(1) பக்கங்களின் எண்ணிக்கை 86.

(2) புதுக்கித் திருப்பிய நாள் 21.10.90

(3) ஆதாரங்குறிப்பவர் சுருக்கொப்பம்

தமிழ்நாடு ஆவணக் காப்பகம்.

தமிழ்நாடு அரசு

P.W.D துறை

அரசாணை எண்.	அச்சகம்
மு. கோப்புத் தாள் எண். 3017	பலவகை
நாள் : 11-11-1991	198

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43 Sheets

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GOVERNMENT OF MADRAS.

LOCAL AND MUNICIPAL DEPARTMENT.

Read—again the following papers:—

G.O., dated 1st October 1890, Mis. No. 1462 M., Local and Municipal.

Read—the following papers:—

G.O., dated 16th September 1890, No. 643, Public.

Order—dated 16th September 1890, No. 643, Public.

His Excellency the Governor in Council resolves to appoint a Committee consisting of—

President:

Colonel Pennycuick, R.E., Chief Engineer and Secretary, P.W.D.

Members:

Mr. J. A. Jones, Sanitary Engineer,
Dr. W. G. King, Acting Sanitary Commissioner,

to consider the lines on which expenditure can be most advantageously incurred on the water-supply and drainage of the Town of Madras, and to furnish, if possible, plans and estimates.

(True Extract.)

(Signed) J. F. PRICE,
Chief Secretary.

To Colonel Pennycuick, R.E.
„ J. A. Jones, Esq., M.I.C.E.
„ Surgeon-Major King, M.B.
Copy to the Department of Public Works.
„ „ Local and Municipal Department.

Order—dated 1st October 1890, Mis. No. 1462 M., Local and Municipal.

Communicated to the Municipal Commissioners, Madras.

(True Extract.)

(Signed) J. F. PRICE,
Chief Secretary.

To the President, Municipal Commission, Madras.

From Colonel J. PENNYCUICK, R.E., President of Committee, to the Chief Secretary to Government, dated Madras, 26th November 1890, No. 4901-C.

I have the honour to submit herewith the report of the Committee appointed by G.O. (Public Department), No. 643, of 16th September 1890, with the following appendices:—

(1) Note of dissent by Mr. Jones regarding the disposal of night-soil.

(2) Note by Dr. King on the sanitary condition of Madras with suggestions for its improvement.

(3) Note by Mr. Jones on the same subject, with remarks by Colonel Pennycuick.

(4) Letter from Mr. J. H. Stephens, Honorary Assistant Engineer, with suggestions for the improvement of the Cooum.

(5) Letter from Mr. B. C. Dumphy, Sub-Engineer, Madras Harbour Works, on the same subject.

(6) Letter from Mr. A. Chatterton, Professor of Engineering in the Madras College of Engineering, on the same subject.

Report of Committee on Water-supply and Drainage of Madras.

The duty imposed upon the Committee by G.O., No. 643, of 16th September 1890, Public, is "to consider the lines on which expenditure can be most advantageously incurred on the water-supply and drainage of the Town of Madras, and to furnish, if possible, plans and estimates."

2. As a preliminary to this question, it is necessary to consider what are the actual requirements of the town in respect of these two services, and they may conveniently be considered separately.

3. *Water-supply.*—As regards the water-supply, this is at present drawn from the Red Hills Lake and conveyed to Madras by an open channel nearly seven miles in length, the sill of which at the Madras end is 29 feet above M.S.L.; and is then distributed by pipes under the head due to this level, no artificial means being used for obtaining increased pressure, and no filtration being employed.

4. It has long been recognised that this arrangement is defective as to the quality of the water, owing to the absence of filtration and the liability to pollution in the tank and in the open channel leading from it; it is defective also as regards quantity of water and regularity of supply, the pressure available not being sufficient to deliver it at the rate necessary for the requirements of the town.

