897. But be this as it may, it does seem passing strange that Mr. Latham should write to the President of the Ahmedabad Municipality at all, to try to disparage the conduct of, and to lecture, the Bombay Municipality in connection with the decision which the latter came to with reference to his Bombay drainage proposals. Doubtless, however, good reasons may be adduced, why the President of the Municipality of Ahmedabad wrote in the first instance his letter of the 31st December 1896 to Mr. Baldwin Latham, and why the latter's letter in reply has not been made public till now. I think, however, it is a pity a copy of, or extracts from, the letter of the President of the Ahmedabad Municipality, No. 1597 of the 31st December 1896, addressed to Mr. Latham had not also been inserted in the issue of the *Times of India* for the 30th July 1898, as without that letter it is not possible for me here in England at all events to comprehend the relevance or otherwise of what I venture to call Mr. Latham's extraordinarily injudicious and exaggerated remarks as they are set forth in his letter in question.

3. What I mean by what I have just stated about Mr. Latham's injudicious and exaggerated remarks I hope to be able to demonstrate later on in this letter.

4. My first impulse on reading the extracts of Mr. Latham's letter in the *Times of India* led me to think it was fortunate that a number of able and honourable Municipal and Government Engineers, Medical Officers of Health and other officials in India knew by this time that Mr. Latham's periodical dogmatic pronouncements against the Skene system of town drainage had been controverted again and again not only in England but in India also, and that in fact they had as often been proved to be as ridiculous as they were scientifically and practically untenable; and therefore I thought it would not be necessary for me or my partner to write a long letter to the *Times of India* by way of reply to his latest demonstration which counts (as it appears to me) about the 100th exhibition of his ill-will and prejudice against my system of town drainage. But of course, when I saw your letter of the 8th ultimo, with its enclosure, addressed to Mr. Ault, I decided at once that it was the duty of one of us to answer through you, in part at least, Mr. Latham's letter to the President of the Ahmedabad Municipality; and as my partner was full, and is still, of work at the office, and as I am away taking a holiday, I undertook to write a reply to the letter myself.

5. I do not propose to dwell upon and to animadvert at length on those parts of Mr. Latham's letter which relate to the main gravitation sewers and outfall works, which he found to exist in Bombay, when he first visited that city, as I feel quite sure you

will, with your intimate and practical knowledge of the existing and proposed outfall, and the drainage works of Bombay, be better able to deal with those works than I can possibly do in England.

6. I should like however to draw attention to two or three of Mr. Latham's statements bearing on the sewerage and outfall arrangements which existed in Bombay, when he first visited it with the object, the more briefly and readily later on, to elucidate my views of the inconsistency of Mr. Latham's theories and statements in regard to the effect of adopting my system of town drainage "in an Indian City."

7. He wrote his Report on the Bombay Drainage on the 13th March 1890. In his letter, dated 21st January 1897, addressed to the President of the Ahmedabad Municipality, he states amongst other things :—

(a) "I am not at all surprised to find that there are persons who are likely to attribute the outbreak of the plague in Bombay to the unsatisfactory state of the drainage of that city."

(b) "I discovered that the system of sewerage which had been brought into operation was by no means such a perfect system as ought to have been adopted in an Indian City."

(c) "But the houses in Bombay have never been connected up to the sewers, so that although the sewers are calculated to convey a considerable volume of sewage, and if they could carry this volume of sewage, they would be more likely to be self-cleansing than they are, yet owing to the sewage not being admitted to them the absolute velocity of flow in the sewers is so small that it is absolutely impossible for it to carry any solid matters forward to the point of outfall."

8. And in his Report on the Bombay Drainage, he states :—

(d) "In Bombay the Authorities have rightly considered works of sewerage necessary to secure the health of the people and have inaugurated a system of sewers; but unfortunately the system is not complete, and what has been done is so misused as, in my judgment, to seriously threaten the health of the people. The sewers of Bombay, instead of being put to their legitimate use, have been converted into underground receptacles of decomposing filth, and, instead of flowing with an ever moving and living stream, are silted up with decaying matters, giving off deadly gases to the positive injury of the health of the people."

9. But he adds in his letter to the President of the Ahmedabad Municipality :—

(e) "The errors which have been perpetuated in the drainage of Bombay have not arisen in the area which has been carried out at Ahmedabad, and the consequence is that while your sewers, according to your own statement, are shown to be absolutely free from deposit, this is not the case in the Bombay sewers."

10. He also states :—

(f) “The delay arising from the question of house connections in Bombay is a matter which an experienced Engineer would have successfully settled in five minutes, but things appear to be governed in Bombay more by sentiment than by actual knowledge or experience. What could possibly be more detrimental to Bombay than the position of its existing out-fall and the large sewage lake which is allowed to exist on its western shore for so long a period? At the present out-fall on the western side the sewage is discharged at all stages of the tide, to be brought back by every flood upon the shore in the immediate neighbourhood, thus fouling the whole coast on the west side, or the side from which the prevailing winds blow that bring the fresh air for the invigoration of the inhabitants of the city.”

11. I have given the foregoing quotations for the reason primarily that I wish to emphasise the fact that when Mr. Latham penned his letter to the President of the Ahmedabad Municipality, he had in his mind what he himself had seen when he inspected the drainage and out-fall works of Bombay eight years ago, and that the insanitary conditions of those works were so bad that, he was “not at all surprised to find” (from something stated I presume in the letter addressed to him on the 31st December 1896 by the President of Ahmedabad) “that there are persons who are likely to attribute the outbreak of the plague in Bombay to the unsatisfactory state of the drainage of that city.”

12. The Shone System was not in operation at the date of Mr. Latham's visit to Bombay, although I have reason to believe it was discussed more or less favourably by a number of people interested in the Drainage question in Bombay, and indeed in India generally. But Mr. Latham, as the then consulted Engineer of the Bombay Municipality, would have none of it, for the selfsame reasons which are advanced in his letter to the President of the Ahmedabad Municipality. In fact, I make bold to say that Mr. Latham misdescribed the Shone System so much, when he visited Bombay, and especially the works and the effects of the works of the System as carried out at Rangoon, that Mr. S. B. Doig, M. Inst. C. E., Sanitary Engineer and Member of the Sanitary Board, Bombay Presidency, visited Rangoon for the purpose of inspecting the works carried out there on the Shone System; but he luckily met Mr. Baldwin Latham in Bombay before going, and told him frankly the object of his mission to Rangoon. After doing so, he asked Mr. Latham to be equally frank with him, by telling him his opinion of the Shone System.

13. Mr. Doig in his official report of 1892, and after his visit to Rangoon, referring to the result of the interview described above, states that Mr. Latham most strongly opposed the System, and in para. 4 of his report enumerates the principal objections which he brought forward against it.

14. Mr. Doig answers the objections in paragraph 34 of his report, but for your convenience, I will give each objection and each answer together. They are as follows :—

Objection (a).—“That the smell of the exhaust air from the Ejectors was most offensive in consequence of its contact with the sewage while under pressure.”

Answer (a).—“Smell practically none, and even if there should be, there is no reason why it could not be got rid of by the erection of a ventilating shaft and passing the exhaust to it.”

Objection (b).—“That the noise made by the Ejectors when discharging, was liable to frighten horses passing in the streets and this might be the cause of serious accidents.”

Answer (b).—“Noise practically none.”

Objection (c).—“That, owing to the faulty design of the Ejectors they were not reliable, and that the sewage and air as were likely as not to escape the wrong way, and cause serious damage to the gravitation sewers.”

Answer (c).—“The Ejectors have proved perfectly reliable ; there have been 26 daily in work during the last two years, and they have never given the slightest trouble.”

Objection (d).—“That the initial cost was enormous.”

Answer (d).—“Low efficiency. Of this there is no doubt; the result of the official trial given in paragraph 9 shows that at present 67·4 per cent. of power is wasted, but it must be remembered that to compensate for this loss, the following advantages are gained” :—

(1). ‘The interception and disposal of the sewage at higher levels and the consequent saving of power, as compared with a single pumping station, at which the whole sewage is collected only to be pumped up again, the fall to the pumps being so much absolute waste of power.

(2). The facility with which one or more districts can be completely and finally sewered, according as funds are available, also the easy extension of the System to other districts.

(3). The size of the sewers is reduced to a minimum. The quantity of water for flushing, and the quantity of air required for ventilation, is also reduced to a minimum.

(4). Deep and expensive excavations and masonry sewers, and manholes at great depths are avoided.

(5). Steep self-cleansing gradients can always be obtained.

(6). And lastly, there is no silting up of the sewers and no ponding up of sewage, which is disposed of finally, as quickly as it is produced a result the value of which from a sanitary point of view, in a country like India, should carry the greatest weight.’

Objection (e).—"The initial cost, coming as it does in Rangoon, with all the additional expense of night-soil depôts, and iron gravitating mains, to Rs. 19 per head, cannot be looked on as ruinous."

Answer (e).—"The annual cost of working, viz., 8 pies, or one penny per 1,000 gallons raised 60 feet high, is also moderate."

And in paragraph 38 Mr. Doig stated :—

"As to the result of my inspection, I have no hesitation in saying, that I consider the Shone Drainage System, when combined with efficient house connections, to be as near perfection as possible from a sanitary point of view, and that it is difficult to conceive how a more simple reliable and sanitary arrangement for the quick disposal of sewage can be proposed than the Shone Ejectors."

