

eight feet in diameter (the culvert being slightly enlarged at the mouth for that purpose) which would cost about the same as the six of three feet, and have an area of a hundred square feet instead of forty-three.

I am however bound to say that I look with some distrust upon these pipes; with the girders and piles for supporting them they will form a nearly solid groyne which must tend to the accumulation of sand on its southern face, and will, in a few years, do away with any advantage which may be gained by carrying the mouth of the culvert into deep water.

Mr. Cousins agrees with me in considering that the canal between the north branch of the Cooum and the harbour might be carried out with advantage to the town (*vide* paragraph 13 of my note of the 22nd July 1891 printed with G.O., No. 1528 M. of 19th September 1891) and if this were done the arrangement would be identical with that proposed by myself with the exception that the area of water-way provided at the river mouth would be only 132 square feet instead of the 197 square feet, which I considered necessary (paragraph 18 of note of the 16th March 1891) and that this would be provided by an independent culvert instead of by sluices connected with the Napier Bridge, an alteration of which, under the circumstances, I quite approve.

If the canal be constructed the steel tubes in continuation of the culvert will be unnecessary as the latter will only be required for exit of water and not for entrance; even for the latter I am by no means certain that they are wanted, and for the reasons given above I doubt if they would attain their object; I would therefore advise the postponement of their construction until it is shown by actual experience whether the culvert without them will not keep open a sufficient communication.

I am disposed, though with some hesitation, to agree with Mr. Cousins that under the altered conditions which will now be introduced, the filling up of the north branch of the river will be undesirable; that it would be an advantage I have no doubt, but if all sewage is kept out of the river the advantage would perhaps be hardly worth the cost.

Mr. Cousins' proposals for the improvement of the water-supply are in general accordance with the recommendation of the Committee of 1890, with certain modifications in detail.

One of these is the omission of the settling tank at the Red Hills; the reasons given for this omission do not altogether convince me. It is true that the tank itself will act to some extent as a settling chamber, but my experience is that water issuing from a tank sluice is always more or less turbid, and it is advisable that as little solid matter as possible should be carried into the conduit. If the dimensions proposed by the Committee are too small, they should be increased, but I think it would be bad policy to omit the chamber altogether. The dimensions proposed give a capacity of 1,080,000 gallons or nearly two hours' supply, a capacity sufficient to effect a substantial reduction in the amount of solid matter held in suspension by the water.

Mr. Cousins also proposes to place the sill of the conduit at its commencement 6.83 feet below the level proposed by the Committee and to give it a fall of one in 3,979 instead of one in 7,920, so that the sill at the delivery end will be about twelve feet lower than the level recommended by the Committee.

There is no doubt that these alterations are in themselves improvements, but it is a question whether they are not purchased at too high a price. The effect of them is that, whatever the level to which the water must be pumped at Kilpauk in order to give the necessary command for the supply of the town, an additional lift of twelve feet is necessary in order to attain this level; in other words that the whole daily supply was to be lifted an extra twelve feet.

For a daily supply of fourteen millions of gallons this means an additional annual expenditure (including interest on first cost of plant) of something like Rs. 25,000 in order to avoid the trifling cost of pumping on the rare occasions when the water in the reservoir is between 26 and 31 above M.S.L. The question really is whether we will have this extra pumping at the Red Hills during a few days on these rare occasions, or all the year round at Kilpauk.

From J. A. JONES, Esq., MEM. INST. C.E., F.R.S.E., Sanitary Engineer to Government, to the Chief Secretary to Government, dated Fort St. George, November 1893, No. 2431.

With reference to G.O., dated 2nd August 1893, No. 1000-A.M., Local Municipal, I have the honour to forward, for the information of Government, five copies of my remarks on Mr. Cousins' report.

ENCLOSURE.

REMARKS of the Sanitary Engineer to Government on Mr. Cousins' Report on the Drainage and water-supply and the improvement of the River Cooum Madras.

DRAINAGE.

I think it advisable, owing to frequent misrepresentation of my views in the local and other papers in India, to preface these remarks by stating that I am by no means, as stated, an apostle and persistent advocate of the open drainage system. But I believe that under certain circumstances such a system is often the only possible one, and that (2) it is often a preferable one. When there is no certain supply of water or where the supply is insufficient, few persons, it is believed, would suggest underground sewers. Again, when the circumstances of the town are such that proper house-drains—i.e., house-drains with proper apparatus for flushing and with the necessary traps and ventilating apparatus—cannot be afforded by the people, it would seem against all reason to adopt a scheme where the provision of such drains and apparatus was a necessity. For, if the habits and circumstances of a people are such that the manner of using such drains and traps causes their effectiveness to quickly disappear and thus renders the admission of sewer gas an easy matter to a dwelling, can it be imagined that any one having a due sense of the dangers which would arise (indeed it would be little else than wholesale poisoning) would, without hesitation, advise the adoption of such a system?

2. It was in pursuance of such views and with a due consideration of the circumstances of Black Town, Madras, that the present open drains were designed and laid down. Mr. Cousins himself admits they are of the highest class of open drains, while Sir John Fowler and Colonel R. H. Sankey, R.E., were of opinion that the description seemed to suit the greater bulk of the people for whom they were designed; is this not always the main question: "What is it that is most suitable to the wants of the people and at the same time the system from which the majority will derive the greatest benefit?" However much opinions may differ as to the suitability of an open drainage system combined with covered sewers for Black Town, Madras, it should be remembered that, notwithstanding all the adverse criticism and very little praise that has been accorded, this open drainage system has been the only one accepted by the Commissioners on behalf of the people and by the Government and has been the only improvement in drainage carried out in the city during the last half-century, if not for a longer period. If there is any credit in that, I by no means claim it all. I was ably supported by Mr. Arundel, the then President of the Municipality, in furthering the scheme. That the drainage and its accompanying improvements is an improvement cannot be disputed by any one who previous to its construction knew the state of the drains and streets in Black Town and who considers that the amount of sewage now carried far north of the town, part of which used to be daily discharged on the shore to the annoyance of all, the remainder fed the soil of Black Town, in place of which all the sewage now feeds a sewage farm which is a source of considerable income to the municipality.

3. I none the less, however, recognise that there are places where the open drainage system cannot be applied, and that if an underground system of sewers to which the houses can be efficiently connected by properly-trapped drains can be constructed, such a system ought to be adopted in preference to an open system of sewerage, with the proviso that, not only must the house-drains be in first place

11. The lines on which the remainder of the scheme has been arranged are what in accord with the proposals made in the report of the Committee on supply and drainage of Madras (November 1890).

12. The scheme also is in accord with the conditions laid down by the Comm as necessary, viz.—

1st.—Storm-water to be kept entirely separate from sewage and to pass to sea by its natural outlets, the Cooum and the Ottary Nullah.

2nd.—All sewage and faecal water, solid as well as liquid, to be removed pipes or covered drains properly connected with the sewers and properly ventilated.

3rd.—All sewage to be kept out of the Cooum and the Buckingham Canal.

13. The details of the scheme now claim attention.

14. Mr. Cousins states that the scheme is intended to carry off (1) the sewage (2) a portion of the rainfall falling on the backyards (how much is not stated), and (3) such sub-soil water as cannot be excluded. The sewers cannot be made practically water-tight, as Mr. Cousins specifies, but they would be so as far as possible and little sub-soil water will enter; and as rainfall is infrequent, the sewers will ordinarily be carrying sewage only.

15. Now the efficiency of an underground sewerage system is greatly dependent on the sewers being self-cleansing. To effect this they must be laid at such gradients as will maintain a certain velocity when the minimum flow occurs.

16. One of the first points which struck me was the very small depth at which the sewers were laid underground, even after long distances had been covered; this because Madras is on an extremely level site could only be because of the slight gradients used in the sewers.

17. Now it is a well-known axiom that the larger the sewer the less may be the gradient; but a precedent to this in all cases is that the sewers are supposed to be suited to the work they have to do. Thus, a 5-foot diameter sewer may be laid at 4 feet per mile; a 2-foot diameter sewer at 10 feet per mile; a 1-foot diameter sewer at 20 feet per mile; but the volume of flow must be in the ratios of 25 : 4 : 1, and if the quantity of sewage flowing in a sewer varies, it is of course necessary to ensure the minimum velocity when only the minimum quantity is flowing, and not less than 2 to 2½ feet per second velocity should be maintained in all sewers.

18. Now, if Mr. Cousins' designs for St. Thomé and Mylapore are examined with these principles in view, we find as follows.

19. The present population is about 23,000, and at 20 gallons per head per diem the maximum discharge per day will be $23,000 \times 20 = 460,000$ gallons. Mr. Cousins bases his designs on the supposition that half the sewage will pass off in 8 hours (experience teaches this to be incorrect, and this point will be referred to later on) so that flows per minute would be—Maximum flow $\frac{230,000}{8 \times 60} = 480$ gallons, say, 80 cubic feet, and his minimum flow $\frac{230,000}{16 \times 60} = 240$ gallons, say, 40 cubic feet.

20. Two sewers carry this to the outfall; each is an ovoid sewer in size 1' 10" $\times$ 2' 9", these have a fall of $4\frac{1}{4}$ feet per mile. The one sewer carries about $\frac{1}{3}$ rd and the other $\frac{2}{3}$ rds of the total sewage of the above population, that is, the minimum flow in one will be 26, and in the other 14, cubic feet per minute.

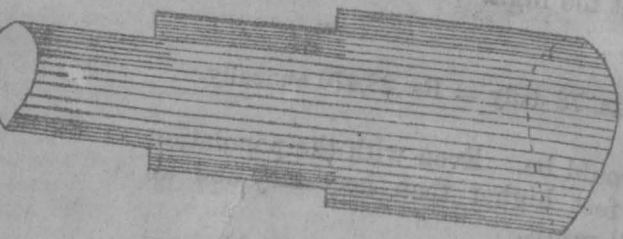
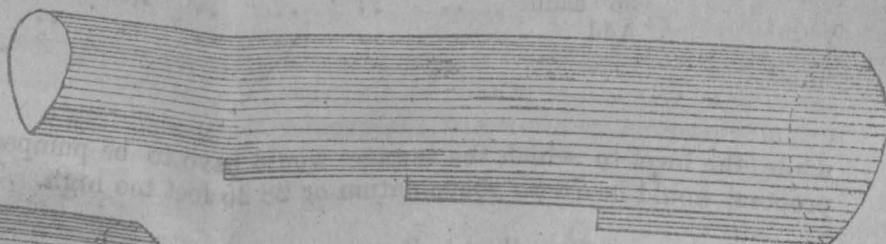
21. These sewers give discharges as follow :—

Depth.	Velocity per second.	Discharge per minute.
0' 6"	FT. 1.35	C. FT. 33
0' 9"	1.5	66
1' 10"	1.7	270

27. Another, and I think illegitimate, manner to which the sewer depths have been reduced is due to the design at the point where one size of sewer merges into the other. Mr. Cousins' plan is thus—



but as the larger sewers will have a greater depth of flow than the smaller, the discharges of the smaller sewers are by this plan reduced. The sewers should be designed according to the extra depth of sewage to be carried thus—



28. Now there is a lesson to be learnt from the foregoing remarks, and that is that if a greater subdivision of area had been made and more pumping stations adopted (and this was the view of the committee), better gradients could have been obtained and smaller and more efficient sewers would have resulted. In view of these considerations alone it would be well for the scheme to be revised. It is true that Mr. Cousins remarks that he has designed his sewers to allow of an increase of 10 to 50 per cent. to the population, but an increase of 50 per cent. of the population will not at the present rate come to pass in the next 100 years.