5. A scheme for remedying these defects was proposed in 1885 by Mr. Jones, the Engineer to the Municipality of Madras, the essential parts of which were the construction of a tower in the deepest part of the tank, by means of which the whole contents of the tank would become available without the pumping which is now necessary when the water falls below a certain level, and the erection of pumps by which the water was to be forced up to filter beds constructed on the high ground in the neighbourhood, from whence it was to be delivered by gravitation through a pipe thirty-six inches in diameter, the distribution in Madras being effected as at present.

6. The works were calculated for a daily consumption of six millions of gallons and their cost was estimated at thirteen lakhs of rupees, which at the present price of iron would probably be raised to seventeen lakhs.

7. Before proceeding any further in the consideration of the measures to be adopted, it is necessary to consider whether the six millions of gallons provided by Mr. Jones' scheme of 1885 is enough for the requirements of the city, and, if not, to what extent this quantity should be increased.

8. Concerning this point it may be noted that whereas in 1884, the consumption was little more than two-and-a-half millions of gallons per diem, in April, May and June 1888, even with the present inefficient means of distribution, it averaged nearly seven millions of gallons per diem, and there can be no question that with a higher pressure and better distribution this quantity will be greatly increased.

9. Allowing for the probable increase of population, the Committee do not consider that it would be right to allow for a smaller consumption than 25 gallons per head per diem for 440,000 people, or eleven millions of gallons per diem, and the following recommendations are based upon this estimate.

10. The Committee have not sufficient data to estimate accurately the head required at Kilpauk where the town distribution begins, but from such information as they have, they believe that this head should not be less than twenty feet in excess of that now existing; *i.e.*, that the water should be delivered at a pressure equal to about 50 + M.S.L. instead of 29 as at present. In order to deliver eleven millions of gallons daily at this pressure, it would be necessary to provide one fifty-six inch or two forty-two inch mains instead of the single thirty-six inch main provided in the original scheme, the effect of which, with the additional pumping power and filtering area required, would be to raise the cost of the works from seventeen lakhs to about thirty-two.

11. It may in fact be accepted that a daily supply of eleven millions of gallons could not be provided on the lines of the present scheme for less than thirty-two lakhs exclusive of the cost of improved distribution.

12. An alternative scheme has been suggested by Mr. Ellis, the present Engineer to the Municipality, by which the water would be brought to Madras by the present channel, the sides of which would be lined with concrete to prevent loss of water from leakage, the pumping and filtration being done at Madras instead of at the Red Hills. The cost is estimated by Mr. Ellis at about seventeen lakhs for a daily supply of ten millions of gallons, and for eleven millions would be about eighteen lakhs.

13. The Committee consider the principle of this scheme as regards the pumping and filtration to be sound, but they do not consider that merely to line the sides of the existing channel with concrete would be sufficient; they consider it essential that the water should be conveyed from the Red Hills to Madras by a covered passage, either of iron or of masonry. The former is necessary if the initial pressure is to be put on at the Red Hills, but if the water can be allowed to flow without pressure from the reservoir to Madras and the pressure obtained at the latter place, a masonry conduit, the cost of which will be less than half of that of an iron pipe of equal area, may be used.

14. After full consideration of the subject, the Committee consider that the following arrangements will best meet the requirements of the case.

15. Construct at the foot of the tank bank, opposite to the water tower already built, a masonry basin about a hundred and twenty feet square, with its floor at 20 above M.S.L. and the top of its walls at 32, into which will be let the pipes from the water tower; from this basin, which will serve as a settling tank, lead off a properly ventilated masonry conduit, with an arched top, five feet wide and four feet high up to the springing line of the arch, the arch to have a rise of one foot. The sill of the conduit at the basin to be at 25+M S.L. or six feet below that of the present municipal sluice and to fall at eight inches per mile to the end of the present delivery channel at Kilpauk, which it will reach at a level of about 20 above M.S.L.

The necessary filtering and pumping works to be constructed here as in Mr. Ellis' scheme.

16. A slight saving in length would be obtained by taking off the conduit at the present municipal sluice and following the line of the existing channel, but the course advocated above has two great advantages: first, the greater facility of construction in an independent line as compared with one following the existing channel, which

would need complicated and expensive arrangements for executing the new work without interference with the supply by the present channel; it is probable that the extra cost of these arrangements would exceed that of the additional length of conduit required by the route proposed.