15. I submit that the foregoing testimony of Mr. Doig, Sanitary Engineer and Member of the Sanitary Board, Bombay Presidency, who at the time of his inspection of the Rangoon works and at the date of his report of 1892 was unknown to me personally, ought to satisfy any impartial man or body of men that Mr. Latham's declarations about the Shone System ought to be set aside as being of no value, except as evidence of the author's unscrupulous determination to do all that in him lies to prejudice the minds of the people of Bombay in particular, and India in general, against it.

16. I must not omit to state here that, after writing his report of 1892, Mr. Doig was requested to write "Notes on Sanitary Works on the Continent and England"; and after visiting and inspecting works in those countries, he wrote a subsequent report, addressed to the Chief Secretary to Government, General Department, Bombay, on the 6th July 1893.

17. When he was in England I saw him, and so did Mr. Latham as his report explains. He of course inspected Mr. Latham's works on the Hydraulic principle, and he inspected a few of the works on my System, as per particulars given in his report, of which he was kind enough to send me a copy.

18. There are paragraphs in this latter report also which are worth reproducing here, viz. :—

"There are few towns in this Presidency which, it is probable, will admit of underground drainage on the above line being adopted without being divided into sections, and consequently it is thought that to ensure efficient sewerage sectional drainage will have to be resorted to, more or less, in every instance. If this is the case, then the only system which at present admits of most of the above requirements being obtained, is sectional drainage combined with either Shone's Ejectors, or Latham's hydraulic pumps. By them the sewers can be designed of minimum size, and they can be laid at as steep gradients as may be thought necessary. Further, by them the sewage can be sealed up almost immediately it is produced, and, finally, by the former it is claimed

“that the sewers can be artificially ventilated, and a more or less constant stream of fresh air drawn into them at all times and conditions of the day and night.

“If artificial ventilation should not be considered necessary, then it is merely a question as to which of the two systems is the cheapest, the most economical and the most efficient.

“On all these points figures are available for forming an opinion on the Shone System; but, as far as I am aware, no details have as yet been published regarding the working of Latham’s automatic pumps.”

19. The foregoing paragraphs appear to me to display the same extreme impartiality on the part of Mr. Doig, as is manifested in his first report. His concluding remarks in paragraph 14 are significant, and they are as true to-day as they were when they were written. That is to say, the wonderful economies in initial structural cost, and in the annual cost of working the hydraulic pumps in lieu of Ejectors, which were to be forthcoming and to be published broadcast to the world, after Mr. Latham’s Friern Barnet, Esher, and Margate works were completed, have never yet been published, although these works have been completed some ten years, and although I have again and again (when he has periodically attacked the Shone System, on the ground alleged by him that the mechanical efficiency realizable by working Ejectors was extremely low compared with hydraulic pumps) asked him for his data, he, as already stated, has never supplied any, and I believe, for the best of reasons, because he knows perfectly well that, if they were fairly and honestly published, so far from proving the correctness of his oft-repeated assurances, that hydraulic pumps as used by him cost less initially and annually than pneumatic Ejectors, they would prove the converse, and that too, in my opinion, in a way which could not reflect credit either upon his skill or his veracity as an Engineer. It must be obvious to you that the inference I have drawn from his conduct is the correct one; otherwise, looking at all that he has said from time to time on those questions of economy, unquestionably he would be only too glad to make them publicly known.

20. The remarks Mr. Latham makes in his letter to the President of the Municipality of Ahmedabad, as to the inferiority in two respects at least, of my pneumatic compared with his hydraulic sewerage system, (1) the alleged deleterious effects of the exhaust air, issuing out of the Ejectors into the atmosphere; and (2) the low efficiency of Ejectors compared even with the abandoned old Love Grove Pumping Plant, are grossly exaggerated and misleading.

21. With respect to the sanitary aspect of my system, he states:—

“It is shown by the figures published in Rangoon in the various trials which have been made with the Shone System in that city, that where air of 26 and 27 lbs. pressure above the atmosphere is used, the actual volume of fresh air was from 4.89 volumes to

" 5·73 volumes for each volume of sewage raised, so that for every
 " million gallons of sewage raised by this plan in the city over 5
 " million gallons of foul air are liberated in the atmosphere.

" I cannot conceive anything more deleterious to health than
 " the large volumes of foul air which must be liberated under the
 " Shone System, within the place in which the sewage is produced ;
 " and in my judgment there would be nothing more likely to lead
 " to the dissemination of the plague and such like diseases than the
 " dispersion of this foul air. In a previous letter I have already
 " drawn your attention to the fact that the recent Government Re-
 " ports show how the health of Karachi has suffered since it has
 " laid its new system of drainage on the Shone System ; and the
 " same thing occurred with regard to Rangoon, and so it will be
 " to the end of the chapter and this is a matter of which the Muni-
 " cipality of Bombay have full knowledge."

22. I will deal with Rangoon first. Mr. Latham's statements in his letter of the 21st January 1897, as to the increased unhealthiness of Rangoon, consequent upon the adoption of the Shone System were refuted on the 22nd January 1896, in an official letter addressed to him by Mr. J. Short, the Secretary of the Rangoon Municipality, and for your information I beg to embody here a copy of that letter together with a copy of the note to me which accompanied it :—

23. " No. 2030—568, dated Rangoon, 22nd January 1896.

" Copy of the following together with a copy of the letter to
 " which it is a reply forwarded to Mr. Shone for information."

" By order,
 " (Sd.) J. SHORT, Secretary.
 " Rangoon Municipality."

24

No. 2029-568.

Copy.

" Dated Rangoon, the 22nd January 1896.

" FROM THE SECRETARY, RANGOON MUNICIPALITY,

RANGOON.

" To BALDWIN LATHAM, Esq., C. E.,

WESTMINSTER CHAMBERS,
 13TH VICTORIA STREET, W. W.,
 WESTMINSTER, S. W.

" SIR,—I am directed to acknowledge the receipt of your letter
 " dated the 23rd August last, regarding the death-rate of Rangoon,
 " more especially in connection with the effect of the Shone System
 " of drainage which has been adopted for a portion of the Muni-
 " cipality. Your letter has not been answered until now as it was
 " thought desirable to include the figures for 1895 so that my reply
 " might furnish you with the latest information.

“ 2. It is noticed that from the information at your command (and
 “ in the last paragraph of your letter you state that you have no
 “ Municipal-reports subsequent to that of 1889-90) you have conclud-
 “ ed that the death-rate has considerably increased, and which you
 “ say ‘ of course I attribute to the pernicious effects of the Shone Sys-
 “ tem in diffusing foul air’ into the district in which it is in operation,
 “ and you add the same thing has happened in the only other districts
 “ in England in which the system has been adopted. I am to point
 “ out that as regards the districts alluded to in England this Muni-
 “ cipality is not concerned, but, as regards Rangoon, both your facts
 “ and the conclusions arrived at by you from them are erroneous.
 “ This is, probably, due to your want of local knowledge of both the
 “ Shone drainage system here, its area of adoption and its effects and
 “ working, and also of certain facts connected with the registration
 “ of vital statistics.

“ 3. As regards registration of births and deaths, no proper sys-
 “ tem was introduced until 1889-90. Previous to that year registra-
 “ tion was left to a large extent to the Police, who simply kept
 “ registers and recorded births and deaths when reported to them,
 “ they were not in any way obliged to see to registration in their
 “ districts and were in no way interested as to omissions to register
 “ or as to the correctness of the returns. The slight knowledge that
 “ you may have of Indian cities will make it patent to you how im-
 “ perfect registration must have been under such a system. The
 “ system employed since 1889-90 is entirely under Municipal control
 “ and as regards deaths, no doubt results in fairly accurate registra-
 “ tion. Registration of births is very defective, not only here but
 “ throughout India probably, and this is due to local causes which it
 “ would, perhaps, be difficult for you to understand thoroughly with-
 “ out a knowledge of the customs of the races inhabiting India, and
 “ their explanation would be tedious and not without difficulty.
 “ However, it is the death-rate which interests you, and the birth-rate
 “ has only been alluded to, to point out that Dr. Farr’s method of
 “ arriving at the death-rate or the method of your own for the same
 “ purpose would be useless in Rangoon, as would any method that
 “ included a calculation based partly on the number of deaths
 “ registered.

“ 4. The presumed population of Rangoon for ten years from
 “ 1891 has been fixed by the Census Commissioner and the following
 “ table gives the death-rate since 1890 in the district of Rangoon,
 “ in which the Shone System had been adopted entirely based on the
 “ Census Commissioner’s figures :—

“ 1890	Death-rate	32.91
“ 1891	Do.	31.24
“ 1892	Do.	25.16
“ 1893	Do.	26.31
“ 1894	Do.	26.95
“ 1895	Do.	21.23

“ The sewage works were formally opened by H. R. H. Prince
 “ Albert Victor on the 23rd December 1889, but the works were

“ not really completed until April 1890. During 1890 and 1891
 “ the Municipal Committee had to use every endeavour to get house-
 “ owners to make drainage connections, and in 1891 obtained power
 “ from the Legislature to compel owners to connect houses. The
 “ result is apparent in the returns. It may be noted that the death-
 “ rate in 1895 for the districts outside of those shown in the above
 “ table was 31·32.