29. The gravitating mains, of which there will be three—(1) the existing one from Ráyapuram, (2) from the Sydenham's road station to the present outfall well at Tondiarpet, (3) a branch main from the Tondiarpet pumping station which joins No. (2)—next call for attention; and these and the pumping arrangements will be considered together.

30. The height to which the sewage has to be lifted at any station is dependent on the size and gradient of the outfall main; the most economical size of main is one such that the cost of the main *plus* the cost of pumping capitalized is a minimum. With a smaller main the sewage will have to be raised to a greater height; with a larger to a less height. The most economical size of main from Ráyapuram need not be considered as the existing main is to be used, and the other mains proposed are the proper sizes taking the population as increased by 50 per cent.

3' 2" $\times$ 4' 9") it is intended to relieve, the point of outfall has been most unfortunately chosen, because it is close to the main drain outfall and the trouble and constant expense this gives to keep open is well known to Government. Constant extensions are required.

38. As this is the only overflow to the sea and as all excessive rainfall from the great portion of the Triplicane and the Veperiy districts must find its way elsewhere (and with it all washing from roads, roofs, backyards, &c.), there would seem no particular reason for its construction.

39. There are several errors in Mr. Cousins' description of existing arrangements, but it is unnecessary to refer to them further. The strictures passed on the use and condition of the existing main drain may be perfectly true, but I fail to find in Mr. Cousins' scheme any work to carry off storm-water from his Pophams Valley sewer; it was hardly worth while to condemn present arrangements while even with new sewers they or something similar would still have to remain.

40. It has not been thought necessary to consider details of the scheme other than those which have been already mentioned. No doubt Mr. Cousins himself would introduce many modifications if he were to carry out the scheme and when he had become better acquainted with the character of the sub-soil and the materials available.

41. The main objection to the sewers having been stated, the next important matter for consideration is the house drainage.

House Drainage.

42. Mr. Cousins devotes but a very short portion of his report to this important question; his proposals are found on a few paragraphs on page 17, and yet this question has been the cause of more discussion and more consideration by sanitarians in India than the question of main sewerage.

43. Nor does he in any way consider the question of house-drainage apart from the question of the admission of night-soil into the sewers. They are, however, indeed questions which need separate consideration.

44. As to the main sewers themselves, it is a matter of no moment whether fecal matter is admitted to them or it is not; as to the house-drains, the question has a much more important aspect and must be decided on very different considerations.

45. Had Mr. Cousins been an expert of some experience in India, it is not doubted but that he would have paid more attention to the matter, but being, as it were, a visitor to the country and having practised in a country where the water carriage system is universal, the difficulties attendant on the question in India were not patent to him. It is a point on which he might well have sought for some information, but I may say that, so far as I am concerned, though probably in Madras I have given the subject more attention than any one, however wrong my view may be, on no point whatever in regard to this scheme was I consulted, and I was therefore somewhat surprised to find my name embodied in Mr. Cousins' paragraph of thanks for assistance.

46. On page 17 of his report Mr. Cousins says:—

"It is a necessity in carrying out a system of sewerage that properly constructed house-drains should be laid, with self-cleaning gradients from every house and connected with the sewer, and when laid under houses they should be surrounded with not less than six inches of cement concrete. There should be a simple description of intercepting syphon placed upon the pipe between the house and the sewer."

To such propositions there can be no objection; they are sound in every way and it is evident that *if* house-drains are a "necessity" the scheme would be of very little use, in fact none at all, without them. As this is so, one would naturally have expected to find provision made in the estimate for this important and expensive work; but this is not the case and what the cost of such drains will be found in paragraph 78 *seq.*

66. From the evidence given in the appendix—*vide* page 20 *seq.*—it will be seen the Corporation of Bombay resolved that nothing but sullage should be carried by their drainage system, and there is nothing in the circumstances of Madras to warrant any other than a similar decision—in fact, everything points in the other direction.

67. Is Madras going to disregard the opinion of men like Dr. Cornish, the best part of whose life was spent in this country studying sanitary wants—like Major Tulloch, who gave the matter the very greatest consideration?

68. In addition to such evidence we have the result of the consideration of this very point (which I discussed in my note of dissent and which is referred to) in the decision of the committee of the Municipal Commissioners of Madras, which is as follows:—

“With regard to the drainage the committee do not think it necessary to say more than that they thoroughly agree with Mr. Jones as to the removal of night-soil and most strongly deprecate its removal by pipes or covered drains.”

69. “He who runs may read.” No decision, no resolution, could be more succinctly, more clearly, stated than the above.

70. What is wanted is a system which will be acceptable to the people—a system which they can afford—a system which is not likely to get out of order—and one which, above all things, will not require constant inspection and frequent visits to their houses and the consequent annoyance. The system proposed meets none of these necessities.

71. One very important matter in regard to these house-connections is their cost. I have already alluded to this matter slightly with reference to the agency by which such drains, if decided on, should be constructed. I do not think that it can be doubted that to secure efficiency—in fact, to get the drains laid at all—they must be so by municipal agency, and it will be a matter of difficulty to recover the cost. I have already quoted the Bombay resolution on this point, and no doubt Madras must follow the same course.

72. The cost of laying down these drains has not been estimated by Mr. Cousins, nor has their number. The number of houses in Madras is as follows:—

Graduation of annual tax.	Number of buildings.	Amount of house, water and lighting taxes thereon.		
		RS.	A.	P.
Under As. 8	54	22	8	9
As. 8 and under Rs. 1½	288	316	0	1
Rs. 1½	12,155	37,348	7	6
“ 5	16,027	1,46,295	11	2
“ 15	5,817	1,21,561	6	5
“ 30 and upwards	3,422	3,92,125	2	3
Total	37,763	6,97,669	4	2

73. We may exclude houses taxed Rs. 1-8-0 and less from our calculation; these probably consist to a large extent of mud-walled huts. This leaves, say, 24,000 houses, but we must again deduct a proportion, and of these we may again exclude for those houses not in the area to be drained and for garden-houses, say, that 3,000 covers, and this is a liberal deduction.

74. We have then 21,000 houses to which to lay drains, the annual taxation of which amounts to about Rs. 3,00,000.

75. The estimation of the cost is difficult because of that unknown factor, viz., the cost of the consequent destruction of house property, but what follows gives some idea of the cost in Bombay:—

The Drainage Estimates.

81. One of the most important points in reference to any scheme is its pro cost. It will no doubt be disappointing to Government and to the public to that the cost of the work, even limited, as proposed by Mr. Cousins will be out proportion to the moderate amount estimated. As to prices and rates it would be that some fundamental error runs through the whole estimate. This may be be the rates have been estimated on a rupee basis and therefore in a currency with the estimator was not intimately acquainted or because of some error in calcu exchange. It is reasonable to take this view of the matter, otherwise the rat down are inexplicable.

82. Besides the deficiency in rates there is also a large amount of street-dr omitted from the estimate altogether. This can be seen from the plans them and to any one having an intimate knowledge of Madras is at once apparent. fact is borne out by a consideration of the estimates and reports of Major T and Mr. Clarke.

83. Major Tulloch said in his report: "Whatever scheme of drainage is a for a town, the length of the sewers and pipes must be almost exactly the same. case of Madras there must be about 140 miles of sewers and pipes, or if not parts of the town must remain undrained. In whatever line 140 miles of drai be laid down, for that sum only and for no less can Madras be drained."

84. Mr. Clarke estimated that, omitting Ráyapuram and Tondiarpet, 127 of sewers would be required. Tondiarpet and Ráyapuram Mr. Cousins includ allows 14.7 miles for these, so that, including these distances, Mr. Clarke's would be, say, 141.7 miles, thus agreeing closely with Major Tulloch. Mr. C total, including sewers and drains of all description, except his storm overflo including even his iron outfall mains and brick culvert, amounts to $131 + 4.6 =$ miles. Major Tulloch's scheme was framed in 1865, Mr. Clarke's in 1875, so t years' increase has in any case to be allowed for, and this, with the deficiencies 7 miles, means that at least 10 more miles of street sewers are necessary than been estimated for.

85. Mr. Cousins' rates for pipe-sewers bear small relation to the probabl mate cost, and I, unless the reasons already given are any way near the truth, see how he arrived at them.

86. I think that the insufficiency of the rates can best be illustrate comparative table. The figures given at Bombay are those sent me in respon enquiry a few days ago by the Executive Engineer (Drainage) of the Corp The bare cost of the pipes f.o.b. Madras obtained from Calcutta and cheap English pipe is given for the sake of comparison. Major Tulloch's rates a given by him 28 years ago when exchange was about at par. The cost of man may have decreased but not at the same rate that exchange has fallen:—

Size of pipe sewer.	Depth at which laid.	Mr. Cousins' per yard.	Bare cost of pipe alone in Madras f.o.b. per yard.	Calculated cost per yard laid at depth noted.	Major Tulloch's average rate for pipes laid per yard.	Bom actu
INCHES.		RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.	
6	5	1 11 0	1 11 0	3 4 7	3 12 0	
6	6	1 13 0		3 11 5		
6	9	2 2 0		5 1 0		
9	5	2 11 0		4 9 7		
9	6	2 13 0	2 13 0	5 0 5	5 4 0	
9	7	2 13 6		5 10 0		
9	8	3 0 0		6 0 0		
9	10	3 4 6		6 12 0		
12	6	4 4 0	5 4 0	7 4 5	6 12 0	
12	8	4 7 0		8 4 0		
15	5	7 1 0		9 1 7		
15	9	7 8 0		10 14 0		Not given
15	18	9 14 6	7 8 0	16 0 10	Not given.	
18	10	10 8 9		15 9 0		
18	12	10 12 6		16 6 2		
18						

95. Be it also remembered that there is in the above not one anna for the of house-drainage. Now there must be some means of taking the house sullage at least to the sewers, and, as I have before shown, if Mr. Cousins' designs are adopted, not less than Rs. 21,00,000 must be added on this account; that would make the estimate Rs. 58,00,000, which is very close to the amount named by the Sanitation Committee, viz., Rs. 60,00,000.

96. If these house-drains are laid so far as the outside of the house on the cost could probably be reduced to Rs. 30 to Rs. 40 per house, or for 30,000 houses, say, Rs. 9,00,000. If this sum be added to Rs. 36,84,353, we get a total of Rs. 46,00,000, under which sum it may be affirmed that Madras will not require a complete drainage scheme.

97. Mr. Cousins has not gone into any calculation of the ultimate annual cost. I venture to set it down approximately, taking the figure as Rs. 46,00,000:—

	RS.
Interest on Rs. 46,00,000 at 5 per cent.* + 2 per cent.	3,22,000
Cost of pumping at Sydenham's road	1,09,500
Do. do. at Tondiarpet	30,000
Do. do. at Rayapuram	37,000
Total	4,98,500

98. While the municipality will be able to effect small economies, such as expenses at Triplicane, Kistnampet and DeMellow's Road and Napier Park, say, about Rs. 20,000 per annum, a large amount of staff for the cleansing and flushing of drains and sewers would be necessary and most certainly a very large staff indeed if house-drains are to be laid. In fact, the expense of keeping the drains in proper order would form a very serious item. It may certainly be considered that without grants the amount above stated is the minimum the municipality will have to pay annually if Mr. Cousins' scheme is carried out.