17. The second advantage is in the greater convenience of the tower site for drawing off the water from the lake as compared with that of the present municipal sluice; this advantage is most apparent when the water-level in the lake is below that of the conduit, and pumping to the latter is necessary; the present site is inconvenient in the extreme for this purpose.

18. The conduit will deliver 26 cubic feet per second, or fourteen millions of gallons per day, with the water level with the springing line of the arch, and up to this limit the supply can be increased at any future time by the provision of additional filtering area and pumping power.

19. The line of the conduit should be laid out so as to be in as nearly as possible six feet of cutting the whole way, and it is believed that there will be no difficulty in laying it out so that the cutting shall rarely, if ever, exceed ten or twelve feet. Where it passes through bad soil or water-logged ground, it will be necessary to construct it of brick or stone in cement, but such ground will be very rare, and for the greater part, if not for the whole of its length, it may be constructed of ordinary brickwork, concrete, or laterite masonry, lined with cement plaster. It will be understood that this conduit is not subject to any internal pressure, as the water will never be allowed to touch the soffit of the arch.

20. It is believed that the cost will not be more than Rs. 90,000 per mile or about Rs. 6,50,000 in all, as against Rs. 3,38,000 provided by Mr. Ellis for "sectioning and concreting the existing channel;" for the other items, pending the completion of detailed estimates, Mr. Ellis' approximate estimates slightly increased on account of the increase of supply from ten millions to eleven may be accepted, except that the unfiltered-water reservoirs provided by him at an estimated cost of Rs. 2,00,000 are not considered necessary, and he appears to have somewhat under-estimated the probable cost of the covered reservoir for filtered water, the cost of which will, it is thought, be not much less than Rs. 3,00,000.

21. The total cost may be taken at—

	Rs.
Land	45,000
Masonry-conduit	6,50,000
Filters	2,90,000
Covered filtered-water reservoir to hold twelve millions of gallons .	3,00,000
Pumping apparatus at Kilpauk	4,20,000
Do. do. at Red Hills	30,000
Engine houses and other buildings	75,000
Basin at Red Hills	30,000
Sand washing boxes	16,000
Recording water	10,000
Contingencies	1,84,000
Total ..	20,50,000

in addition to the expenditure already incurred and to the cost of distribution; the Committee do not believe that an efficient supply can be obtained for less than this.

The annual cost of pumping and repairs may be taken approximately at Rs. 1,20,000.

22. There does not appear to be any reason for doubting the capacity of the lake to provide the increased supply now contemplated; the amount is in fact so small in comparison with the consumption for irrigation and the losses by evaporation that the effect upon the lake levels of increasing the town supply from seven millions of gallons to eleven is quite insignificant.

Only once since the restoration of the tank in 1885 has the water fallen below the level of the municipal sluice, and then only some forty-five millions of cubic feet were used out of the five hundred millions contained in the tank below the level mentioned, and with the reduced levels now proposed for the off-take of the conduit it is probable that pumping at the Red Hills will rarely, if ever, be required.

The Committee consider, however, that no extension of irrigation under the tank beyond that already existing should be permitted.

23. In the improbable event of increased storage being required at some future time, it might be obtained either by stopping the irrigation under the Cholavaram tank and keeping the latter entirely as a reserve for the Red Hills, or by raising by means of falling shutters or otherwise the level of the weir of the latter tank. It is, however, believed that this latter plan would be disapproved by the Public Works Department.

24. The water in the lake is now exposed to pollution by the existence of villages within its drainage area, and the Committee consider that means should be taken for preventing this as far as may be practicable.

25. The Committee consider that, to ensure proper professional and financial control, it would be desirable for the preparation of detailed designs and estimates for the works indicated above, and their subsequent execution, to be undertaken by Government, a special officer of the Public Works Department being employed for the purpose as soon as possible; the works for the extension and improvement of the distribution in Madras being undertaken by the Municipality, and they would advise that the latter should at once detail an officer to consider what improvements may be made in the present system of distribution. In many portions of the system the mains are too small and require enlargement. A plan of existing mains and proposed alterations, and diagrams showing the areas to be supplied by each main, and the loss of head at the point on it most distant from Kilpauk, should be prepared as soon as possible; when this is done, the head necessary at Kilpauk can be accurately determined.