“ 5. I am to add that the Municipal authorities are perfectly
 “ satisfied with the Shone system as applied to Rangoon both from
 “ an engineering and a sanitary point of view. It is to be regretted
 “ that from want of correct information, which could easily have
 “ been obtained from this office, that you should have arrived at con-
 “ clusions that are at complete variance with the facts, and it is more
 “ to be regretted that you should have made your conclusions pub-
 “ lic. Your public statements as to the increasing unhealthiness of
 “ Rangoon due to the introduction of the Shone System will, prob-
 “ ably, not do any particular harm to Rangoon, but as they are in-
 “ correct and might possibly prejudice people against both Rangoon
 “ and against a drainage system which has been proved to be most
 “ admirably suited to the place, the President trusts that, now you
 “ are fully possessed of the facts, you will make a point of correcting
 “ the statements you have made.

“ A copy of this letter has been forwarded to Mr. Isaac Shone
 “ together with a copy of your letter, to which it is a reply.—I have,
 “ &c.,

“(Sd.) J. SHORT, Secretary.”

25. A copy of Mr. Latham's letter (dated 23rd August 1895), to which the above is a reply, will be found in Appendix I at the end hereof.

26. Mr. Latham, however, was not satisfied with Mr. Short's reply to his communication of the 22nd January 1896, and so he addressed another letter to Mr. Short on the 15th September 1896 (see Appendix II), which was replied to as follows :—

27. *Copy.*

RANGOON, 25th January 1897.

“ FROM THE SECRETARY,
 “ Rangoon Municipality, Rangoon,
 “ To BALDWIN LATHAM, Esq.,
 “ 13, Victoria Street, Westminster.

“ SIR,—I am directed to acknowledge the receipt of your letter
 “ dated the 15th September 1896, regarding vital statistics and the
 “ Shone System in Rangoon.

“ In reply, I am desired to forward a statement showing the num-
 “ ber of deaths in, and the population of, the districts served by the
 “ Shone System and those not so served and the last report of the

“ Health Officer. All the copies that can be spared of the Municipal Administration Reports for years previous to 1895-96 have already been distributed, but a copy of the report for that year is forwarded. No charge is made for these documents.” I am to point out that in your letter dated the 23rd August 1895, you stated that you had had access to the various reports made by the Municipal Commissioners of Burma, so apparently the information you desire has been already obtained, although I am to say that such an official as a Municipal Commissioner of Burma is unknown here.

“ With regard to the concluding paragraph of your letter under reply, I am to say that the President has no desire to interfere with you in ‘ exposing humbug wherever it is found,’ but he has neither the inclination nor the time to join you in a crusade of such magnitude. He would also suggest that, instead of devoting your attention to Rangoon drainage, you could find better and more suitable opportunities in England, where the matter to be exposed would be readily accessible to you, so that you could make yourself acquainted with the facts before making public your opinions.

“ As has already been pointed out to you in my letter No. 2029—568, dated the 22nd January 1896, the Shore System has given complete satisfaction in Rangoon, both from an engineering and a sanitary point of view, and the statements you have publicly made in regard to it are not in accordance with facts.—I have, &c.,

“ (Sd.) J. SHORT, Secretary,
“ Rangoon Municipality.

“ P. S.—A copy of this letter together with a copy of your letter, to which this is a reply, is being furnished to Messrs. Shone and Ault.

“ Statement showing the number of deaths in, and the population of, the districts served by the Shone System and those not served :—

Year.	Rangoon Town served by the Shone System.		Remainder of Rangoon.	
	Number of Deaths.	Death-rate.	Number of Deaths.	Death-rate.
1890 ...	1,727	32·91	5,392	44·84
1891 ...	1,679	31·24	5,009	40·41
1892 ...	1,509	25·16	4,603	36·05
1893 ...	1,628	26·31	4,573	34·78
1894 ...	1,676	26·95	5,274	38·94
1895 ...	1,381	21·23	4,400	31·32”

28. Comment on the above is unnecessary, but before I dismiss sanitary statistics relating to Rangoon, I cannot refrain from adding here a copy of an extract which appeared in the “Sanitary Record” on the 6th September 1895.

29. It is as follows:—

“ The Shone System in Rangoon.

“ A recent report of Dr. Sutherland, the Medical Officer of Health for Rangoon, on the water-supply of the town shows in the clearest possible manner the benefit which has accrued to the Town as a result of the adoption of an efficient sanitary system of sewerage. We cannot do better than give the following extract from the report of the proceedings of Halawga Water-supply Committee, the replies in question being those given by the Dr. Sutherland to queries put by the Committee, which will speak for itself:—

RANGOON MUNICIPALITY.

“ Proceedings of the Halawga Water-supply Committee.

“ Extract from the report of W. H. Sutherland, M.B., C.M., Edin. (Health Officer of Rangoon) in reply to queries by the Committee:—

“ Q. 3.—The Shone system is at present connected up with about 40,000 people's dwellings. What are the conservancy arrangements for the remaining 160,000?

“ Reply.—The following table shows the distribution of conservancy which, condensed, is as follows:—

“ On the Shone system, 40,000 people ;
 “ By hand conservancy, 90,500 } 70,500 of which are disposed of
 “ No conservancy, 69,500 } finally in Shone sewage mains.

“ (N.B. by the President—Thus 40,000 plus 70,500 equal to 110,500 or about 50 per cent. of the population benefited by the Shone system, directly or indirectly.)’

“ Q 7.—Is the death-rate lower in localities served by the Shone system?

“ Reply.—Yes. In the year 1890, the year in which the system was opened, the death-rate in the Tarokten and Sule divisions exceeded that of the whole area of the town, whilst in 1894 the death-rate of those divisions is less than for the whole area.

	Death-rate for combined circles Tarokten and Sule.	Death-rate for the whole area of the town.
“ 1890 ...	54·89	53·06
“ 1894 ...	30·61	38·54

“ (Mem. Tarokten and Sule are the areas comprised in the town proper, to which the Shone system is supplied.)’

“ Q 9.—On the supposition that money is available, do you give preference to improved conservancy or lake water-supply?

“ Reply.—As far as the town is concerned, the water-supply for some years has remained the same, but the death-rate has decreased

"owing to the improved condition of the town, which is principally due to the Shone system. This applies to the town proper and excludes Lamadaw."

30. I write this many miles from London, otherwise I should be able to put my hand on the official papers relating to the above extract. But on reflection I think it would be more satisfactory for you to apply to the Municipality of Rangoon direct for information, confirmatory or otherwise, of Mr. Latham's allegations, as they appear in his letter to the President of Ahmedabad. In the meantime you may take it from me, that what I have written is substantially true in every respect, and that my statements will be corroborated officially by Mr. Short if he is appealed to on the subject.

31. You will observe that Mr. Latham states in effect that, wherever my system has been and will be adopted, the results obtained from its adoption in Rangoon will go on "to the end of the chapter." In this conclusion I believe in my soul he is right.

32. You know now as well as I do, that for the hydraulic conditions essential to make sewage flow in sewers and drains at self-cleansing velocities (given the volumes of sewage necessary to generate that velocity), you can depend upon the system which I have invented and which bears my name, and which, I am glad to say, is now known, appreciated and adopted all the world over. I say these conditions can be created by the adoption of my system in the most perfect manner possible, whether the houses to be drained of their sewage-discharges are built on low-lying or flat surfaces, such as exist in parts of Bombay and India generally, or not.

33. No one knows this better than Mr. Latham, because his so-called Hydraulic System is really my system worked however by Hydraulic pumps, instead of Hydro-pneumatic Ejectors. At the onset and for years afterwards, he denounced my system. He began his attacks upon it by ridiculing the idea of placing a number of what he described as unmechanical pumping machines like Ejectors under the streets and distributing them amongst so many drainage sections in a town. He illustrated his objections to my Ejector stations by saying that even at one water-pumping station he had to do with, and where the machinery was in duplicate, he received a telegram one day, to say that both pumping engines broke down, and then he stated in effect, with a chuckle and a shrug of his shoulders, "Well, what do you think would happen if you had "20 Ejector stations in this town, etc., etc.?"

34. Those and other remarks of Mr. Latham were uttered before an audience which consisted partly of scientific men, but mostly of the citizens of the town in which the meetings of the British Association were being held at the time. He stated also at the same meeting that the efficiency of the Ejector was only about 18 per cent. at most, even with a lift of about 12 feet, which was the lift, he said, to which the Ejectors in Warrington raised the sewage of one of the suburbs of Warrington.

35. These publicly uttered statements I need not tell you were as false as the statements he made in his letter to the President of Ahmedabad about the results of the working of the Shone System in Raagoon. For instance, with a lift of 25 feet, Professor Unwin made tests with Ejectors which were worked by compressed air, supplied by a small gas engine air compressor, and the efficiency he obtained was practically equal to 50 per cent. And yet in the face of the knowledge which Professor Unwin's scientific and practical tests of the Ejector reveal, and the details of which were published and were made known to Mr. Latham, he was injudicious enough (nay, he was foolhardy enough) to write to the President of Ahmedabad on the 21st January 1897, that he is confident if a fair and proper trial were made with the Colaba Ejector Plant, it would not exceed one-fourth of that of the pumping engine which gave out 36 per cent. efficiency and which has been done away with. In other words, Mr. Latham now says the efficiency of the Ejectors is no longer 18, but simply 9, per cent. ! Verily, an Engineer's folly could no farther go ! What, I ask, can be done with a man of this type, but expose him and treat him, as I do, with contempt ?