99. I may now sum up my conclusion as based on the foregoing remarks:—

That the scheme is unsuitable or defective—

- (1) in respect to the proposal for an outfall at St. Thomé;
- (2) as regards the flat gradients and large sewers proposed and the fact that they would be sewers of deposit with large areas for the escape of sewer gas;
- (3) in respect to the length of sewer estimated for;
- (4) because that the proposals in respect to house-drains are unsuited to the people but could not be carried out with any difficulty and expense;
- (5) because the cost of such house-drains and the water apparatus necessary has been omitted from the estimate;
- (6) because the cost of the scheme generally has been greatly underestimated;
- (7) because the execution of the scheme would require such interest and annual maintenance as is probably beyond the power of the Municipality to carry out.

* Note.—These figures can be reduced if Mr. Cousins' plans are altered—see page 6 of this report.

		Mr. Cousins'.		As revised	
		Rate.	Amount.	Rate.	
		RS. A. P.	RS. A. P.	RS. A. P.	
Triplicane—cont.					
No.	4 lampholes and ventilating shafts, on 15-inch pipe sewers, laid at an average depth of 8 feet	50 12 0	203 0 0	50 12 0	
	5 ditto, on 18-inch ditto, ditto 10 feet	51 10 0	258 2 0	51 10 0	
	2 ditto, on 2 ft. 4 in. X 3 ft. 6 in. brick sewers, ditto 14 feet	56 6 0	112 12 0	56 6 0	
	13 automatic flushing chambers, on 6 and 9 inch pipe sewers, laid at an average depth of 4 feet	..	4,567 10 0	..	
	Contingencies, engineering and supervision	..	38,555 0 0	..	
		..	2,95,593 0 0	..	
Chintadripettah.					
Lin. yds.	1,941 of 6-inch pipe sewers laid at an average depth of 5 feet	ANNAS. 27	1,589 0 0	3 4 7	
	012 " 6 " " " " " " "	29½	1,865 14 0	4 5 0	
	481 " 6 " " " " " " "	32	962 0 0	4 11 0	
	5,363 " 9 " " " " " " "	45	15,083 7 0	5 0 5	
	1,260 " 9 " " " " " " "	52½	4,134 6 0	6 12 0	
	270 " 12 " " " " " " "	68	1,147 8 0	7 4 5	
	1,406 " 12 " " " " " " "	71	6,239 2 0	8 4 0	
	1,725 " brick sewer, 3 ft. X 4 ft. 6 in., laid at an average depth of 14 feet	RS. A. P. 17 14 6	30,888 4 6	40 7 8	
No.	47 manholes and ventilating shafts, on 6 and 9 inch pipe sewers, laid at an average depth of 6 feet	142 7 0	6,994 9 0	142 7 0	
	6 ditto, on 9-inch ditto, ditto 10 feet	159 11 0	958 2 0	159 11 0	
	10 ditto, on 12-inch ditto, ditto 7 feet	146 12 0	1,467 8 0	146 12 0	
	10 ditto, on 3 ft. X 4 ft. 6 in. brick sewers, ditto 14 feet	192 2 0	1,921 4 0	192 2 0	
	2 special ditto, on ditto, ditto 14 feet	..	400 0 0	..	
	26 lampholes and ventilating shafts, on 6 and 9 inch pipe sewers, laid at an average depth of 6 feet	49 14 0	1,296 12 0	49 14 0	
	5 ditto, on 9-inch ditto, ditto 10 feet	51 10 0	258 2 0	51 10 0	
	5 ditto, on 12-inch ditto, ditto 7 feet	50 5 0	251 9 0	50 5 0	
	6 ditto, on 3 ft. X 4 ft. 6 in. brick sewers, ditto 14 feet	56 6 0	338 4 0	56 6 0	
	5 automatic flushing chambers, laid on 6-inch pipe sewers, at an average depth of 4 feet	294 2 0	1,470 10 0	294 2 0	
	1 ditto, laid on 12-inch ditto, ditto 5 feet	520 0 0	520 0 0	520 0 0	
Lin. yds.	306 of 20-inch cast-iron pipes, laid through bed of river Cooum ..	42 6 0	12,966 12 2	59 0 0	
	Contingencies, engineering and supervision	..	13,567 14 6	..	
		..	1,04,021 0 0	..	
Egmore.					
Lin. yds.	3,206 of 6-inch pipe sewer, laid at an average depth of 6 feet	ANNAS. 29	5,810 14 0	3 11 5	
	256 " 9 " " " " " " "	43	688 0 0	4 9 7	
	383 " 9 " " " " " " "	45	1,077 3 0	5 0 5	
	1,013 " 9 " " " " " " "	45½	2,880 11 0	5 10 0	
	468 " 9 " " " " " " "	48	1,404 0 0	6 0 0	
	466 " 12 " " " " " " "	69	2,010 4 0	7 14 0	
	580 " 12 " " " " " " "	73	2,646 4 0	8 10 0	
	635 " 12 " " " " " " "	77½	3,085 11 0	9 0 0	
	306 " 12 " " " " " " "	80	1,530 0 0	9 6 0	
	1,695 " brick sewer, 1 ft. 8 in. X 2 ft. 6 in., laid at an average depth of 11 feet	RS. A. P. 12 13 0	21,717 3 0	27 4 4	
	116 " 3 ft. + 4 ft. 6 in., laid at an average depth of 17 feet	18 13 3	2,184 1 0	46 11 11	
No.	15 manholes and ventilating shafts, on 6-inch pipe sewers, laid at an average depth of 6 feet	142 7 0	2,136 9 0	142 7 0	
	14 ditto, on 9-inch ditto, ditto 7 feet	146 12 0	2,054 8 0	146 12 0	
	15 ditto, on 12-inch ditto, ditto 9 feet	155 6 0	2,330 10 0	155 6 0	
	17 lampholes and ventilating shafts, on 6-inch pipe sewers, laid at an average depth of 6 feet	49 14 0	847 14 0	49 14 0	
	5 ditto, on 9-inch ditto, ditto 7 feet	50 5 0	251 9 0	50 5 0	
	9 ditto, on 12-inch ditto, ditto 9 feet	51 3 0	460 11 0	51 3 0	
	6 manholes and ventilating shafts, on brick sewers, 1 ft. 8 in. X 2 ft. 6 in., laid at an average depth of 17 feet	205 1 0	1,230 6 0	205 1 0	
	6 lampholes and ventilating shafts, on ditto, ditto 17 feet	58 7 0	292 3 0	58 7 0	
	4 automatic flushing chambers	418 2 0	1,672 8 0	418 2 0	
	Contingencies, engineering and supervision	..	8,446 15 0	..	
		..	64,758 0 0	..	
Elemboor.					
Lin. yds.	733 of 6-inch pipe sewers, laid at an average depth of 6 feet	ANNAS. 29	1,328 9 0	3 11 5	
	586 " 9 " " " " " " "	45	1,648 2 0	5 0 5	
	560 " 9 " " " " " " "	45½	1,592 8 0	5 0 5	
	130 " 12 " " " " " " "	71	576 14 0	8 10 0	
	1,100 " 15 " " " " " " "	118	8,112 8 0	10 0 0	
	833 " 18 " " " " " " "	171	8,902 11 0	15 0 0	

* *Note.*—The figures in Italics show revised figures; the remaining figures are the same as those in Mr. Co
information not being available for their revision.

		Mr. Cousins'.		As revised *	
		Rate.	Amount.	Rate.	Am
<i>Black Town—cont.</i>					
No.		RS. A. P.	RS. A. P.	RS. A. P.	RS.
301 lampholes and ventilating shafts, on 6 and 9 inch pipe sewers	..	51 3 0	15,27 0 0	51 3 0	15,1
16 ditto, on 12-inch ditto, laid at an average depth of 9 feet	..	55 2 0	819 0 0	55 2 0	8
5 ditto, on 15-inch ditto, ditto 18 feet	..	57 12 0	275 10 0	57 12 0	6
17 ditto, on 1 ft. 8 in. X 2 ft. 6 in. brick sewers, ditto 16 feet	..	300 0 0	981 12 0	300 0 0	77
20 automatic flushing chambers	..	..	6,000 0 0	..	693
Contingencies, engineering and supervision	..	..	48,845 2 0	..	..
		..	3,74,483 0 0	..	..
<i>The Fort.</i>					
Lin. yds.		ANNAS.	9,683 7 0	5 0 5	17
3,443 of 9-inch pipe sewers, laid at an average depth of 6 feet	..	RS. A. P.	6,060 5 0	27 4 8	12
473, 1 ft. 8 in. X 2 ft. 6 in. brick sewers, ditto 11 feet.	..	12 13 0	..	..	..
No.		142 7 0	2,136 9 0	142 7 0	..
15 manholes and ventilating shafts, on 9-inch pipe sewers, laid at an	..	179 3 0	358 6 0	179 3 0	..
average depth of 6 feet	..	..	798 0 0	49 14 0	..
2 ditto, on 1 ft. 8 in. X 2 ft. 6 in. brick sewers, ditto 11 feet	..	49 14 0	108 10 0	54 5 0	..
16 lampholes and ventilating shaft, on 9-inch pipe sewers, laid at an	..	54 5 0	..	..	..
average depth of 6 feet	..	..	418 2 0	418 2 0	..
2 ditto, on 1 ft. 8 in. X 2 ft. 6 in. brick sewers, ditto 11 feet	..	418 2 0	..	..	..
1 automatic flushing chamber, on 9-inch pipe sewer, laid at an average	..	..	360 0 0	10 0 0	..
depth of 4 feet	..	10 0 0	2,988 9 0	..	..
Lin. yds.		..	22,912 0 0	..	..
36 of 9-inch cast-iron pipes, laid and jointed	..	..	..	..	..
Contingencies, engineering and supervision	..	..	..	..	..
<i>Tondiarpet.</i>					
Lin. yds.		ANNAS.	4,578 6 0	3 11 5	..
2,528 of 6-inch pipe sewers, laid at an average depth of 6 feet	..	29	2,118 9 6	5 10 0	..
745, 9, 7, 8, 10, 12, 13, 13	..	45 1/2	18,180 0 0	6 0 0	..
6,060, 9, 8, 10, 12, 13	..	48	4,455 15 0	6 12 0	..
1,358, 9, 8, 10, 12, 13	..	52 1/2	2,628 6 0	9 13 2	..
516, 12, 8, 10, 12, 13	..	81 1/2	3,750 10 0	10 4 10	..
706, 12, 8, 10, 12, 13	..	85	3,267 0 0	12 8 10	..
396, 15, 8, 10, 12, 13	..	132	..	..	..
No.		RS. A. P.	569 12 0	142 7 0	..
4 manholes and ventilating shafts, on 6-inch pipe sewers, laid at an	..	142 7 0	4,229 12 0	151 1 0	..
average depth of 6 feet	..	151 1 0	1,514 13 0	168 5 0	..
28 ditto, on 9-inch ditto, ditto 8 feet	..	168 5 0	690 8 0	172 10 0	..
9 ditto, on 12-inch ditto, ditto 12 feet	..	172 10 0	1,950 0 0	50 0 0	..
4 ditto, on 15-inch ditto, ditto 13 feet	..	50 0 0	420 0 0	52 8 0	..
39 lampholes and ventilating shafts, on 6 and 9 inch pipe sewers	..	52 8 0	105 14 0	52 15 0	..
8 ditto, on 12-inch ditto, laid at an average depth of 12 feet	..	52 15 0	3,000 0 0	300 0 0	..
2 ditto, on 15-inch ditto, ditto 13 feet	..	300 0 0	7,718 6 6	..	..
10 automatic flushing chambers	..	..	59,178 0 0	..	..
Contingencies, engineering and supervision	..	..	..	..	..
<i>Royapuram.</i>					
Lin. yds.		ANNAS.	8,457 12 0	3 11	..
4,666 of 6-inch pipe sewers, laid at an average depth of 6 feet	..	29	1,933 12 0	5 10	..
680, 9, 7, 8, 10, 12, 13	..	45 1/2	16,065 0 0	6 0	..
5,355, 9, 8, 10, 12, 13	..	48	2,115 10 0	9 6	..
423, 12, 8, 10, 12, 13	..	80	3,438 4 6	9 13	..
675, 12, 8, 10, 12, 13	..	81 1/2	..	..	..
No.		RS. A. P.	22,049 3 6	29 3	..
1,670, 1 ft. 8 in. X 2 ft. 6 in. brick sewer	..	13 3 3	..	..	..
14 manholes and ventilating shafts, on 6-inch pipe sewers, laid at an	..	142 7 0	1,994 2 0	142	..
average depth of 6 feet	..	151 1 0	1,963 13 0	151	..
13 ditto, on 9-inch ditto, ditto 8 feet	..	168 5 0	6,059 4 0	168	..
36 ditto, on 12-inch ditto, ditto 12 feet	..	187 13 0	1,314 11 0	187	..
7 ditto, on 1 ft. 8 in. X 2 ft. 6 in. brick sewers, ditto 13 feet	..	..	548 10 0	49	..
11 lampholes and ventilating shafts, on 6-inch pipe sewers, laid at an	..	49 14 0	913 8 0	50	..
average depth of 6 feet	..	50 12 0	367 8 0	52	..
18 ditto, on 9-inch ditto, ditto 8 feet	..	52 8 0	445 8 0	55	..
7 ditto, on 12-inch ditto, ditto 12 feet	..	55 11 0	3,000 0 0	300	..
8 ditto, on 1 ft. 8 in. X 2 ft. 6 in. brick sewers, ditto 13 feet	..	300 0 0	10,599 6 0	..	..
10 automatic flushing chambers	..	..	81,266 0 0	..	..
Contingencies, engineering and supervision	..	..	..	..	..