26. *Drainage.*—With regard to the question of drainage, the Committee consider that no drainage scheme can be accepted as satisfactory which does not fulfil the following conditions:—

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

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

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

27. It should be explained here that, although the Committee consider closed drains and water-borne sewage to be preferable to open drains and separate removal of solid excreta, such preference is conditional on the existence of properly-trapped house connections, an ample supply of water, and efficient mechanical arrangements for flushing. If these conditions cannot be fulfilled, either on account of expense, or on account of the habits of the people, they consider that it would be better to adhere to a suitable modification of the "open drain system" conjoined with separate removal of fœcal matter—methods which were adopted in the case of Black Town in consideration of these defects; but such a system cannot be described as complete, efficient or satisfactory according to modern ideas of sanitation.

28. On the whole, they are of opinion that if the conditions they have laid down can be fulfilled, the best scheme would be one on the general lines of that proposed by Mr. Clarke in 1875, omitting Black Town, Washermanpett, Ráyapuram, St. Thomé and Mylapore, the sewage of the remaining portion of the city to be collected at a central pumping station near the People's Park and there conveyed to the existing sewage farm at Tondiarpett.

They consider the existence of this farm to be in no way objectionable, and as land for its extension is available to a practically unlimited extent, no better final outfall could be obtained.

29. The remaining sewage farms are not considered to be at present objectionable, but they are likely to become so in course of time, the area available for the use of sewage being limited; and the scheme contemplated provides for their extension as the areas which they now serve are connected with the main outfall.

30. The greatest distance to be traversed by the sewage on its way to the central pumping station would be about three miles, and to avoid the difficulties inherent in the construction of sewers at a considerable depth below the ground in such soil as that of Madras, it might be desirable to lift the sewage at one or more intermediate points, either by intermediate pumping stations, or by a modification of the Shone system; this, however, is a matter of detail which can only be settled when the detailed estimates are being prepared.

31. The omission of Black Town from the scheme contemplated is proposed, because this portion of the city has already a fairly efficient system of drainage, and although this system is based upon the use of open street drains, which the Committee consider, under the conditions which it is hoped will shortly prevail in Madras, decidedly inferior to closed ones, they do not consider this inferiority to be so great as to justify the sacrifice of what has been already done—at all events until the more urgent needs of other parts of the town have been attended to. The value of the system has never been properly developed, owing to defective conservancy and insufficient control. Triplicane and Chintadripetta, Choolay and Vepery are the portions most urgently in need of attention and should be first attended to.

32. It is proposed to omit St. Thomé and Mylapore because their distance from the northern outfall is so great that it will certainly be more economical and probably more satisfactory to deal with them separately. The drainage of Washermanpetta and Ráyapuram can be taken to the present Black Town pumping station, which can be extended if necessary; the present drainage outlet of those portions of the town (except a small portion of Ráyapuram which is drained towards the sea) finds a natural outlet towards the point indicated.

33. The above is a brief outline of the scheme which, with their present information, commends itself to the Committee, but before any definite conclusion can be arrived at, it is necessary that the whole subject should be taken up by a competent Engineer, and the Committee strongly recommend the employment for the purpose of an Engineer from England, experienced in drainage operations.

34. In making this recommendation, the Committee do not contemplate the employment of an eminent gentleman who would spend a day or two at Madras and sketch out off-hand the outlines of a scheme, leaving the details—by much the most important part of the work—to be filled in by any agency which happened to be locally available; but that of an Engineer of experience who would be content to devote his whole time to the work for a year or so, and to work out the scheme in complete detail.

35. It is believed that it would be good economy to retain the services of an Engineer of this character, at a salary of from Rs. 2,000 to 3,000 a month, and that the total cost of preparing a complete scheme would not be much less than Rs. 60,000.