36. But certainly I never expected to live to see the day, when poor Mr. Latham, wearied and tired of his efforts at trying futilely to stop the growth of the Shone System, turning round and adopting it. If you will read his report on Bombay, as to the sanitary and other advantages which would follow sectional drainage in Bombay, and if you will substitute the words "Shone Hydro Pneumatic Ejectors" for "Hydraulic Pumps" you have a description of my system, which I have used hundreds of times in trying to point out its merits before Mr. Latham became a convert to it. The following remarks of his, in the Bombay report, in the face of what he stated at the outset, about the absurdity of having more than one sewage pumping station in a town, because of the liability to accident with automatic Ejectors, are particularly refreshing at this stage of our seemingly endless controversy, viz. :—

"By the sectional pumping, and division of the district, the risk arising from the break-down of the pumping engines is diminished, as by a proper arrangement of the sewers one or more districts may be made to relieve any section of the district in which there might be a break-down of the pumping machinery."

37. Let me now ask your attention to what Mr. Latham asserts about the air exhausted by the Ejectors after the sewage has been ejected by them.

38. He calls this air foul air and tries to lead the uninitiated reader to believe that it is as foul, if not fouler, and more dangerous than such foul air, for instance, as is to be found overlying what Mr. Latham calls "The large sewage lake of Bombay which is allowed to exist on its western shore" or which is generated within the main sewers of Bombay; and the ordinary uninitiated citizen

reading such statements would naturally become alarmed, especially at this period, when the plague is unhappily decimating its inhabitants.

39. Mr. Latham wrote the remarks I refer to, as I believe, with the object of frightening the people of Bombay, into his alleged belief, that the exhaust air from the Ejectors, diffused in the pure atmosphere of the City, polluted it to such an extent as not to fail to make it the vehicle for spreading the plague and other like diseases within the City to a far greater extent than would otherwise be the case.

40. Well, to begin with, I deny *in toto* that the air which is exhausted from the Ejectors is foul air in the sense in which Mr. Latham would have his readers to understand. In fact, the air issuing out of the Ejectors is practically, and to all intents and purposes, in the same state and condition, as it is when it is drawn into the air compressors at the air compressing station. How can it be otherwise? You have only to look at a working model of an Ejector in glass to appreciate what I state. When the apparatus, like a glass bottle, is full of water, the automatic valve on the top of it instantly admits the compressed air into the Ejector to force the water out. Whilst this operation is proceeding, you will see the water gradually subsiding, and if you did not know any better you would think it was flowing out of the Ejector by gravitation, because the invisible air-power forcing it out does not disturb its surface; but directly the full charge of water has escaped out of the glass Ejector, the compressed air within it escapes into the atmosphere. Then you see the effects of liberating the compressed air into the atmosphere, namely, to cause it to expand to its original atmospheric volume and pressure, but in doing so vapour is formed, which slightly dims the transparency of the glass, and at the same time minute particles of globules of water like dew appear to adhere to the glass for a moment or two. This natural phenomenon very quickly vanishes and the glass of which the body of the model Ejector is made again becomes transparent. You then see the fresh charge of water flow into it and rise in the Ejector, and the charge of air remaining in the Ejector at atmospheric pressure is gradually but surely driven out by the inflowing water; and so the process of alternately filling and emptying the Ejector of water and air goes on so long as there is water and compressed air to flow into it.

41. The working of a sewage Ejector is precisely the same as the working of the water Ejector, and I contend that in gravitating sewers designed, for example, as yours in Colaba, are (as I know of my own knowledge) the sewage when the house connections you have estimated for are made will reach the Ejectors, in a brief space of time, in the majority of cases, in fact in a few minutes, and certainly before it can get into a foul decomposed state.

42. Sewage of this description would foul neither air of the sewers (*i. e.*, in a practical sanitary sense) nor the spot or place to

which it would be ejected. But let us suppose that the condition of the Colaba sewage, when it arrived at the various Ejector stations, was extremely foul like the sewage of the Bombay "sewage lake" referred to in Mr. Latham's letter. What happens? This; the sewage, foul as it is, is of course in contact with *the air of the sewer to begin with*, and into this air is emitted what we call sewage-gas, as fast as it is generated within the sewage, precisely in the same way as it is emitted from the sewage in the sewage lake. There is a limit to the rate per square inch, or foot, or metre, at which it can escape from the sewage and ascend into the atmosphere; but whatever that rate may be per minute, or per hour, it is manifest that whilst the sewage is filling an Ejector, for instance, in half a minute, the volume of the escaping gases in that period of time cannot but be infinitesimal, though whatever it is, it is emitted not into foul sewer air, but into fresh atmospheric air *en route* to the atmosphere of the heavens *via* the tall ventilating shafts which are connected with the Ejector Stations.

43. When, however, the Ejector is full of sewage and when the ejecting air, containing, say, 5 volumes of fresh atmospheric air, presses on the sewage and discharges it out of the Ejector (say, in half a minute), in that half minute interval sewage gas could not ascend and mix with the incoming air, because of the fluid or air-gas pressure which would have the effect of driving into the sewage itself any sewage gas which would otherwise escape out of the sewage under atmospheric pressure. The globules of air-gas under these conditions would enter the pores, so to speak, of the surfaces of the sewage, and in very minute quantities it would penetrate, or would be absorbed by, the sewage water; in the same way as air is absorbed in an air vessel connected with a water pumping main; but as is well known the rate at which water absorbs air, even under high pressures, is comparatively very slow. It will thus be seen that while the sewage is being ejected fresh volumes of atmospheric air, in the proportion of 5 to 1, of the sewage is being driven into the Ejector until the moment arrives, when the whole charge of sewage is ejected out of it, and then the compressed air is released and it escapes, expanding rapidly until it assumes its normal volume and pressure. The same phenomena which I have described as taking place within the glass model Ejector takes place within the sewage Ejector, the moment the compressed air is released and when it is expanding to its natural volume.

44. Now, I submit, that for Mr. Latham to call the exhaust air of the Ejectors foul, as if it were comparable to the air of foul sewers, and foul sewage lakes, as they are found in Bombay according to his printed statements, is simply scientifically and wickedly absurd.

45. Some years ago Professor Sir Henry Roscoe, F.R.S., was employed to report for the then Metropolitan Board of Works, upon the deodorization of the London sewage, and as he is a professional Chemist of the highest eminence, I prefer to be guided by him than

by anything that Mr. Latham, who is no Chemist at all, may choose to say. He said in his report amongst other things :—“ It next has to be considered whether any more satisfactory or less costly means can be devised for effecting the end in view, viz., the prevention of sewage nuisance. In my opinion, the only other feasible plan is that of aeration. Free Oxygen is to be had for nothing, and the cost of pumping air need not be considerable. The adoption of such a plan raises questions which am not now in a position to deal with, although I believe that this may turn out to be a solution of the problem. At any rate, I feel sure that this is a matter deserving of further inquiry. *The rapid purifying effects of aeration on the sewage have been repeatedly observed in my laboratory experiments.*”

46. Sir Henry so stated that the way to keep the sewers themselves in a harmless and a reasonably satisfactory condition was to cause a free circulation of air within them; and yet Mr. Baldwin Latham in his report on the Bombay Drainage question states strangely enough :—

“ Every endeavour should be made to prevent direct currents of air passing through the sewers, for it must be borne in mind that the more air enters a sewer the more stinking air will leave the sewers.”

47. On the other hand, I should have thought that the more air you pass into, through, and out of the sewers, the less stinking and deleterious will be the air of the sewers, and the less potent as an insanitary agent will such air consequently be when it makes its escape into the atmosphere. What is wanted to be done with sewage and air is to cause both to be on the move. The late eminent sanitarian, Sir Edwin Chadwick, K.C.B., used to preach, in his later years, the doctrine of “ circulation not stagnation,” for the latter meant death while the former meant life.

48. Dr. Fergus, in giving evidence on the question of the purification of the River Clyde, stated :— “ There is no doubt that running water has considerable power to destroy excremental matter, but it is the air contained in the water that has that effect.”

49. Again, Dr. J. B. Russell, Medical Officer of Health for Glasgow, in a lecture on “ the theory and prevention of infectious diseases,” which was delivered and published under the auspices of the Lord Provost, Magistrates and Council of the City of Glasgow, said :—“ The destructive processes to which these cast off matters are subjected are all processes of oxidation, and are all, directly or indirectly, effected by atmospheric air. They partake, therefore, of the nature of combustion * * *. The decomposing activity both of soil and water depends upon the air which they contain * * *. We are told by the Rivers Pollution Commissioners, that the oxidation of the organic matters in water is effected chiefly, if not exclusively, by the atmospheric oxygen dissolved in the water. Such dissolved oxygen being

“ well known, to be chemically much more active than the gaseous oxygen of the air. It must be explained, however, that, although in equal volumes, the oxygen in water may be chemically more active than the oxygen of the air, as we find it in operation around us, from the more frequent renewal and the greater quantity thus brought into action, air is much the most destructive agent, and soil and water are destructive in proportion to the air which they contain.”