* Note.—The figures in Italics show revised figures; the remaining figures are the same as those in Mr. information not being available for their revision.

"That a committee, composed of the following gentlemen, be appointed for the purpose of inquiring into the sanitary effect of the house connections already constructed and of reporting thereon and of suggesting such remedies as may appear desirable or necessary."

"That the committee be empowered to call for papers or to take evidence."

"Six to form a quorum and the President to be Chairman."

Examination of Mr. J. W. Smith, M.I.C.E., Acting Executive Engineer, Bombay.

Mr. Blaney: Do the public misuse the house-connections?—Yes.

Very grossly?—Yes.

Is that from ignorance?—Yes. I have always noticed that when we first put house-connections up, they are very much more troublesome and become much more frequently choked afterwards when the people get more accustomed to the use of them.

They do choke up?—Occasionally.

How do the people misuse the house-connections?—They force all sorts of things in down-take pipes—waste food, leaf-plates, ashes, sand and earth; and besides that, the connections are used for urinating and defecating, as is shown in the case of a petition recently placed before the Corporation.

And that causes the house-connections to be a nuisance?—In some cases.

Do you mean to say that in some cases they are misused and still do well?—Yes.

With urine and night-soil?—Yes.

Where are these cases in which extraordinary sanitary results prevail, where the you foul the connections the better they do?—I do not say that; what I said was that in houses the connections become more frequently choked than in others.

Mr. Mehta: What do you attribute that to?—It is difficult to say; perhaps some use them more judiciously than others in employing a larger quantity of water. That likely the reason.

Mr. Blaney: I suppose this work of putting in house-connections in Bombay is less factory than it would be in an English town?—O yes.

Why?—Because of the kinds of abuse they are subjected to.

Do you happen to know if the house-connection drains are more foul in the hot than in the cold?—I think the probabilities are that they would be fouler in the hot.

Do you happen to know whether fevers are more prevalent in some houses than in others and in some localities more than in others?—I have ascertained that from the Health report.

Did you put in the Fort sewage system?—Yes.

Were house-connections omitted?—I explained at the last meeting of this committee they were only partially made in the Fort, and I explained how far they went. There nothing more done than what is sufficient to pass the sullage into the sewers in the street.

But practically the house-connections were omitted. You don't find an estimate of the four lakhs?—I have not referred to the estimate.

It is not there, and Mr. Ollivant told the Corporation that house-connections were omitted. I proposed an amendment that they should be put in but it was rejected.

Do you think they ought to have been put in?—I think so.

And probably the health of the district is not so good by omitting them?—Yes.

Was your plan of connecting the Honorable Fazulbhoy Visram's chawl by an running along the front of the house an experiment or a known improvement?—experiment.

Is it a better plan than the latest plan adopted for the Dhobie Talao district finished and has had no trial.

Do you think more experiments of this kind are necessary?—Yes, of some kind.

In connection with the house-connections generally?—Well, I should be suggest certain modifications.

The idea in your mind is, I understand it, that you adopted an open drain in Mr. Visram's chawl in order to overcome the faults of the natives who misuse the system giving them an open system you thought that they would better understand it?—the great point.

Have you ever tested the efficiency of the house-connections?—I don't quite that. I have examined them very frequently indeed.

You can state in that way?—I have examined them frequently in all parts of

Have you ever found derangements?—Yes.

Very often?—Yes.

Through the faults of the people?—Yes.

Examination of Mr. Weir by Mr. Pheroza M. Mehta.

In your report of the first quarter of this year you say: "in my opinion all attention should be fixed on the construction of drains, and, as I have before urged, the construction of all house-connections should be abandoned." When did you urge that?—I urged it about two years ago.

I suppose to the Commissioner?—No, but I have written reports to the Commissioner pointing out the defects in house-connections.

You have?—Yes.

In the same report you say: "Moreover, I do not think the system of house-connections is suitable for dwellings in which each room is let out to tenants." What was your reason for giving that opinion?—You must consider the necessities of the people who live in tenements. Each room has from 4 to 5 people and each person has 4 or 5 cooking-pots and you have a moree in which they bathe during the day and during the night use for urinating, and in which you often find two stones placed for the use of children to be used as a privy at night. The cooking-pots have to be cleaned with sand, muttee or ashes and grass or fibre when they come home at night; there has been a great change in the life of the poorer people of Bombay owing to the mills. The women now go to work as well as the men, and the result is that they have to cook their food when they return home and have no time to go outside and carry the earth, sand and other matter used for cleaning the pots in a basket for perhaps fifty yards. Their object is to cook their food quickly, and consequently they throw everything into the moree. Another thing is the cow-dunging of floors. The cow-dung is washed over afterwards with water and swept into the down-take pipe. It forms a most tenacious mass and with the addition of night-soil forms a mould. Then there are the Hindus who eat from leaves, which are often put into the morees and either obstruct the pipe or trap. If we were in the same position, I daresay we should do exactly the same.

Does this apply to by far the largest number of houses where there are house-connections?—To a very large number and to all the poor classes.

Some of the habits you have described will apply to the middle classes to a certain extent?—Certainly amongst Hindus, but not to the same extent. The poorer classes of Christians, as I have seen opposite the Municipal offices, are just the same and equally careless with regard to morees and pipes.

Have you seen the notice produced to-day by Mr. Smith? Are they of much use?—I hope they will be, but my unfortunate experience is that they are not of much use.

The Commissioner: They were issued at the request of the Corporation, I think (Laughter).

Mr. Pheroza M. Mehta: Even with notices do you think the habits of the people can be given up considering their circumstances?—I do not think they are habits at all; they are necessities, and I should do exactly the same in the same position of life.

No amount of notifying can make them give them up?—The poor classes of India are not a bit worse than they are in Great Britain.

So you say the habits are a necessity of the conditions of the people?—Yes.

Taking these habits of the people and the necessities into account, what has been the general effect of the house-connections in the districts in which they have been made, from a sanitary point of view?—Statistically the facts are not displayed in any way, but I think that in the districts in which they have been carried out there is a decrease of mortality. But the statistical results must be received with caution. In some districts, Dhobie Talao for instance, I think house-connections are undoubtedly a great improvement, but in other districts I am doubtful as to their effecting any improvement.

You say you are doubtful as to their effecting any improvement. Do you think they have been injurious?—In the case of house-connections which are, or may be, often obstructed, they are much more dangerous than the open gullies; the difference is this, that in a house such as represented by the old model you have the sewage directly underneath the rooms, but in the case of open gullies you have it outside.

You say in your last report that you complain of the delay of the removal of obstructions and the nuisance arising from them. Are there many cases of such obstruction and delay?—Many: I did not write in that report exactly what I intended; what I wished to say was that the system caused delay, and I did not mean to say that the Drainage department was more dilatory than the Health department would have been under the same circumstances.

Nor did I read it in that way. I understood that the delay was in consequence of the system and that it was almost a necessary delay?—Yes, that is so; the delay may be one week, two weeks or even more.

What is the state of the people living in the houses in the meantime?—It is a lamentable state of nuisance. There was one case in the Fort which lasted several weeks.

Mr. Blaney: So it did at my house. I hung by my fever three weeks.

Mr. Pheroza M. Mehta: Do the Drainage department look to the people themselves to remove the nuisance?—Yes.

How do they expect them to do it? If a syphon is obstructed they must bring a plumber and have the pipe removed and cleaned. That is the only way of doing it?—It is extremely difficult when one puts one's self in the position of a householder. Syphons are not easily cleaned.

It would necessitate removing the pipe?—Not in every case.

Do you think we have too few ventilating shafts?—Yes. But still we have more than they have in Europe.

It appears to me that you think the safest sewers are open canals?—No, I think you ought to have shafts or surface ventilation at every fifty or one hundred yards.

But surely surface ventilation is dangerous?—You render it innocuous if you have a large number of surface openings; the emanations are much less perceptible from the old sewers than they are from the new and better-constructed sewers.

But you don't get, *ex hypothesi*, if the sewers are in proper order, any emanations at all. However, you do not advocate open sewers?—Certainly not. But at the same time if the city could and had open drains, perhaps it would be the most perfect you could have.

Is it not necessary that the system of house-connections should be suited to the habits and customs of the people?—I think it is absolutely necessary.

It is possible to educate the people to the required knowledge of the system in a few years?—No. I think your system must work upon the lines that have been adopted by the people.

Especially when you find in Europe people don't change their habits and customs?—Poor people are always conservative.

You are aware that owing to this habit of the people in regard to cleaning their pots and utensils, there has been chockage of down-take pipes?—Yes.

Can any recommendation with regard to syphons which have the approval of Sanitary Engineers in England be made applicable to the state of things here?—I think the opinion of authorities in Europe must be modified in this country to suit the habits of the people. I would like to say to the Commissioner with regard to syphons that the cow-dunging of rooms here opens a means towards the fouling of syphons which does not exist in Europe. Cow-dung and rice or any food form a tenacious mould.

Are there any houses in England inhabited by tenants in the same manner as in Bombay? There is not the same crowding.