36. What the cost of execution of the scheme would be, the Committee, as will be gathered from the preceding remarks, are unable to say with any approach to accuracy; it is certain that Mr. Clarke's original scheme was enormously under estimated, and it is probable that the cost of a complete scheme, including house connections, would not be less than sixty lakhs of rupees, in addition to what has been already spent in Black Town.

37. This sum, added to the twenty lakhs required for the improvement of water-supply, may appear large, but it is very much less in proportion to the population than other towns have spent upon similar objects, nor (omitting all consideration of assistance from Provincial funds) does it appear that the provision of the interest on such a sum need be beyond the powers of the town.

38. The present annual incidence of taxation in the other Presidency towns is—

	RS.	A.	P.	
Madras	2	2	8	per head.
Bombay	5	6	0	„
Calcutta	6	8	2	„

Making every allowance for the supposed greater poverty of the population of Madras as compared with that of Bombay or Calcutta, it does not appear impossible that Madras should be able to bear half as much taxation per head as Calcutta, which would enable the former town to raise an additional income of four-and-a-half lakhs of rupees per annum.

39. *General Sanitation.*—Having regard to the terms of the reference made to them, the Committee do not propose to discuss in this report the question of general sanitation except so far as it is affected by the water-supply and drainage, but the three subjects are so connected that it is impossible to discuss two of them without consideration of the third.

40. The Committee desire to urge most strongly that no system of drainage, however complete, can be expected to produce satisfactory results as regards the health of the town unless attention is paid to domestic sanitation. It is desirable that every effort should be made to spread among the inhabitants a knowledge of elementary sanitary principles, and to enforce attention to them. Much may be done in this respect by Government and by the Municipality, and still more by the efforts of individual citizens.

41. Attached to this report are Memoranda by Mr. Jones and Dr. King on the subject of general sanitation, the remarks contained in which have the concurrence of all the members of the Committee, except where dissent is specifically stated.

42. *Improvement of the Cooum.*—The condition of the Cooum is an important element in the sanitary state of the town, and its improvement must form a portion of any scheme for protection of the latter against the effects of bad drainage. It has already been stated that the Committee consider it essential that all sewage should be kept out of the river, but something more than this is wanted; for a great part of the year the bar at the mouth of the river prevents the entry of tidal water, and the amount of land drainage received during this period being quite insignificant, the bed is filled with stagnant water, which would probably be more or less offensive even if all sewage were excluded from it.

43. An essential condition of the purification of the river is the free entrance of tidal water at all times of the year.

44. Attached to this report is a letter from Mr. J. H. Stephens, Honorary Assistant Engineer, Public Works Department, explaining a scheme by which he proposes that this object should be obtained. The scheme is sound in principle, but would require careful consideration and possibly modification in details before it could be accepted.

Letters from Mr. Dumphy, Assistant Engineer, Madras Harbour Works, and from Mr. Chatterton, Professor of Engineering in the College of Engineering, Madras, on this subject, are attached to this report; and Mr. Jones, by order of Government, has under preparation another scheme for the same purpose, which he hopes to have ready for consideration in detail by the end of the year. Mr. Pogson, the Engineer of the Madras Harbour Works, has also worked at a scheme, but has declined to give the Committee any information as to its nature without a promise of payment, which they are not in a position to offer.

45. The Committee, therefore, think that consideration of this point had better be deferred until Mr. Jones' scheme is complete, when it can be examined together with any other schemes which may be brought forward, either by a Committee, or by their President in his capacity as Chief Engineer, Public Works Department.

46. *Assistance by Government.*—The Committee recommend that such assistance as Government may be disposed to give from Provincial funds should take the following form:—

1*st.*—The provision of the necessary establishment for working out the detailed estimates for the completion of the water-supply and for the execution of the works.

2*nd.*—The provision of the necessary establishment, including the employment of an Engineer from England, for working out the drainage scheme in detail.

3*rd.*—The grant of such contribution as Government may think proper to make towards the actual cost of the works, the water-supply having the preference.

(Signed) J. PENNYCUICK, Col., R.E.,
President.