50. Now, I hope, I have adduced evidence enough to show you that Mr. Latham's objections to my using God's greatest and in its natural normal state the cleanest and most purifying agent in the world, as my motive power, to expel sewage out of Ejectors, and in the process to cause air movements within the gravitating sewers, are not only contrary to common sense but contrary to the accepted theories of the most eminent and learned chemist and medical men of the day.

51. One of, if not the highest authority, perhaps, at the present moment on the Plague is Dr. Payne. This gentleman wrote an article upon it in Allbut's System of Medicine in 1896, and as you may not have seen this article, and as the subject of it is a pressing one at Bombay just now, I have thought you would like to see the gist of it, and I therefore put some extracts touching salient points, as an appendix to this letter. (See Appendix III.)

52. You will see that Dr. Payne states that plague is a soil disease, and that he does not think it is communicated much, if at all, to either rats or flies by the medium of atmospheric air, in the sense in which Mr. Latham insinuates may be done, by discharging the exhaust air of the Ejectors in the manner adopted at Colaba.

53. This view, I see, corresponds very much with the theory given in the “Report on the Bubonic Plague in Bombay by Brigadier-General W. F. Gataore, C.B., D.S.O., Chairman of the Committee, 1896-97.”

54. He states:—

“ Amongst other sources of the spread of the disease throughout the epidemic, the influence of rats has been shown in many extraordinary ways. Grain depôts are often the first centres in the spread of the plague, the infection having been imported into the colony of rats that haunt the depôts, spreads amongst them, and they die in large numbers. In this way the grain bags are infected and become sources of conveyance of the disease to human beings. The Committee have, during disinfection, invariably treated those places where rats have been known to die as plague-infected localities * * *. The oriental habit of constantly cleaning all metal utensils, in which food and drink are stored, with earth or sand scraped from the mud floor or from the roadway which are often indescribably filthy, must likewise be a fruitful source of danger.

"It must be remembered that in all oriental cities a very large proportion of the population are very poor and cannot afford to pay the rent of a really sanitary building; they, therefore, are forced to live in miserable shanties, dark, low, small and built on insanitary sites, without plinth added to which, with a view to bringing the cost of this habitation to the lowest point, 16 or 20 persons will sleep, eat at and cook in a space hardly sufficient for the requirements of four."

55. On seeing this report, I was curious to know whether the first recorded case of plague originated by or near to the Bombay "Sewage-Lake" or by or near to Upper or Lower Colaba, where the Shone System is installed, thinking, that if it had occurred at or near any one of these places, especially at the latter, Mr. Latham would be sure to say his theory was exemplified, &c., &c. But the first case occurred in a district called Mandvi, which is $2\frac{1}{2}$ miles from the centre of the Colaba Districts, where the Shone System is established and $3\frac{1}{2}$ miles from the Bombay "Sewage-Lake." I also find that the first case is supposed to have occurred on the 8th August 1896; and that in the three months following this first case no fewer than 2,345 fatal cases occurred, 26 only of which took place in Colaba.

56. Under these circumstances, therefore, I do not think Mr. Latham's theory that the exhaust air from the Ejectors is dangerous and calculated to spread the plague, and such like diseases far and wide in Bombay, or any where else in fact, will avail him much, in his most recent resuscitation of his propaganda against the Shone System, especially when it is borne in mind that although I have said the Shone System was established at Colaba at the time referred to, yet, as a matter of fact, it was only established, so far as the special machinery and public sewers were concerned: these latter were not made use of to any appreciable extent at least, at the date of the outbreak of the Plague for the simple reason that, comparatively, very few house-drain connections with the public sewers had then been completed and the sewers utilized for the purposes for which they were intended. No one knows these facts better than yourself, as the responsible Engineer for the Colaba Drainage Scheme as a whole.

57. But any impartial open-minded sceptic would naturally say, if Mr. Latham's theories as to the extraordinary insanitary character of the exhaust air of the Ejectors were sound, he ought, seeing that the Shone System has been in existence for many years, to be able by this time to produce positive and incontrovertible evidence in support of his theories.

58. Unfortunately for Mr. Latham, but fortunately in the interest of public health, in connection with all the experience hitherto acquired of the practical working of the Shone System, both at home and abroad, there has not been to my knowledge, and I am certain there has not been to Mr. Latham's knowledge (or otherwise I and the

sanitary engineering world, would have been made acquainted with it ere this) a solitary case, on record of any kind of disease, much less Zymotic disease, having been attributed by any responsible or irresponsible sanitary authority, to the effect of working one single hydro-pneumatic sewage Ejector! It is true, Mr. Latham has stated by letter, to the Secretary of the Municipality of Rangoon, that the health of that city had suffered seriously from the working of the Shone System. But he did this in ignorance of the fact that the exact contrary was the case; as is revealed by the copies of the official letters of the Secretary of the Rangoon Municipality addressed to Mr. Latham, and which are embodied in this letter.

59. Nature's ways of doing things must either be unknown to Mr. Latham, or she is very perverse, and determined not to work in the particular way he would like her to work. Take Rangoon for instance, where the Shone System has been at work for nearly 10 years. I venture to say that those characteristics described in Brigadier-General Gatacre's report on the Bubonic Plague in Bombay, as being peculiar to Indian cities generally, are more or less peculiar also to Rangoon; and yet, although there are at least 26 separate Sewage Ejector Stations, within the area drained in that City on the Shone System, so far, I am pleased to say, no cases of plague have occurred, either within or without the areas drained by it in Rangoon. Indeed, if the theory of Mr. Latham were true there would be evidences of its correctness to be obtained in every house and town, where it is applied, and especially in Eastbourne, the town in which the system was first established many years ago, on a large practical scale.

60. Every Englishman who knows the principal sea-side health resorts of England, must know Eastbourne as being one of, if not the prettiest, cleanest and best cared for health resorts in England. After the first installation on my system had proved a success in that town, a second, third, fourth, and fifth installation was determined upon; so that by the present time there is more so-called dangerous "foecalized" exhaust air, with "*particles of sewage*" suspended in it, diffused into the heavenly atmosphere of Eastbourne, than there ever was before, not however with the result prophesied by Mr. Latham, but with the very opposite result; that is to say, instead of the death-rate being now *higher* than it ever was before, it is *lower* than it ever was, as the vital statistics of the Medical Officer of Health for Eastbourne for the past 10 years abundantly testify.

61. If you will write to His Grace the Duke of Devonshire, the present Mayor of Eastbourne, I am sure he will furnish you with information, corroborative of what I have just stated.

62. As it happens, I have not any of the Medical Officer's statistics by me here, where I write this letter, otherwise I would send extracts from them herewith. I have however a newspaper cutting in my possession, which a friend of mine presented to me, knowing that my system of drainage was in operation at Eastbourne; and

as the matter of the extract, bears out what I have written above about Eastbourne, I will insert a copy of it here ; it is as follows :—

“ Eastbourne is absolutely the healthiest town in the country. During 1897, there were only 300 deaths, and some of these were of visitors while others took place in hospitals and the workhouse. This is at the rate of only 8·96 per 1,000, and if nonresidents were excluded, who were mainly invalids, the rate is brought down to the phenomenally low rate of 7·6 per 1,000. No health resort can show such a record as this, and it is high testimony to the standard of the sanitary administration.”

63. There is yet one more place in England, where my system is in operation, which I must not, for a special reason, omit to mention to you, and that is the Houses of Parliament, in Westminster. In 1886, when His Excellency the present Viceroy of India, the right Hon. the Earl of Elgin, was First Commissioner of H. M. Works, it was decided by Parliament, on the recommendation of a Select Committee, appointed by the House of Commons to report on certain alleged defects in the drainage and ventilation arrangements of the Houses of Parliament, to adopt my system of drainage there ; and Lord Elgin did me the high honor to appoint me the Engineer to design and carry out the works. While these were in progress, I saw a good deal of His Lordship and the Chairman, who presided over the Select Committee, *viz.*, Sir Henry Roscoe, F.R.S., and I can testify to the fact that both these gentlemen took a very keen interest in the works.

64. After the drainage works had been in operation at the Houses of Parliament for about 5 years, another Select Committee was appointed in June 1891, “ to inquire into the ventilation of the House.” The report of this Committee, which consisted of Dr. Farquharson, Sir Guyer Hunter, Mr. Richard Power, Sir Henry Roscoe, and Mr. Plunket, the latter gentleman being then the first Commissioner of H. M. Office of Works. In their Report, which was ordered to be printed on the 24th July 1891, the following paragraph appears :—

“ The Committee also took evidence as to the system of drainage of the Houses of Parliament which was established in pursuance of the Report of the Select Committee on the ventilation of the House in 1886, and they find that the system works satisfactorily. The Committee are satisfied that the connection between the Houses of Parliament sewers and the Metropolitan main low-level sewer is so constructed that no back-water or return of sewage or of sewage gases from the Metropolitan sewer can enter those of the Houses of Parliament ; and the Committee are convinced that no offensive smells or injurious emanations now proceed from the drainage system of the Houses of Parliament, which, they are of opinion, is as perfect as possible.”