The Commissioner: There is something very like it in London. Is there anything in the habits of the people—referring to the Chairman's question—opposed to having a flushing tank at the head of the gully?—No.

Is it the general opinion of all Sanitary Engineers that no large town can exist in a healthy condition except it has drains?—Yes.

Mr. Blaney (to Surgeon-Major Weir): Are there any drains in Worlee village?—No.

What is the population; about 11,000?—That is the census return, but it includes the whole district.

What is the rate of mortality?—The rate of mortality for the whole district is very low.

Steadfastly low, much below that of the city of Bombay?—Yes.

The Commissioner: Is Worlee as crowded as Kamathipura?—The district is not.

The inhabitants are nearly all fisher-people?—Yes.

People who lead a healthy life?—Yes.

Mr. Blaney (to Surgeon-Major Weir): Is a syphon in Bombay more likely to become a source of nuisance than in Europe?—Yes.

Because the decomposition takes place more readily?—Yes.

The Commissioner led you on to show what a bad set of people the English are in the use of the water-closet and sewers; is it the exception in England to misuse sewers?—The poor classes in England are as bad as they are here.

Is it the exception in England to misuse sewers by introducing solid matter, and is it the rule in India?—That is a question I would hesitate to answer without consideration.

But do the people in India put more solid stuff into the sewers than they do in England?—I think there is much more solid stuff put in here.

Would smells and stinks from water-closets be more injurious here than in England?—They are injurious anywhere.

They rise more quickly here?—Yes, but I must qualify the answer; there are more means of ventilation in this country.

Extract of a Letter of Surgeon-Major Weir to the Commissioner.

The system of drainage which we have adopted is not one which finds favor in the mind of the great bulk of the population. Even the educated classes do not generally approve, and there are many Europeans who distrust the principle, the prevalent idea being that the system of traps and ventilators is too complicated and not suited to the requirements of an oriental population. We are committed to the system; we must make the best of it and endeavour to remove by every possible means all causes which might give rise to dissatisfaction and complaint.

Examination of Mr. D. Gostling.

The President: What is the special point on which you are prepared to give evidence, Mr. Gostling?

Mr. Gostling: Mr. Barrow sent me a series of questions prepared by Dr. Blaney, Dr. Bhalchandra Krishna and Dr. Katrak. I have considered these questions and have written

Note.—Mr. Gostling advocates open gully drains and is asked—

Do you think the system you advocate would have to be replaced in the course of ten or fifteen years, or, say, twenty years, when the habits of the people have improved?—So long as educated natives refuse to clean syphons with their own hands, so long it will be necessary not to have that system.

If the municipality did the work, your objection disappears?—I don't think so, because when a syphon chokes it has to be cleaned in five minutes or there is a nuisance. The old open paved gullies are a source of danger?—Undoubtedly.

Do you think that under your system all this will disappear?—Largely, I think. I do not say that what I propose is perfection, but I say it will be a great improvement on what we have. Excluding the habits of the natives, I understand you to say the present system of house-connections is a most desirable system?—I cannot as a practical man exclude the habits of the natives; you must work from induction, not deduction (Hear, Hear).

That is an admission on your part that, barring the habits of the people, the present system is the best one?—The first consideration is to ascertain the habits of the people amongst whom you live and for whom a system of sanitation is required, and having done that you work out the best system to relieve them of the trouble which they feel. There is no absolute truth in sewage questions any more than in other questions (Hear, Hear.)

Is this system the one in vogue in England?—I am sorry to say it is not; I wish it were. England, I think, is the worst sewered country in the world. My family were nearly poisoned in a house in London. The system, however, is not suited to India. I would advocate it for use, but you must have intelligent co-operation on the part of the residents. I have been in English houses in Drury Lane, London, where poor people live, whose water-closets have been choked for a week inside the house; not outside, as we have them here.

Have you any objection to the diameter of the pipe now used for house-connections?—I have no objection to it.

You think 2½" ample?—Not ample, sufficient; 3" is ample. You would not advise the municipality to substitute a larger pipe?—What you want is to devise means of preventing kachra getting into the pipes, and having done that they will do their work well.

Do you think that the larger the surface of pipe, the greater the source of bad smells?—Yes. That is partly why you think 2½-inch pipes are sufficient?—2½-inch pipes will take any quantity of water that can possibly be put into a moree.

I wish to be certain that citizens are not unnecessarily alarmed about the present system of house-connections, and without foundation prejudiced against them.

Mr. Blaney: That is not a question.

Mr. Viegas: I have not finished.

Mr. Blaney: It is a political question.

Mr. Viegas: You really believe, Mr. Gostling, that the dangers of the present system are such as warrant on the part of the municipality the greater expenditure which will be necessary to substitute the present house-connection system—do away with them or remove them—in the localities in which they have already been fully established?—I would answer that in this way. Under the present system the municipality not unfrequently undermine the foundations of houses (Hear, Hear). I, a short time ago, had to inspect a house in Withalwady inhabited by rich people, where the municipality had excavated their gully pipe 6 or 7 feet below the floor of the house. That was no doubt necessary for the purpose of giving a sufficient fall to a closed pipe, because a closed pipe cannot be cleansed easily, and a choke may not be found out for days and, therefore, a large fall is necessary. In this case I was obliged to advise the re-building of the side of the house, as it was shaken from bottom to top, and it was clear that the excavation of the municipality was the cause of the mischief. That frequently occurs. In the system which I advocate it will never be necessary to carry the drain more than 2 or 3 feet below the surface of the ground floor and it can never possibly undermine the house. There is also another reason; a surface drain is so simple it can be cleaned at any time, and men go to see it every day, whilst, with a pipe underground, it may be breeding disease and no one knows anything about it until it chokes and refuses to work. Therefore, I say, this system of house-connections fails because it is unsuited for our present requirements.

This very much strengthens the argument I used as to the non-possibility of constructing house-drains as designed.

The following conversation at one of the Committee meetings after receipt of a letter from Mr. John Hewson, M.L.C.E., M.S.A., shows the state of affairs in regard to the matters dealt with by the Bombay sewerage scheme:—

Mr. Blaney: Mr. Hewson was one of our Engineers for six or seven years and was in charge of our Panwell brickworks and also did duty in the Municipal office in the building and other departments. He left our service and became an Associated Member of Civil Engineers immediately afterwards and started practice in Bombay, and has been ever since that is, 16 or 18 years ago. He has had all that experience.

Mr. Kaikhosro Kabraji: But our sewerage is only constructed for sullage water; we had better inform him of that fact.

Mr. Muncherji Murzban: Are we so positive that our sewers are only for sullage?

Mr. Kaikhosro Kabraji: That is what I think.

Can you tell me whether you expect sufficient water from Tansa to flush the drains yes.

How have you formed that opinion? Is it your own or formed in consultation with Water Engineer?—Yes, and with my knowledge of the quantity of water brought in.

Do you think it is sufficient for flushing purposes?—Yes.
You have no idea that the Municipal authorities are rather doubtful about that now have heard that.

Re-examination of Mr. Smith by Mr. Kaikhosro N. Kabraji.

You say about 100 houses have water-closets?—Yes.

Does that include buildings like the High Court?—Yes.

Then private houses in the native town must be much less than 100?—Yes.

Since they are allowed to have privy connections, can you account for the fact that do not apply for the system generally?—The cost deters them.

Are people disinclined to adopt the system?
Mr. Nanabhai Katrak: Perhaps it is not generally known.

Mr. Kaikhosro Kabraji (to Mr. Smith): Do you know that, when Mr. Ollivant returned from England, he reported to the Corporation that he had studied the house-connections in England, and was of opinion that night-soil ought not to be carried into the sewers, and that that time there was some modification made in the system of sewer pipes? The drains were constructed only with a view to carry sullage?—The sewers from the very first have been constructed with sufficient capacity for night-soil.

But after a certain time when it was said the system would not be advisable for Bombay they were somewhat modified?—There has been no such modification.

Examination of Mr. J. Wallace, C.E., by Mr. Blaney.

What is the death-rate in Cawnpore?—For ten years 54 per thousand per annum.

Do any of the open street-gullies work well?—In some few cases very well.
Describe the best of them?—The best one I know is in Gallis Bazaar Street which is 950 feet long with gutters on each side and lined with brick. Waste water from the houses enters these gutters by passages made by the owners of the houses. These passages are badly built and obstruct the escape of much of the waste material thrown out of the houses; so, generally, it is more or less decomposed before reaching the street. The grade of this street is 1 in 100, and taking 7 gallons per inhabitant for 475 inhabitants plus 45 gallons used by the bheestees, the street gutters are kept in excellent condition and without more than the ordinary smells which one would expect to find. If the side drains leading from the houses were properly laid, the system would be as complete as could be desired.

Is the open system of house-drains a suitable system for Bombay?—I think so.

Do you wish to say on what you base your opinion?—Principally on the evidence I have just given concerning Cawnpore, my observations made at various times of the day and in the hot weather when there has been a shade temperature of 105° and night temperature of 90° and humidity about 17 to 23 or 25 per cent. I, therefore, think that if a street of 950 feet long can be kept in good condition with such a small water-supply, shorter lengths of drains could be safely introduced in Bombay and well worked.

And with a larger water-supply?—Yes.
Are you of opinion that an open channel is a good means of communication between the house and the street?—I am.

Examination of Mr. Wallace by Mr. Nanabhai Katrak.

What are the real advantages of having open drains broadly?—I think the first advantage is the distance which separates the house from the sewers, the distance in air, rendering escapes impossible, the advantage that solid matter which might decompose is arrested and removed, and thirdly, the advantage of economy.

Is there not free ventilation?—That is included in the first proposition—the separation of the houses from the contamination of the sewers.

Examination of Mr. Wallace by Mr. Bhalachandra K. Bhatawadekar.

Do you think the present house-connection system in Bombay is based on scientific principles?—Well, that is a vague question.

Are they scientifically correct?—I would suggest that you ask—Are they suited to the habits of the people?

Are they scientifically correct, examined independent of the customs of the people—I mean theoretically?—I would rather say that, if I were designing the arrangement, I would make them different. Nearly every one has some different opinion in carrying out sewage works.

Are they adapted to the habits and customs of the people?—I think the habits of the people must be like those of Cawnpore. I consider I am acquainted with the habits of the people and I don't think this system is suitable. It looks too much like an English model.

The Committee therefore recommend that the Corporation should ask the Commissioner to carry out these experimental trials on such a scale as he may think necessary for arriving at practical conclusions, and further that a grant of money sufficient to defray the cost of the same should be made. Five schedules are attached, describing briefly the main points of the five schemes.

That the President be asked to forward a copy of this report to the Standing Committee with a view to a further recommendation being made to the Corporation for a grant of defraying the cost.

BOMBAY,
2nd September 1893.

(Signed) . . .

WATER-SUPPLY.

Mr. Cousins' proposed scheme is almost on the lines laid down by the Sanitary Committee. No objection can be taken to the scheme itself, but some of the details require reconsideration.

2. Mr. Cousins has misunderstood the proposals of the committee in reference to a settling tank and considerable exception can be taken to his remark that the Red Hills tank itself is a settling tank. The tank, call it settling or otherwise, as proposed by the committee, was proposed in view that under the committee's plan it might be necessary at long intervals to raise the water just outside the bund into the culvert the committee proposed.