(„) W. G. KING, D.PH.,
Surgeon-Major, I.M.D.

(„) J. A. JONES, M.I.C.E., F.R.S.E.

APPENDIX No. 1.

NOTE.

I have signed the above report, because, except in regard to one matter, I concur in the recommendations and conclusions of my colleagues; agreeing in the main with the recommendations regarding future drainage, in one suggestion which may seem of trivial, though it is of the greatest, importance, I am unable to concur; that suggestion is as regards the admission and the manner of admission of night-soil into the sewers.

2. The Committee has stated very distinctly those conditions under which underground drainage may be resorted to and those under which such a method has better be avoided; while the former conditions prevail the Committee recommend the carrying off by means of water carriage of the fœcal matters and the liquid portion of the sewage, in fact, everything that a sewer can carry.

3. It is here that my views differ from those of the other two members.

4. Under the conditions laid down, underground drainage is probably preferable to open drainage if proper after-maintenance can be secured; to those conditions I make no objection, but, when it is recommended that all fœcal and liquid matters should be carried off by the sewers *direct* from the houses, then I think that the Committee have resolved on a course, which, while not being suitable to the country, would result in much danger to the inhabitants.

5. A distinction must be drawn between the admission of ordinary house sulliage and of fœcal matters. The former can, by the existing house drains, be brought *outside* the house and then (if underground drainage is adopted) delivered over a trap near the side of the street, which trap will be in connection with the underground pipe or brick sewer in the street. Even this plan requires the use of a great deal more water than the open surface drainage system requires, where the less amount of water used in one house is compensated by the use of a larger quantity in another; but even with this plan, by which all the house connections will end *outside* the house, these connections must be laid and must be maintained by the Municipality or they will give considerable trouble and probably cause more inconvenience than the open drains. The plan also requires an additional expense of about 30 feet of 6″ pipe drain for each 30 feet of street, in fact doubles the length of underground drains to be constructed in the city; if money is available to carry out the drainage on this plan it will have the advantage that probably less detritus will enter the drains than does so now and the further very doubtful advantages that the drain will be covered from public view as so also will any matters that may tend to choke it. The advantages and disadvantages of the two systems were, however, so nearly balanced that I have not deemed it necessary to dissent from the conclusions that under certain conditions it may be advisable to use covered drains for the conveyance of sewage between the houses and the street sewers.

6. But when the admission of fœcal matter direct from the houses is also desired, I feel myself bound to strongly dissent from such a proposal.

7. It is, therefore, necessary for me to show what the carrying out of such a proposal entails—

(1) It requires a continuous pipe between the sewer and the *inside* of the house.

(2) It requires the provision of traps, ventilators, gratings and some kind of flush closet.

(3) It requires a high pressure supply in the house and a cistern to hold a sufficient quantity of water to ensure a flush.

(4) It requires an alteration in the existing drains of every house.

(5) It requires a large expenditure per house, probably not less than Rs. 200 on an average, and the majority of persons are not able to afford to put in the necessary appliances which must therefore be put in by the Municipality.

(6) It requires very careful after-maintenance of the appliances.

(7) It means a class of trained plumbers, who, as yet, do not exist and who, when brought into existence, if not under very strict municipal supervision, would when making repairs (with the desire for economy rather of safety which would in many cases prevail) render the house appliances of little value.

(8) It means, if the water-supply becomes deficient or if the appliances are not kept in order, the admission of sewer gas direct into the house with incalculable resultant evils, &c.; and as the evolution of gas is much more speedy in tropical as compared with temperate climates, the dangers from closed sewers are enormously increased while the chance of maintaining the traps and other appliances in proper order would be in an inverse ratio.

8. One advantage the system is supposed to possess is that it will do away with the necessity for the sweeper class and thus save money to the individual householders. I doubt this—the sweeper in most houses does not average a cost of annas 8 monthly and it is not likely that less than that sum will be necessary to keep the house appliances in order, besides the sweeper is required for other duties.

9. It is very evident that in the majority of the houses such a system could not be introduced unless by the expenditure of public funds, firstly because of the original expense it would entail and secondly because of the after cost of maintenance. In such houses then the existing system must still prevail and these will not be under 60 per cent. of the whole.