65. Again after more than six years' additional experience of the working of the Shone System at the Houses of Parliament, (making about 11 years altogether), one of the members of both the first and second Select Committees appointed to investigate and report upon the drainage of the Houses of Parliament (I refer to Dr. Farquharson, M.P.) on the 14th September 1897, in his Inaugural Address to the Sanitary Congress at Leeds, stated :—

“ May I give you one other illustration? I think it was
 “ in 1884 or 1885 that serious complaints began to be made
 “ about the drainage and ventilation of the House of Commons.
 “ Bad smells were about, members got sleepy and seedy, and
 “ influenza came in and spread, and grumbling became loud
 “ and general. A Committee was appointed, under the pre-
 “ sidency of Sir Henry Roscoe, to investigate the whole ques-
 “ tion, and we had many sittings and took much evidence, and
 “ rambled through drains, much hampered in our operations
 “ by the fact that no plan could be found and we had to trace
 “ out their situation and arrangement as best we could. And
 “ then we came to report and we had to tell the legislators, on
 “ the basis of a very important investigation by the late Pro-
 “ fessor Carnelley, that they were actually breathing sewer gas
 “ and that the sooner they put their house in order the better
 “ for themselves and the country. So £10,000 was voted
 “ *nem. con.*, Shone's Ejectors cut us off from the main sewer ;
 “ and I make so bold as to claim for the sanitary operation,
 “ national importance in improving the health and temper of
 “ our senators, enhancing the quality of their work, and lead-
 “ ing to the increased efficiency of our public departments by
 “ increasing the administrative capacity of Parliament chiefs
 “ who are responsible for the conduct of affairs.”

66. Now, inasmuch as the houses of Parliament works were carried out under the auspices and to the satisfaction of the present Viceroy of India, it becomes a duty incumbent upon me to state the fact, as a special reason, why I should now take exceptional trouble to expose the libels Mr. Latham has attempted to circulate in India, concerning the consequences of working the Shone System in England and in Rangoon in particular.

67. I could go on quoting as many indisputable testimonies favourable to the Shone System as would fill a big book ; but the foregoing will doubtless suffice, in the meantime, to dispel any misgivings which Mr. Latham's letter to the President of the Ahmedabad Municipality, condemnatory of the Shone System, may have created in the mind of the recipient of that letter, and in the minds of some of the members of the Bombay Municipality, after they became acquainted with its contents. But, I will just give you one additional important testimonial to the foregoing. I quite omitted to state, when I referred to Mr. Doig's official report on the Shone System, that Mr. J. C. Pottinger, M.I.C.E., Sanitary Engineer to the

Government of Bombay, submitted a report "on various Sanitary Systems in England" to the Secretary of State for India, in September 1892.

68. Mr. Pottinger, like Mr. Doig, visited the only three places where Mr. Latham's hydraulic system was at work, viz:—Friern Barnet, Esher, and Mergate ; and he also visited a number of places where my system is in operation in England, the particulars of which he gives in his report, which was printed at the Education Society's Steam Press, Bombay, in 1894.

69. I take leave to copy two brief statements only, of the many which are to be found in the Report in question, relating to my system, as he found it at work in England :—

"(1) From a purely sanitary point of view, the system is theoretically perfect, as the sewage is rapidly removed in a fresh state, and from first to last, it cannot pollute the air *en route*."

"(2). *It is, moreover, an astonishing fact that, in everyone of the numerous cases in which it has been adopted, both the Borough Engineer and the Local Board concerned, have nothing to say but in praise of it.*"

70. With regard to what Mr. Latham states about Karachi, I regret to say I have no particulars about Karachi here, but I know as a matter of fact, from information which has been forwarded to us from time to time, regarding the practical working of the Shone System, so far as it has been applied at Karachi, it has been eminently successful. I have also heard that the authorities there had all but proved to demonstration, that the first case of plague which occurred at Karachi, had been imported there. I have also heard that a variety of reasons had been assigned for the increase of the death rate in Karachi, but not one of these took cognizance of the reason given by Mr. Latham, as being the cause of the increased death-rate in that City. The ground and meteorological conditions obtaining in Karachi, preceding and during the plague epidemic, may have had a powerful influence for evil, and Karachi being an Indian city, possessing in a more or less large measure all the characteristics peculiar to Bombay, as described in Brigadier-General Gatacre's Report, and the plague being a contagious and infectious disease, it is difficult for me, or for any body else in England, without studying the data obtainable on the spot, to diagnose the probable cause of the increase in the death rate. I have no doubt, however, but that the Engineer and Medical Officer of Health will explain, if asked to do so, the cause of the alleged abnormal increase in the death rate of Karachi. More than this I cannot say at present.

71. Finally, I desire to enumerate briefly, the chief points raised by Mr. Latham in his letter to the President of the Ahmedabad Municipality, and about which he and I are hopelessly at issue :—

(a). As to the insanitary effects of the exhaust air from the Ejectors, as evidenced, as he alleges, by the working of the system everywhere.

(b). As to the abnormally low efficiency of the Ejectors, compared with hydraulic pumps, as used by him, and by the employment of which he claims to be able to obtain an efficiency of 60 per cent. (*vide* his Report on Bombay) compared with 9 per cent. efficiency by hydro-pneumatic Ejectors.

72. I hope and believe, however, that what he has alleged with reference to the first point (a), has been disposed of in the body of this letter, in a manner satisfactory to every one who will take the trouble to understand the nature and character of the differences between us both. Only fancy his contention that the conveyance of "particles of sewage" by the exhaust air, *via* the tall ventilating shafts into the atmosphere of the heavens above, is a frightfully dangerous proceeding, whilst, not mere particles, but enormous volumes of foul sewage, discharged on to land for irrigation purposes (although these enormous volumes of sewage are all the while in contact with atmospheric air) strange to relate, affect the health of the people who work on sewage farms in a most beneficial manner, as not only is their health good, but, according to Mr. Latham's own statistics, they, on the whole, enjoy even better health than most people!

73. In his Bombay Report, Mr. Latham states:—

"The destruction of the organic constituents of sewage is very rapid in sea-water, as every gallon of sea-water contains about two cubic inches of oxygen, which speedily oxidizes the decaying organic constituents of sewage."

74. But a cubic foot of free air at a temperature of 60° F. with 30 inches of barometer pressure, contains about 35 times more free oxygen, than a cubic foot of sea-water! How therefore can only particles of sewage, forced into the atmosphere by exhaust air, containing say, as at Rangoon, ($5 \times 35 =$) 175 times more oxygen than sea-water generate and disperse into the atmosphere of the heavens, a gas which is terribly inimical to public health?

75. (b) The 60 per cent. efficiency claimed by Mr. Latham for his hydraulic pumps is a mere statement of his. No such efficiency has ever been realized by the working of any hydraulic sewage pumps. He made a similar declaration many years ago at the Society of Arts just before his first hydraulic installation was put down at Friern Barnet. The actual efficiency of that installation was carefully estimated by two competent Mechanical Engineers when the pumps were working at their best speed, &c., and the efficiency proved to be 16 per cent., not 60 per cent.! And as to Eshar and Margate, he has never yet ventured to state what the respective efficiencies at those places proved to be, as I have already intimated to you.

76. Besides, the erection and working of the most efficient pumping engine in the world, on the site of the old Love Grove Pumping Station, would not render the non-self-cleansing sewers referred to in Mr. Latham's letter and report self-cleansing and sanitary. High efficiency in a pumping engine means a low con-

sumption of coal per indicated or actual horse power: it does not mean that the sewerage system of a town is rendered efficient also. The Shone System aims at getting a high efficiency in the working of gravitation sewers, to render them self-cleansing and self-ventilating, and consequently sanitary.

77. I have already stated that Professor Unwin had tested Ejectors lifting water against a head of 25 feet, which is more than double the head against which the Warrington Sewage Ejectors worked—(according to Mr. Latham's declaration, uttered some years ago, at a meeting of the British Association) and that the Professor estimated the efficiency practically equal to 50 per cent. But let us for a moment ignore Professor Unwin's tests, as Mr. Latham does; and let us also ignore what Professor Unwin has demonstrated mathematically, through the medium of the Transactions of the Institution of Civil Engineers, for the enlightenment of its members, as to the relative properties and values of compressed air, and compressed water, for power purposes. Let us, in fact, assume for argument sake only, that Mr. Latham can employ compressed water to work pumps developing *small horse powers*, (as the Ejectors do, in many instances, in practice) and thereby obtain a higher efficiency than is practicable by using compressed air by means of hydro-pneumatic Ejectors. If, however, the initial cost of the works, the cost of attendance and wear and tear on hydraulic pumps, the initial cost of the water to be used for driving the pumps and the cost of filtering the sewage water to deprive it, (as is done at Esher for example) as much possible, of every trace of solid matters in suspension so as to prevent it from scoring the cylinders and valves of the pumps, I say, supposing these various indispensable costs amount in the aggregate to a sum considerably in excess of the aggregate sum required to do the same volume of work on the Shone system, then the argument as to the superior efficiency of the hydraulic method of pumping sewage over the pneumatic plan falls to the ground.