3. Mr. Cousins proposes to place his culvert at a much lower level and points out that at the level proposed by the committee the flow of water from the tank would be below the amount required when the tank fell to a level of 31.14. This, however, is incorrect; the committee did not contemplate placing the tank at the end of the 550 feet of 24-inch piping, but close to the bund, and the length of piping would be 170 feet; a delivery of 14,000,000 gallons per day requires a discharge through each 24-inch pipe of 4,860 gallons per minute and requires a grade of $\frac{3}{1000}$ as the level of the water in the culvert was to be $25 + 4 = 29$, the lowest level in the lake before pumping became necessary would be $29 + \frac{3 \times 170}{1,000} = 29.51$, and not 31.14 as stated by Mr. Cousins. By lowering the level of his culvert Mr. Cousins increased the amount of water available by 1,280 (a) million gallons—this is an advantage if the lake ordinarily fell below the level of 29.51. An examination of the records shows that the lowest level attained by the lake in each of the past 11 years has been as follows:—

September 1882	..	..	..	..	..	36.91	above M.S.L.
October 1883	..	..	..	..	..	36.51	" "
November 1884	..	..	..	..	..	23.60	" "
May 1885	..	..	..	..	..	32.92	" "
November 1886	..	..	..	..	..	39.70	" "
September 1887	..	..	..	..	..	31.97	" "
October 1888	..	..	..	..	..	38.08	" "
August 1889	..	..	..	..	..	36.85	" "
November 1890	..	..	..	..	..	36.21	" "
September 1891	..	..	..	..	..	32.54	" "
May 1892	..	..	..	..	..	34.00	" "

* Bund breached.

4. From the above it will be seen that the lowest level attained in any year was 31.97 (this, of course, excepting in 1884 when the bund breached). Under the committee's proposal water could have been drawn down to 29.51, so that even with a slightly-increased consumption the level selected by the committee was sufficiently low to obviate pumping and that was anticipated.

5. If Mr. Cousins' estimate of 11.17 lakhs for his culvert had been anywhere near the probable amount it could have been easily shown that, even with a bad year once in four, the committee's plan to have subsidiary pumping machinery and to pump

(a) Difference between Mr. Cousins' and the committee's proposals.

The service-reservoir as designed by Mr. Cousins will cost (amount to be stored 2,750,000 gallons) $\frac{2,750,000}{1,000} \times 50 = \text{Rs. } 1,37,500$ against Mr. Cousins' Rs. 66,100. I have, however, to submit that the reservoir is too small for the requirements; then let Q equal the quantity to be delivered in 24 hours, then $\frac{Q}{2}$ will be the maximum draught in 6 hours and $\frac{Q \times 6}{24}$ is the inflow to the service-reservoir during the same period; the service-reservoir must at least hold the difference between these quantities or—

$$\frac{Q}{2} - \frac{Q}{4} = \frac{Q}{4}$$

and this in the case of Madras amounts to—

$$\frac{* 14,000,000}{4} = 3,500,000 \text{ gallons} = \text{say, } 600,000 \text{ cubic feet.}$$

Mr. Cousins' reserve would contain only 2,750,000 gallons or 440,000 cubic feet. The cost of the reservoir should therefore be, not as above stated, but—

$$\frac{600,000 \times 6\frac{1}{4}}{1,000} \times \text{Rs. } 50 = \text{Rs. } 1,87,500,$$

and this of course for a reservoir just sufficient in size and no more.

13. I am not in a position to check the estimate of the engines and engine-house as no details are given. Taking the figures as altered above, Mr. Cousins' estimate will stand as—

Difference in reference to Mr. Cousins' estimate.							Mr. Cousins.	
+	-							
4.60		Conduit ..					LAKHS.	LAKHS.
	0.71	Filtered-water reservoir ..					6.50	11.17
	5.33	Filter beds ..					1.87	0.66
	1.14	Pumping machinery, &c. ..					8.47	3.14
	0.68	Engineering and contingencies ..					5.10	3.96
4.60	7.86						2.57	1.89
		Total ..					24.51	20.82

The cost of buildings for staff, sand-washing machinery, meters, &c., has not been included in either estimate.

14. The annual charges of the work would approximate as follows:—

	RS.
24.51 lakhs at 7 per cent. (interest and sinking fund) ..	1,71,570
Pumping ..	1,90,000
Cleaning filter-beds and sand-washing at Rs. 2-8-0 per 1,000,000 gallons ..	11,000
Total ..	3,72,570

15. Mr. Cousins does not recommend any increase in the size of the mains nor does he state how he determined the lift of 73 feet (viz., to a level of 66.70 above mean sea level); it would apparently be much cheaper to increase the size of some of the mains and reduce the height of the lift and thus save expense in pumping. It is a matter of calculation, but the municipality have not, as recommended by the committee, yet calculated the required hydraulic gradients on their existing mains, and the necessity for this cannot be too strongly insisted upon. The plan of placing a small iron tank to pump into is not economical, because pumping will always have to be done to that height; at night, only one-third that height would be necessary; the pumping should be direct.

* This is for the maximum supply proposed.

consideration as he has mine. He indeed does not refer to it at all, because a risky and dangerous experiment can refer only to such groins as would alter the line of the coast which in-shore groins would not do. It is to be regretted, therefore, that Colonel Pennycuik's proposals have not been considered, because the result would, at any rate, bring into play similar forces to those which, Mr. Cousins, states keep open the bar, viz., the flowing of the backwater.

2. Mr. Cousins is in general agreement with my scheme for the improvement of the Cooum, except in regard to the following points:—

(1) The manner of keeping the mouth open.

(2) The closure of the north branch and the disposal of the spoil from the dredging of the river.

3. Mr. Cousins—I think unfortunately—proposes a scheme (it cannot be called one for keeping the mouth of the river open, but one for keeping the river in connection with the sea), which is, as I shall show will be, not only insignificant in operation and in comparison to what is required, but has elements, not of uncertainty, but certainty in regard to it which are sufficient to condemn it *in toto*; and at the same time the following principles, which commend themselves to most engineers, have been lost sight of:—

“(1) That the dispersal of bars can be accomplished by increasing the volume and velocity of the tidal water passing over the bar and by giving a greater preponderance to the ebb current.”

This principle is thoroughly observed by the introduction to the Cooum of water *via* the proposed canal and its outlet by sluices after half-ebb.

“(2) That the mouth of the river ought to be capacious enough to allow of the entry of sufficient water to fill up all the reaches of the river.”

“(3) That the depth of water should be sufficient for the propagation of the tidal wave.”

“(4) That all obstructions to the free flow of the tidal current are prejudicial to the outfall.”

4. Mr. Cousins' scheme is the construction of an underground culvert as far as high-water mark and an extension by 36-inch diameter pipes for 220 feet.

5. These pipes are to be supported on piles 8 feet apart.

6. The first objection to this proposal is that the proposed construction would undoubtedly act as a groin, and one result of the construction of such a groin is very certain, viz., the sand would lodge against it and under it and the pipes would be finally and quickly covered in; that this action would take place is based on experience—first, in regard to what occurred on the erection of a pier high above water in the year 1877, and, secondly, in regard to a pipe supported on piles which used to carry the discharge from the Fort pumping station before the construction of sewer No. 3 into which it now flows.

7. As to the pier which was constructed opposite the lighthouse to give additional facilities to land rice, the shore very rapidly advanced after its construction, and I think within six weeks the pier, owing to the shoals, was of no further use.

8. The discharge pipe at the Fort pumping station from the years of its existence gave constant trouble, and during the period of the south-west monsoon it was always difficult to keep it clear; at other times of the year a considerable scour took place. To avoid this trouble, a staging was erected as far as the third surf and a line of piles driven, on which the pipes (which were only 10 inches in diameter) were fixed. 220 lineal feet of piping were laid well above sea-level (this is the exact length which Mr. Cousins proposes) and we had then arrived at a depth of 10 feet of water. The result, notwithstanding that the pipes were not below water-level at all, was that within two years the depth of 10 feet was reduced to 2 feet, and, had not the intercepting sewer then been constructed, the work would have had to be begun all over again. Here, be it remarked, the silting action was due to the piles alone, the pipe being above sea-level.

9. It may be said that, before the Madras harbour was built, the Madras pier offered no objection and did not silt up, but it is just the very fact of the Madras

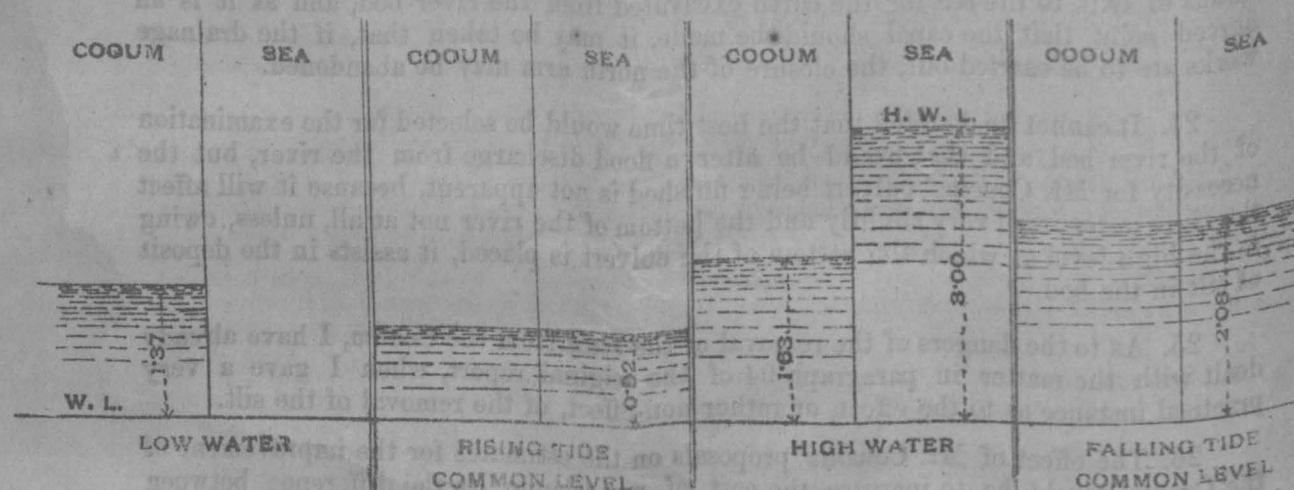
16. But with an entrance so throttled as that proposed it was evident that the condition of inflow and outflow would be very much modified than if through a comparatively wide mouth, and it was desirable that a mathematical investigation should be made; the question is by no means an easy one, but Major Love and Mr. Middlemast, of the College of Engineering, have gone carefully into the matter, and in the following are some of the results.

17. It was evident that, if the Cooum were at low water when the culvert came into operation, the amount of inflow and outflow would be materially different in amount, and it was also evident that, after a certain number of tides, an equilibrium would be established.

18. It was found that, under the above conditions, the first tide would raise the Cooum 1.09 feet and after n tides the depth in the river above low water would be—

	FT.
at low tide in sea	1.37
at common level (tide rising)	0.92
at high tide in sea	1.63
at common level (tide falling)	2.08
at low tide in sea	1.37

Hence the alternative cycle is as follows:—



From low water 1.37 — .92 = 0.45 flows out } tide rising.
 1.63 — .92 = 0.71 " in }
 2.08 — 1.63 = 0.45 " in } tide falling.
 2.08 — 1.37 = 0.71 " out }

So that the Cooum will, during the continuance of a tide, rise and fall between the limits of 0.92 above low water to 2.08 feet above low water or 1.16 feet.