10. My opinions are very fully confirmed by what we find in other cities in India.

11. Take, for example, Calcutta, where the underground sewage system has been in operation for some thing like 24 years and we find Dr. Koch of the German Sanitary Commission reporting thus (1887-88): "For the removal of rain water and of sulliage, Calcutta is provided with a net work of subterranean drains, the introduction and extension of which will be referred to later on. *These drains are not intended to receive human ordure*, which is removed from the houses and collected in a suitable manner by mehters* (Hindus of the lowest caste) and carted away; doubtless, however, this rule is frequently violated. Rain water reaches the drainage system only, inasmuch as it is not absorbed by the numerous tanks which have no other source of supply;" and a note of the Health officer as follows:—* "This is only partly correct; although the mehter system prevails, there are numerous depôts throughout the town, which communicate direct with the sewers. It is to these depôts the mehters convey the night-soil and cast it into the sewers.—W.J.S."

12. This very plainly shows that even after 24 years very few of the house closets are in connection with sewers. The rate of connection as shown in the Calcutta report of 1887-88 shows 81 as having been connected that year. For the portion of Madras, the drainage of which it is proposed to be first undertaken, there are about 30,000 houses, so that the house closets at that rate would be connected in $\frac{20,000}{81} = 250$ years! and there is no reason to suppose that the Madras public are better able to afford or will be more willing to accept the change than the Calcutta public.

13. Here is a statement made at the Calcutta Health Society by a Judge of the Small Cause Court in Calcutta:—

"If, also, it could be shown that the sections most thoroughly provided with sewers were healthier than those less thoroughly sewered, the fact would be fully in harmony with universal experience, and it might reasonably be expected that 'where there were no sewers and no pure water, cholera preponderated to the extent of about 5 or 6 to 2'." Alas! these unrelenting statistics tell a different tale,—the experience derived from a succession of fatal seasons proving that those self-same sections, which have been most thoroughly provided with sewers and generally improved in other respects, have become the breeding-grounds *par excellence* of cholera. The statistics demonstrate that, whatever its nature or origin, an organic change has overtaken the health conditions of these wards, and it is manifest that we have something yet to learn regarding them."

14. This has reference to places provided with underground sewers and since that is the case ought not we to pause before directly connecting houses with underground sewers?

15. It will have been observed that in Calcutta the night-soil after being collected from the houses is put into the sewers at certain selected places where arrangements for flushing on a large scale exist. To me the only recommendation that this system has is its economy as compared with the necessity for carting the soil away to a further distance. Ventilation of sewers in this country is a very difficult matter and though the soil is in a very insignificant proportion to the total of the liquid sewage, yet its comparative offensiveness is in the reverse ratio. The smells arising from covered sewers now are bad, but admit night-soil and matters will be ten times worse.

16. To show how expensive proper house connections are, in the Bombay municipal report for 1888-89 it is stated that in the Agripada district the cost of house sulliage water connections to 212 houses in their own compounds will be Rs. 88,665, an average of Rs. 418, and to 448 street houses, Rs. 1,02,415 or Rs. 229 per house. In Victoria Cross *Lane* in the same district, the estimated cost per house is Rs. 277. These amounts do not, let it be remembered, cover the cost of appliances which would become necessary if the closet system were introduced, but let us suppose in Madras that such rates would cover that system; take the lowest rate, viz., Rs. 229, and we require for 20,000 (only tiled and terraced houses included) houses in the area now proposed to be drained (this is without ventilating shafts or flushing chambers, &c.) Rs. 40,00,000.

17. Here is some further evidence against the proposal of my colleagues, by men who have devoted a considerable amount of attention to the question.