78. You will be better able to see the force of the foregoing remarks if I quote here what Mr. James Atkinson, M.E., wrote to me ten years ago after he had inspected Mr. Latham's hydraulic pumping station at Friern Barnet. I may state that Mr. Atkinson is well-known in England as a first-class mechanical engineer. He has invented a number of mechanical appliances, amongst which may be mentioned the "Cycle" gas-engine, which proved itself to be, according to tests instituted by the Society of Arts, the most economical gas-engine in the market at the date of the Society of Arts Report.

79. On the 10th April 1888, Mr. Atkinson addressed a letter to me from which, for the sake of brevity, I copy the following extract only:—

"Respecting the other features of comparison I have been in a good many chambers in which your ejectors are fixed, and have

“invariably found them clean, dry and with no objectionable smell, but at Friern Barnet the hydraulic pumps are in a chamber which is, to put it mildly, foul, slimy hole. In your ejectors the valves are moved to the utmost, say forty times per hour, compared with 600 times per hour in the pumps. I ALSO noticed at Friern Barnet that **THE SHOCK OF ARRESTING** the column of water made the whole machine vibrate, especially when they both happened to reverse at the same time; this must tell severely on its durability, also on the joints and packing.”

80. The above described installation, Mr. Latham insinuated by speech at the Society of Arts, would have the effect of demonstrating to the world what he then contended and what he has gone on contending, ever since, viz., the superiority of his hydraulic plan, both as regards efficiency in coal consumption and efficiency in a sanitary sense, over my hydro-pneumatic plan!

81. But is it not strange that, notwithstanding Mr. Latham's vapourings for many years against the Shone System, and in favour of his hydraulic method, he had never been able, up to the present time, to persuade any sanitary authority to imitate the Friern Barnet, Esher, or Margate installations. I suppose that the fiascoes which his works at those places resulted in frightened people generally, as they must have staggered some of the engineering inspectors of the Local Government Board, and there can be no doubt, in my opinion, that Mr. Acworth, before he finally rejected Mr. Latham's hydraulic proposals for the drainage of parts of Bombay, had been made acquainted with the Friern Barnet, Esher, and Margate experiences, and that these, and these alone, led him to elect to adopt the Shone System for the drainage of the flat and low-lying habitable areas of Bombay.

82. My partner, Mr. Ault, and myself believe implicitly in the efficacy of the Shone System, in a sanitary sense, when, of course, it is properly installed and worked; and although we also believe that for high lifts and large power, such as obtain in mines, hydraulic pumping at one station would probably give out better efficiencies, as regards coal consumption than could be obtained by the use of ejectors, especially if the liquid pumped is water, yet we contend that for pumping large or small volumes of sewage automatically, as fast or as slow as it flows, in its crude unscreened state, down gravitation sewers to such moderate heights as is generally required to be done, in connection with the sectional drainage of towns built, for the most part, on level plains, the hydro-pneumatic Ejectors will give out efficiencies superior in every way to hydraulic pumps. These latter, in order to keep them working continuously, require frequent and very careful overhauling, and that, too, at the hands of trained expensive mechanics. With hydraulic pumping, moreover, it is necessary to carefully screen the sewage flowing down the gravitation sewers before it enters the wells or pits from which the hydraulic pumps lift it to its destination; and, of course, the solids

intercepted or kept back by screens or otherwise from the pumps gradually, but surely, accumulate and become more or less offensive, and consequently these filthy unsanitary accumulations have to be periodically removed by costly disgusting manual labour. Whereas, as I have already stated, the Ejectors receive every thing, liquids and solids alike, and eject both in combination to their final or other destination with as great a certainty as if the liquids ejected were clean filtered water and not crude sewage.

83. For these and other reasons, Mr. Ault and myself, I assure you, so far from being ashamed of what has been done in India and Burma already on the Shone System, are, on the contrary, exceedingly proud, and if your council will but act wisely by taking no heed of *Mr. Latham's untenable attacks on the system*, and if they will also, as I believe they will, have patience to await the proper completion of the Colaba and the other works proposed and in progress on the system in Bombay, we are absolutely confident that they also, as a Municipality, and you as their Special Drainage Engineer, will be more than satisfied with the final results.

84. Having traversed the chief charges made by Mr. Latham and brought to the special notice of the people of India through the medium of the Bombay Municipality, whose transactions are reported in the *Times of India*, and I presume in other important and widely circulated newspapers, it only remains for me to ask the Municipal Commissioner of Bombay, through you, to do me and my partner, Mr. Ault, the honor and justice to treat my letter in the same way as he treated Mr. Latham's letter to the President of the Ahmedabad Municipality, *i.e.*, to print it and circulate it amongst the members of your Municipality.—I am, &c.,

ISAAC SHONE.

JAMES W. SMITH, Esq., M.I.C.E.,
Special Drainage Engineer,
Bombay Municipality.

Appendix I.

Copy.

WESTMINSTER CHAMBERS, 13, VICTORIA STREET,
WESTMINSTER, S.W., 23rd August 1895.

To THE PRESIDENT, Rangoon Municipality.

DEAR SIR,—I am very much indebted to you for having forwarded me the report of the Medical Officer of Rangoon for the year 1893. I regret that I have not had any time to look through it until recently when my attention has been directed to the subject of the

sanitation of Rangoon, and in going through it I find that some error has evidently crept into it; for instance, in table 12, as I was very desirous of knowing what was the relative state of health of the different districts, in adding up the total of the columns for 1888, 1890 and 1891 I found that the number of deaths at the foot of the column does not agree with those inserted in the column itself. Evidently there is some discrepancy especially as it would appear that for the district called Tamway there must be some misprint or error.

In looking into all the figures which refer to Rangoon, I am very much impressed with the extraordinary change which appears to have taken place in the health of the district since the Shone system has been in operation;—and that if the five years before, from 1885 to 1889, are compared with the five years subsequently, 1898 to 1894, there appears to be a most extraordinary increase in the death-rate, such increase, however, not occurring in any of the towns of Lower Burma or in Burma itself, showing that, in spite of the lavish expenditure on the Shone System introduced into this district, it has been anything but of a beneficial character.

I am quite aware of the statement which has been made with regard to the improvement since 1898 in this district, but unfortunately a district in which a new system has been introduced cannot be compared with itself. If compared with itself it must be with some period of years when not under the influence of the special system in operation.

If the population of the districts are properly interpolated according to the late Dr. Farr's method, as adopted by the Registrar General of England, and in other cases, it would be at once seen that in the five years before the Shone System came into operation in Rangoon, compared with the five years subsequently, there has been an increase in the death-rate of nearly 10 per thousand in the latter five years which of course I attribute, as I have pointed out, to the pernicious effects of the Shone System in diffusing foul air into the district in which it is in operation.

The same thing has occurred in the only other districts in England in which the Shone System has been entirely adopted, namely at Honley-on-Thames, that is comparing the years subsequent to its adoption with the years previous there has been also an increase in the death-rate of the district.

You cannot bring air under high pressure into contact with sewage without liberating into the atmosphere an enormous amount of sewage or fecalized air which is most detrimental to health, of all forms of pollution, and a very slight test made by charging the sewage with some chemical compound easily detected in the air, such as lithia, and then testing the air escaping from the ejectors by spectrum analysis will show at once how the sewage air is diffused into the atmosphere by the Shone Ejectors and this sewage air escapes in very considerably larger volumes than the sewage it-

self which is removed from the district, and this sewage air, distributed at numerous points throughout your district is scattered by the winds of heaven in various directions to exert its pernicious effects upon the health of the population. Moreover, the combination of air for raising water in which the same pipes are used which may be directly in connection with these foul ejectors is not a system to be commended when it appears that the ejectors at times are not under pressure, so that there is a means of getting direct access of sewage air to the water-supply.

What I really wanted was, not the reports of the Medical Officer of Health, a single copy of which has been forwarded to me, but the annual Reports of the Municipality itself which give quite sufficient information upon the question of the health of Rangoon, and also the statistics which are not contained in the Medical Officer of Health's report, but I should very much like to know which are the districts in which it is alleged that the actual Shone System is in operation as the tables I, VII and XII do not show which districts are in the town proper and have the Shone System or which have got a pipe water-supply, all of which are points of very considerable importance.

Of course from a study of the various reports I personally know that certain districts are within the suburbs, but as to what are the districts which the Municipality themselves take into consideration no information is given, although they make statements in the reports as to relative differences in the health of the districts.

If you wish to know the actual state of health for Rangoon at any time, it may be readily found from a method which I introduced some years ago, of proportional mortality, which is very fully described in the *Times of India* of the 11th May of the present year. For example the population of Rangoon in the census year of 1891, in the middle of the year if properly interpolated is 181,862 which would give a death-rate of 36.78 per thousand in that year. Now if the births are divided by the deaths in any year and the result is multiplied by 93.62 and taken from the tabular number applicable to Rangoon of 73.55 it will give the proportional death-rate in any year, that is, the death rate proportional to the death-rate in 1891. With 6,950 deaths in 1894 and 3,102 births, the proportion of births to deaths is .4463 and the proportional mortality is therefore 31.76 per thousand, which is a less death-rate than if we assumed the population since 1891, as increasing in the same ratio as it had previously to 1891 and which shows that in all probability the population has increased faster than it had done previously to 1891 and the district is certainly healthier than it was in that particular year 1891, as the proportion of births to deaths is larger and the health of a district might just as well be ascertained from the proportion of births to deaths as in any other way.