19. It is not known how Mr. Cousins arrived at his quantity of 12 million gallons, for if it were considered that the whole Cooum rose and fell to the same extent as it will do at the inner end of the culvert, the inflow and outflow would each equal—

$$1.16 \times 4,250,000 \text{ square feet} \times 6.25 = 30,800,000 \text{ gallons.}$$

This is very much more than Mr. Cousins' estimates, but is still small as compared with the original scheme estimated at 80,000,000 gallons.

20. But it cannot be considered with a throttled mouth of six 3-foot diameter pipes that the horizontal tidal range will extend anything like the same distance as with a mouth (100 × 9 ft.) fairly wide in comparison with the breadth of the river; hence a very considerable reduction should be made in the amount of 30,000,000, and perhaps Mr. Cousins' estimate of 12,000,000 may be based on this consideration.

21. The level of the river would near the mouth alternate, it may be observed, from 0.58' below mean tide level to 0.58' above mean tide level. Mr. Cousins' quantity would give 0.25' on either side of that level.

Order—dated 25th January 1894, Mis. No. 82 M., Local and Municipal.

The papers will be referred back to the Honorable Colonel Pennycuik with the request that he will deal fully with the engineering aspect of the several questions raised by Mr. Jones and will give his opinion, after examining the plans, as to the probable cost of the works proposed by Mr. Cousins. Meanwhile complete information will be obtained regarding the systems of drainage adopted in the towns of Bombay, Calcutta and Rangoon and their cost.

(True Extract.)

(Signed)

J. F. PRICE,

Chief Secretary.

To the Chief Engineer, Public Works Department, with plans.

READ—also the following papers:—

From J. A. BOURDILLON, Esq., C.S., Officiating Secretary to the Government of Bengal, Municipal Department (Municipal Branch), to the Chief Secretary to the Government of Madras, dated Calcutta, the 7th April 1894, No. 1641-M.

I am directed to acknowledge the receipt of your letter, Mis. No. 160 M., dated the 14th February 1894, in which you request that the Government of Madras may be furnished with certain information relating to the system of drainage in operation in the town of Calcutta.

2. In reply, I am directed to forward herewith a copy of a letter, No. 5655, dated the 28th March 1894, from the Chairman of the Corporation of Calcutta on the subject, together with a copy of Mr. Clerk's report, dated the 29th December 1855, referred to in paragraph 3 of the letter. At the same time I am to commend, for the consideration of His Excellency the Governor in Council, the suggestion made by the Chairman in paragraph 4 of his letter that an engineer may be deputed from Madras to inspect the working of the sewerage system in Calcutta.

ENCLOSURE.

From J. G. RITCHIE, Esq., C.S., Officiating Chairman of the Corporation of Calcutta, to the Under Secretary to the Government of Bengal, Municipal Department, dated Calcutta, the 28th March 1894, No. 5655.

Referring to your letter No. 948 M., dated 25th February last, asking for full and detailed information as to the system of drainage in operation in Calcutta, its initial cost and annual charges and the results of its working, I have the honour to state that the underground drainage system of Calcutta was commenced in 1859. The total expenditure incurred on the work up to the 31st March 1893 was Rs. 1,11,27,700. The number of premises connected with the sewers is 27,560. There are 43 miles of main or brick sewers and 144 miles of pipe sewers, and its working is undoubtedly a success.

The charges for sewer cleaning and relaying amounted to—

1891-92	RS.
1892-93	57,935
	70,855

For the house drainage department (or the department which supervises the connection of private premises with the sewers) the expenditure was—

1891-92	RS.
1892-93	17,120
	18,005

The annual cost of the unfiltered water-supply which is chiefly used for sewer flushing was Rs. 9,91,910 for 1892-93.

2. The sewerage system of Calcutta is so closely connected with the water-supply system that no report on the sewerage system alone would be complete. The preparation of a detailed report, such as seems required by the Madras Government, will be a very laborious business and will take some time. The engineer informs me that he has under preparation a paper on the subject which he proposes to present to the Institute of Civil Engineers, London, and if the Madras Government could afford to wait till this paper is ready, they would have a much completer report than could otherwise be furnished.

8. While the main sewer was being constructed, pipe sewers connected with the same were laid in a district which has been called the first drainage section comprising (754) acres.
9. The pipe sewers are for the most part 9 inches in diameter, but in some cases 12 inches.
10. They were laid with gradients giving a velocity of at least 3 feet per second when running full or half full, except in one instance where a flatter grade could not be avoided, but that is an example not to be followed.
11. The main sewer receives at its head the sewage of the Elphinstone Reclamation extending from Carnac Bandar on the south to Wari Bandar on the north and from the Great Indian Peninsula Railway on the west to the Harbour on the east.
12. This district was many years ago drained by the Port Trustees on the single system, that is to say, one system of drains common both to storm water and house sullage or sewage. The sewage formerly discharged into the harbour at Carnac Bandar, but is now intercepted by the main sewer at all times except during a heavy rainfall.
13. This district will undoubtedly sooner or later have to be sewered on the separate system, but as sewers, however imperfect, are better than no sewers at all, those districts of Bombay which are entirely unsewered demand prior consideration.
14. The main sewer also receives night-soil from the Carnac Bandar depôt, which is the principal night-soil depôt in the city. The night-soil collected by hand in baskets is put into night-soil carts which dump their contents into tanks at Carnac Bandar. The night-soil is diluted in these tanks with water and then flows from the tanks into the main sewer. The main sewer thus receives the night-soil of the city under the most objectionable condition, for its being turned *en masse* into the sewer at one point at one period of the day is entirely different from the very superior condition of being discharged from houses under the water-closet system little by little at all hours.
15. The main sewer also receives, except during a heavy rainfall, a very large quantity of sewage at Bellasis Bridge from districts at present unconnected with the new system of sewers.
16. The first branch of the main sewer is the Hornby Road and Town Hall ovoid sewer 2' 6" x 3' 9" similar to it in shape and construction and connected with it near the Crawford Market. It extends through Hornby Road, Fort Street and Mint Road to the Town Hall.
17. It receives besides the sewage of houses along its route all the sewage discharged into it at its head by the Fort system of pipe sewers.
18. The second branch of the main sewer is the Queen's Road and Girgaum ovoid sewer 2' 6" x 3' 9" similar to it in form and construction and connected with it at the junction of Ketwadi 10th Lane and Khetwadi Back Road.
19. It passes through Charni Road and Queen's Road to a point opposite the Marine Lines Hospital.
20. It intercepts an old drain at that point, another at Sonapur near Lohar Street, and another near Khetwadi.
21. It receives besides the sewage of houses along its route all the sewage collected by the pipe sewer in the Queen's Road and Girgaum district (an area comprising 460 acres) and by the 15-inch pipe sewer in Marine Lines, or, Wellington Road, in the western part of Church Gate Street and in Mayo Road.
22. It receives also the night-soil from a small depôt lying off Mathew Road a few hundred yards north-west of the Charni Road Railway Station.
23. The third branch of the main sewer is the Kamatipura ovoid sewer 2' 6" x 3' 9" similar to it in shape and construction and connected with it at the junction of Grant Road and Falkland Road.
24. It extends through a part of Grant Road, part of Kharsetji Suklaji Street and part of Bapty Road to the south end of Kamatipura Bazaar Street.
25. It receives the whole of the sewage of Kamatipura including the night-soil from a depôt only second in size and importance to the Carnac Bandar depôt.
26. The fourth branch of the main sewer is the Clerk Road ovoid sewer 2' 6" x 3' 9" similar to it in shape and construction and connected with it where the latter crosses Clerk Road.
27. It extends in an eastern direction along Clerk Road to a point opposite the Victoria Gardens.
28. It receives the sewage collected by an ovoid sewer 2' 6" x 3' 9" which runs through the whole length of Ripon Road; by the pipe sewers in the Agripada district (an area comprising 371 acres) by an 18-inch pipe sewer running northwards through DeLisle Road to its junction with Elphinstone Road and by the pipe sewers from Parel village.

43. The annual charges of the sewage of Bombay is as follows:—

	RS.
Drainage engineer and his establishment of clerks and surveyors.	26,640
Inspection of man-holes and sewers and cleaning, &c., drains, gutters and main sewers and repairs and alterations to drains and gutters	94,304
Maintenance and working of Love Grove Pumping station	77,870
Maintenance and working of different sluices	4,333
Total	2,03,147

44. The new sewerage system has undoubtedly effected a very great improvement in the condition of Bombay, but in its present incomplete state the advantage cannot be more than partial. Thousands of houses yet remain to be connected, and until they are connected the sewers cannot have fair play, nor can the full advantage of them be realized.

From the Secretary to the Chief Commissioner, Burma, Municipal Department, to the Chief Secretary to the Government of Madras, dated Rangoon, the 8th June 1894, No. 190—2 T-14.

In reply to your letter No. 160, dated the 14th February 1894, I am directed to forward the papers mentioned in the annexed list which contain full information regarding the system of sewerage in Rangoon. The results of its working have proved satisfactory. Its initial cost amounted to 23½ lakhs of rupees, and its annual charges are Rs. 60,000.

ENCLOSURE.

List.

- (1) Extract from the Rangoon Municipal Administration Report, 1889-90.
- (2) Extract from the Municipal Engineer's Report for 1891-92.
- (3) " " " " " for 1892-93.
- (4) " " " " " for 1893-94.
- (5) Report by the Municipal Engineer of Penang.
- (6) " " " " " of Singapore.
- (7) Municipal Engineer's Report of 19th June 1891.
- (8) Memorandum of Answers to Queries put by the Town Clerk of Brisbane.
- (9) Pamphlet prepared by Messrs. Shone and Ault and O. Deacon Clark on the project for the sewerage and supplementary high pressure water-supply for Rangoon on the Shone Hydropneumatic system.
- (10) Pamphlet on the Shone Hydropneumatic Sewerage and Water-supply system.
- (11) Pamphlet by Messrs. Shone and Ault on the Rangoon Sewerage and Water-supply Works on the Shone Hydropneumatic system.
- (12) Mr. H. F. White's Report on the Shone system.
- (13) Mr. C. E. Cardew's Report on the Shone system.
- (14) Mr. J. Stark's Report on the Shone system.
- (15) Mr. S. B. Doig's Report on the Shone system.

No. 760-D.

Note by the Chief Engineer, Public Works Department.

A very careful and elaborate study of the plans submitted by Mr. Cousins in connection with his report on the drainage and water-supply of the town of Madras, and of Mr. Jones' remarks thereon, as contained in the papers recorded with G.O., No. 82, of 23rd January 1894, has not induced me to modify the opinions expressed in my note of the 28th September last on the merits of Mr. Cousins' scheme so far as it deals with the question of the drainage of Madras from an engineering point of view.

drainage, with which Mr. Cousins hardly deals at all, namely, that of the house connections, and I cannot but consider the absence of a proper consideration of this subject a blot on an otherwise admirable scheme.

11. The poverty of construction and small size of the average native house in Madras will render the connection of the houses with the sewers certainly a more expensive and probably a more difficult matter than it would be in a town like Calcutta or Bombay, and there is probably no part of the scheme which will try the skill and energy of the executive staff more than this; but I entirely decline to believe that there will be any difficulty in carrying out these connections which the professional talent at the disposal of Government and the Municipality will not be fully equal to meeting.

12. While, however, the more complete study of the scheme which I have been able to make since my return to India has confirmed the views as to its engineering merits expressed in my note of September last, it has also confirmed still more strongly the views expressed in that note as to its probable cost. On this point I am entirely in accord with Mr. Jones, my only doubt being whether he has gone far enough in the additions which he has made to Mr. Cousins' estimate. Looking to the fact that in almost every case where data are available it has been found necessary to revise Mr. Cousins' rates by from twenty to a hundred and twenty per cent. it would be rash to assume that in those cases where such data are not available these rates will be found sufficient.

13. I am certain that the portion of the work which Mr. Cousins estimates at Rs. 23,38,176, and for which Mr. Jones' partially revised estimate amounts to Rs. 34,49,124, will not in practice be found to cost less than Rs. 40,00,000.

To this has to be added the cost of the house connections, and for these I consider Mr. Jones' estimate of Rs. 21,00,000 to be as near an approach to accuracy as we can get at present, with perhaps a slight—but a very slight—error on the side of liberality.

14. It may be suggested that the cost of these connections should not be taken into consideration, as they should be executed not by the Municipality but by the house-owners themselves; this is really a point that does not admit of discussion the connections must be executed by the same agency as executes the main system and the cost will have to be met by the house-owners in some form, either in their corporate capacity as rate-payers or in their individual capacity as house-owners.

15. The financial aspect of the subject will be dealt with later on; but for the present it is sufficient to say that the cost of a complete drainage scheme will approach very closely to the sixty lakhs at which it was stated by the Committee of 1890.

16. Turning next to the question of water-supply, Mr. Jones' criticisms are almost identical with those contained in my note of October last; the two main points on which we differ from Mr. Cousins are, first, as to the provision of a settling tank outside the reservoir, which Mr. Cousins proposes to omit, and, second, as to the level at which the culvert is to leave the reservoir and the fall to be given to it.

17. On the first point I see no occasion to alter my view that the settling tank is a necessity, and that the dimensions proposed by the Committee of 1890 are sufficient.

18. As to the second point, as stated in the postscript to my former note, Mr. Cousins considers that the nature of the ground compels the adoption of the profile proposed by him, and if this were so the superior advantages of the higher level must of course be abandoned but after a careful examination of the plans I am satisfied that this is not the case and that even on the route selected by Mr. Cousins there would be no difficulty whatever in taking off from the Red Hills at the level proposed by the committee; without further surveys I am not certain whether by a small deviation from Mr. Cousins' route the slighter gradient, gaining some five feet more, could not be obtained, but this is of less consequence than the level of the off-take, as the increased gradient is in itself an advantage which to a great extent balances the drawback of the additional lift at Kilpāk. While, therefore, I am of opinion that the level of off-take proposed by the committee should be adhered to, I see no objection to adopting the increased gradient and reduced section of culvert proposed by Mr. Cousins.

that mentioned in paragraph 27 of this note, but there is in my mind some doubt as to the route which the canal should take; three different routes have been contemplated:—

(1) From the north side of the harbour to the north of Black Town and joining the canal near the basin.

(2) From the south side of the harbour along the foreshore to the east of the Fort, joining the river near its mouth.

(3) From the south side of the harbour, passing to the west of the Fort and joining the river near St. Mary's bridge.

31. Of these, No. 2 may, I think, be left out of the question; it would be somewhat cheaper than No. 3, but would be an exceedingly inconvenient route in many respects and would not be nearly so efficient for the cleansing of the river as either of the others.

No. 3, while more efficient than No. 2, is a good deal cheaper than No. 1, and for this reason I formerly concurred in Mr. Jones' recommendation that it should be adopted.

No. 1 is however incomparably the best route as regards convenience of navigation and sanitary efficiency; its cost would be considerable as it would pass through a good deal of valuable land, and involve the destruction of no small amount of buildings, and I fear that this consideration would be prohibitory; it should, however, be estimated for in detail, and, if possible, adopted.

32. In the last paragraph of his note on this subject Mr. Jones suggests that the whole of the papers should be sent to some engineer who has made such questions his particular study. I earnestly hope that the Government will do nothing of the sort; there is not the smallest necessity for any such reference, nor would any information or advice better than is now at the disposal of Government be obtained by means of it.

33. It will be useful to consider, not the only first cost of the works proposed, but all the annual expenditure involved in their working and maintenance. The former is estimated at—

	RS.
(a) Drainage scheme	61,00,000
(b) Improvements to water-supply	25,00,000
(c) Do. to the Cooum	8,00,000

The annual cost will be—

	RS.
(a) Interest at 4 per cent. Sinking fund at 1 per cent.	3,05,000
Working expenses	1,80,000
Maintenance—	
Machinery, 10 per cent. on Rs. 5,00,000	50,000
Masonry works, 1½ per cent. on Rs. 35,00,000	52,500
House connections, 6 per cent. on Rs. 21,00,000	1,26,000
Inspecting establishment	50,000
Total	7,63,500

from which has to be deducted the present expenditure for the removal of night-soil.

	RS.
(b) Interest and Sinking fund on Rs. 25,00,000	1,25,000
Working expenses	2,01,000
Maintenance—	
Machinery, 10 per cent. on Rs. 6,00,000	60,000
Other works, 1 per cent. on Rs. 18,00,000	18,000
Total	4,04,000

in addition to charges on existing works.

	RS.
(c) Interest and Sinking fund on Rs. 8,00,000	40,000

No allowance is made for working expenses on (c), as the latter, which will be very small, will certainly be recouped by receipts from wharfage and navigation.

34. If, therefore, Mr. Cousins' proposals be carried out in full, the total additional expenditure which the Municipality, with such aid as Government may give, will have

ORDER—dated 7th November 1894, No. 1651 M., Local and Municipal.

The papers read above deal with the schemes of Mr. Cousins for the drainage of Madras, for its water-supply and for the purification of the Cooum river.

2. Mr. Cousins proposes to deal with the drainage of the city by a system of under-ground sewers, and his scheme divides Madras into four portions, one of which (that comprising Mylapore and St. Thomé) it is proposed to drain by gravitation into the sea, while the other three are to be served by three distinct drainage systems from each of which the sewage is to be pumped to the existing Black Town sewage farm and there dealt with. He estimates the cost of the scheme to be Rs. 23,38,176. The Chief Engineer, Public Works Department, however, while considering that from an engineering point of view Mr. Cousins' scheme leaves nothing to be desired, points out in his note upon it read above that its cost has been very greatly under-estimated, and that, as far as can be judged from the data that are available, it would without doubt amount to not less than Rs. 40,00,000. To this sum has to be added the cost of making connections between the houses and the sewers, which is a work that could not safely be left to the house-owners, but must be undertaken by skilled labour under competent supervision, that is, by the municipality itself. Mr. Cousins' estimate does not provide for the construction of the house connections, the cost of which both the Chief Engineer and the Sanitary Engineer to Government consider would amount to little short of Rs. 21,00,000. The total cost of the scheme would thus reach the sum of Rs. 61,00,000, and the Chief Engineer estimates that its working (including interest and sinking fund) would entail an annual expenditure of Rs. 7,63,000. The gross revenue of the Madras Municipality in 1893-94 was Rs. 12,32,517. The adoption of Mr. Cousins' scheme would therefore entail an increase of some 62 per cent. in the existing taxation of the city.

3. The scheme proposes, as has been stated, to deal with the drainage of Madras by a system of sewers connected separately with each house. In the Black Town quarter of the city, where, owing to the density of the population the need for an efficient system of drainage is more pressing than in any other part of it, very few of the houses are more than one story high. The number of connections to be laid would therefore bear a very high proportion to the population to be served by each of them. The houses are moreover usually poorly constructed, and they are crowded together with little or no space between them, and are very frequently built back-to-back in such manner that it would be impossible to connect them with the sewers by any other means than by pipes laid under their front main walls. House connections in that important portion of Madras would therefore be unusually numerous, very expensive in proportion to the value of the houses to which they were laid, and difficult to examine and repair. Water, again, is laid on to but a small proportion of the houses in the city, and the flushing of the house connections would therefore require to be done by hand. Unless this were frequently and conscientiously performed in every house connected with the sewers, there can be little doubt but that the dangers attendant on the proposed system would greatly exceed those to which the population is under existing circumstances exposed. Constant care would also be required on the part of all house-holders to ensure that the pipes were not fouled by the introduction into them of matter which they were not constructed to carry. An indispensable pre-requisite, in short, to the success and safety of the scheme is the intelligent and willing co-operation of the population which it is designed to serve. The system, however, is one which runs entirely counter to the traditions and practice in such matters of all the native inhabitants of the city, and would on this account have without doubt to contend with strenuous opposition from all but an insignificant fraction of the population.

4. In view of these circumstances, and after a careful consideration of the scheme in its several aspects, and of all the issues involved, His Excellency the Governor in Council is of opinion that the attendant conditions which are essential to the success of a system such as that proposed by Mr. Cousins are wanting in the City of Madras, and that the time has not yet arrived when the Municipal Commission could with confidence be advised to incur the large expenditure which its adoption would entail.

11. His Excellency the Governor in Council agrees, however, with Colonel Pennycuik and Mr. Jones that this scheme will scarcely secure such an efficient cleansing of the Cooum as is desirable. The proportion of the total contents of the river that would be displaced at each tide would be comparatively small. Owing, moreover, to the abandonment of the drainage scheme it will be impossible to calculate upon the total elimination of sewage from the Cooum, and it is on this account the more necessary that any scheme for the purification of the river that may be adopted shall ensure the replacement by sea-water at regular intervals of a very considerable proportion of its contents. The Government is of opinion that the proposals formerly put forward by Colonel Pennycuik in modification of those made by Mr. Jones, which are referred to in paragraph 27 of his note read above, would provide for a degree of circulation in the river which would meet the necessities of the case. A canal from the north side of the harbour to the basin in the Buckingham canal would permit of the entry twice in the twenty-four hours of a large body of water at one point of the connected waters of the Buckingham canal and the Cooum, and for its discharge at another and a distant point, and would thus effect a continual replacement of a considerable portion of the contents of the canal and river. Such a canal should, moreover, be of great value to the harbour and the commerce of the city. It is roughly estimated that the cost of this proposal would be some eight lakhs of rupees, and this would involve an annual charge for interest and sinking fund of Rs. 40,000. The Chief Engineer will now be requested to at once make arrangements for drawing up detailed estimates of the outlay that the execution of this project would involve. The estimates should provide for a lock to admit of boats passing between the canal and the harbour, as well as for sluices to allow of the entry of sea-water during flood tides and of its discharge at the Cooum mouth during ebbs.

12. His Excellency the Governor in Council trusts that the execution of the schemes for the water-supply of the city and for the purification of the Cooum now approved will be followed by a marked advance in the sanitary condition of Madras.

(True Extract.)

W. Francis

for Chief Secretary.

To the President, Municipal Commission, Madras.
 „ Sanitary Engineer.
 „ Sanitary Commissioner.
 „ Public Works Department.
 Editors' Table.

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LOCAL AND MUNICIPAL.

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18-12-94

Encl.

G.O., 7th Nov. 1894, No. 1651 M.

NOVEMBER.

Sanitation.

Passing orders on Mr. Cousins' schemes for the improvement of the drainage and water-supply of Madras and for the purification of the river Cooum.

submit without delay
proposition statements
for the establishment
required for the preparation
of these plans and estimates,
further instructions regarding
which will be issued
by the Chief Engineer

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