The only report of the Municipality of Rangoon, which is in my possession is that for the year 1889-90. I should very much like to see the subsequent reports, but I have had access to the various

reports made by the Municipal Commissioner of Burma and other documents which are in this country at the India office.

Yours faithfully,
(Sd.) BALDWIN LATHAM.

To the President,
Rangoon Municipality.

Appendix II.

Copy.

13, VICTORIA STREET,
WESTMINSTER, S.W., 15th September 1896.

TO THE SECRETARY, Rangoon Municipality.

SIR,—It has been my intention to reply to your letter of 22nd January 1896, but before doing so I wished to see the Sanitary Administration Report for Burma for the year 1895, which I regret to say has not up to the present time come to hand at the India Office.

It is stated in Clause 5 of your letter that correct information could easily be obtained from your office. May I ask you therefore, if the information is obtainable, to give me the correct figures which I asked for in my letter of the 23rd August 1895, and also will you kindly give me the figures of the population and the actual number of deaths upon which you say the statistics from 1890 to 1895 given in your letter are based and at the same time the similar figures in reference to the death-rate in the suburbs of Rangoon mentioned in your letter? Will you also supply me with the most recent copy of your Medical Officer of Health's Report and also with copies of the Reports of the Municipality, since the years 1889-90? I shall also feel obliged if you will inform me on what date the Shone System ceased to be used for the purposes of raising the high pressure water in Rangoon. If there is any charge for the documents asked for, I shall be happy to pay the cost of same.

You shall receive a full reply to your letter and also some remarks on other figures which have been circulated by your Municipality with reference to the working of the Shone System.

In conclusion I desire to say that I have no interest or object whatever in endeavouring to injure Rangoon or any other place by any statements I may make, but I am solely desirous of encouraging all real sanitary works while exposing humbug wherever it is found, and if on full investigation it can be shown that Shone System adopted in Rangoon is a sanitary economical and proper system, I should certainly not oppose its extension in that City or any other place, but until this is shown not by mere assertion as set out in your letter but upon all the facts being fully investigated I shall hold that the system is both insanitary and not economical.

Yours faithfully,
(Sd.) BALDWIN LATHAM.

Appendix III.

Extracts from Allbut's "System of Medicine on Plague by J. F. Payne, pages 917—939, Vol. 1".

The Bacillus of Plague.—Great interest attaches to the recent discovery, in Hong Kong, by Kitasato, confirmed by Yersin, of a micro-organism which seems to fulfil all the conditions required by the problem, and is probably the specific cause of the disease *Ecogenic Existence of the Bacillus.*

Yersin was able to cultivate and isolate a bacillus from earth of an infected house, four to five centimetres below the surface, which precisely resembled that from buboes but was not virulent. Kitasato found in one instance that dust from an infected house communicated plague by inoculation. Yersin found that flies die from the disease, their bodies containing the bacillus; and by inoculation of material contaminated with a dead fly he conveyed plague to animals. The conclusion is that the bacillus has been discovered capable of parasitic existence in men and animals, capable of ecogenic life, showing spontaneous variability in virulence and thus fulfilling all the conditions necessary to explain the observed phenomena of plague.

Endemic Plague.

Mountain districts are perhaps the most persistent foci of plague now known.

Endemic Plague as a soil disease.

In all the places where plague is endemic, there is reason to believe that the virus resides permanently in the soil, and that human beings acquire it thence by certain channels of communication. Plague is therefore partially, though not wholly, a miasmatic or soil disease. It differs from malarial disease in that it exists only in the soil of inhabited places, and has never been acquired from mere telluric conditions. Since the living virus is a bacillus which exists in the affected subjects, it will pass from them back into the soil, and a mutual relation be thus established. The soil theory of plague is a popular belief in some parts of the world. It was dimly perceived by many older writers (by Bognhurst in the seventeenth century); but was obscured by other less tenable hypotheses of infection of the air and epidemic constitutions. It was clearly recognized by Dr. C. R. Francis as the explanation of the Indian plague of Kumaon in 1853. It was suggested as possible by Liebermesster in the article on plague in Ziemsson's Cyclopædia of Medicine and adopted, subject to further evidence, by myself in the Encyclopædia Britannica and elsewhere; but it was first definitely formulated, with the aid of Petten Kofor's theory of soil water, by Dr. Croighton in his History of Epidemic Diseases. It is apparently not held by most epidemiologists.

The arguments in favour of this view are somewhat as follow :—

(1) The remarkably limited geographical distribution of plague, so widely different from that of diseases caused by a floating or purely personal contagion, is hardly consistent with any other hypothesis.

(2) In localities where the disease is permanently established, animals living under ground are often affected in a peculiar way. Usually before the outbreak of an epidemic such animals, especially rats, perish in large numbers. They come out of their holes evidently very ill, and die, or are found dead underground; so that this phenomenon is considered by the people in India and China, where it has been chiefly observed as the sign of a coming epidemic. Recent observation in China has shown that the rats suffer not merely from poisoning, but from true bubonic plague. They have buboes, and their organs contain immense numbers of the plague bacilli. It cannot, therefore, be doubted that the virus exists underground before it affects human beings. In some countries other animals are said to be affected, but this is less certain. (In the older European epidemics it seems doubtful whether this death of rats was actually observed. The old books contain general statements of the same kind regarding animals which live in the ground, but they have the appearance of being traditional, and borrowed from the Arabian writers, especially from Avianna, who is very copious on this point).

(3) Within an endemic area of plague the disease often occurs year after year, or in successive epidemics, precisely in the same spots, even in the same houses, and springs up simultaneously in several independent foci. In London in 1665 it was said the disease "fell upon several spots of the city and suburbs like rain."

(4) Of places apparently under the same conditions, and in free communication with one another, one is repeatedly affected, the other never. Dr. Francis observed in India two villages on the same mountain, with the same aspect, scarcely 500 yards apart, of which, at every visitation of plague, one always escaped, the other suffered. In old days again, it was observed in Egypt that Alexandria might have terrible epidemic, while Cairo entirely escaped; in another epidemic the converse relation might obtain, and this in spite of unchecked communication.

(5) In cities where a notable part of the population lives on the water in boats and barges, it has more than once been noted that such persons have entirely escaped the plague. It was so in London in 1665, and recently in Canton, where 250,000 people live and sleep on the water, this part of the population enjoyed almost complete immunity.

(6) It has often been observed that while those who live on the ground floor of a house are seized with plague, the inhabitants of the

upper stories may entirely escape; so that it used to be said, "Plague does not go upstairs." This has been signally confirmed in the late epidemic of Canton.

(7) In a general way, the beneficial effects of local sanitary measures, as compared with mere prevention of contagion tell in the same direction; but the bearings of these facts can only be thus briefly indicated.

It would appear from the above reasons that the endemic prevalence of plague is comparable to that of Cholera or Typhoid, and governed by somewhat similar laws; though in other respects it differs very much from those diseases. In the double infection of the soil and the organism it resembles anthrax. Along with infection of the soil, there appears to be a passage of the virus in some form into the air, so that it has always been believed that the disease may be acquired by inhalation, like typhus. Scientific explanation of this method of receiving the virus is however still wanting.

Plague as a Communicable Disease.

Transmission of plague from one place to another not previously infected must also be regarded as well established; though doubtless, this has often been wrongly assigned as the cause of purely local outbreaks. That this is possible by means of infected ships is clearly proved by the records of the Quarantine at Marseilles (quoted by Prus), when in several instances the infection was, so to speak, caught on the sieve, that is to say, the infected ships gave rise to cases of plague within the quarantine station, of which some were fatal. The like possibility on land has often been established, though doubted by the extreme school of anti-contagionists. For instance, in the London Plague of 1665, towns and villages in communication with London became affected, though they were previously healthy, and had not suffered from plague for many years, if ever. The infection is doubtless generally conveyed by persons either affected with the disease or in the stage of incubation. Such persons convert the house they occupy into a focus of infection, till possibly the virus passes into the soil, and a severe epidemic may result. Conveyance by means of infected objects is doubtless possible, but probably much rarer. With regard, however, to this mode of transmission, it should be observed that, according to old and sound tradition, the plague does not spread when it is sporadic, but only when it is in an epidemic form. Furthermore, its diffusibility varies as much as its contagiousity in the narrower sense, being very marked in great epidemics, very slight or self-limited in others. Many epidemics have burnt themselves out on the spot, or travelled but a few miles; others have spread over whole continents. Generally successive epidemics, if unchecked cover each time a somewhat wider area.

The rate of extension is also variable, but is generally slow. Plague has taken weeks or months to pass from one side of a city to

another; it creeps along from point to point, so as to be compared by some to a drop of oil on paper.

Such gradual extension suggests the slow progress of a virus in the soil itself, and probably that is in some places the explanation; but, obviously, only transmission through short distances can be thus accounted for.

Transmission by the air cannot be said to be impossible and was once much dreaded, but while this may be possible through distances measured by yards, it can hardly be so through distances measured by miles.