18. Captain Tulloch in his report on the drainage of Madras says: "I must not omit to explain in this place how I intend that the excreta should be disposed of; so far as the urine is concerned the matter will be very simple. The connection at present between the privy drain and the house drain will be stopped, and the former will be joined to the new earthenware pipe through which all the urine will escape to the sewers. For the removal of the ordure, I would encourage, as much as possible, the system which obtains at present throughout the town, but I would, at the same time, try to improve it. The abominable smells in all parts of Madras are not produced, as is generally supposed, by the excreta of the population, but by defective drainage. It is the *refuse water* in the houses and in the streets into which all manner of garbage is thrown to ferment and generate foul gases that creates the dreadful nuisances so much complained of. What is chiefly required to prevent excreta producing a nuisance is a constant inspection of the privies in the dwellings. Although the ordure is removed daily, yet the privies themselves are not kept clean. Very often there is a stoppage in the channel which carries away the urine, or the ordure is dropped on the bare floor, from which it is impossible to remove it altogether. Now, if the Municipal Commissioners would organize a system of inspection and insist on every householder keeping his privy in a wholesome state, we might soon get rid of the evil. Of course, the use of clay, ashes, &c., should be encouraged as much as possible. This would be nothing more than the dry system applied to dwellings, and would have this advantage that each householder would be saddled with no more than the expense of removing the nuisance produced in his own house and by his own family. The cost of this plan to the Municipality would really be most trifling. For the first few months it might be necessary to examine each privy once in every two or three days, but after a few men had been punished for the filthy state of their privies, even this amount of inspection would not be called for. A weekly inspection would subsequently answer every purpose. Twenty-five Native inspectors would suffice for the whole of Madras. In each district there should be one European or East Indian superintendent, who should keep the inspectors up to their work and receive their daily reports. Both the superintendent and the inspectors should have no work but that of looking after the privies." And this after designing a scheme for Madras expected to cost 31½ lakhs with an annual expenditure of 8 lakhs.

19. Mr. Standish Lee in his scheme for the drainage of Black Town says: "There is a well-established objection to open channels emptying into pipe drains. In treating, therefore, of house drains, pipes have been proposed, but the fact must not be lost sight of that house connections of this description are expensive and if only such are allowed the benefits to be derived from the drainage works will be out of the reach of the bulk of the people. The history of the Calcutta drainage proves that even well-to-do people are not very ready to adopt a system by which expensive machinery, such as syphon traps, gully grates, and pipe ventilators is rendered indispensable.

"The habits of the Hindus and the primitive style of construction of most of the houses of the lower classes suggest that the system best suited to their wants is the one, the principles and details of which can be easily understood by the least intelligent amongst them. Taking this view of the case, it is recommended that the present house drains should be allowed to remain in all instances where the owner is not willing to adopt the more perfect, but, at the same time, more expensive system. An open drain for the house connection is not without some advantages,—the oxydizing and antiseptic influences of sun and air retard decomposition of the sulliage, and the drain being open can be regularly washed clean by the inmates, while even if neglected and gases form no serious results would follow, as the gases would escape in a state of dilution and in that condition though they might pollute the atmosphere would not provoke disease. It has besides the high recommendation that the poorest householder can afford to keep it in repair."

20. Dr. Cornish, when reviewing Captain Tulloch's scheme, said: "I do most decidedly protest against the application of the European system of sewage with its closets and house drains and admirable contrivances for the effectual spreading of epidemic disease."

21. I might add much more evidence of a similar nature, but I feel that my note has already extended to a somewhat inordinate length, not more, however, than the importance of the matter warrants.

22. Before concluding I would sum up what may be considered the advantages and disadvantages of the water carriage of night-soil and the proposed introduction of the water-closet system.

Advantages.

Easy and speedy removal when the appliances are kept in good condition.

Private economy (1) in the fact that a servant can be dispensed with, (2) that the number of Municipal carts can be reduced.

Disadvantages.

Great initial expense for drainage pipes and appliances and water-supply. Continual future expense for both items.

Possible introduction of sewer gas into the houses. Probable increase of sewer gas in the streets. Improbable acceptance of the system for many years for reasons already given.

Certain non-removal if the appliances get out of order, and no other means of removal will then exist if system is in full operation.

23. To put the case in a few words, the system demands an immediate and continued expenditure; the acceptance of the plan both on practical and financial grounds and from caste prejudices is doubtful, while the results are extremely problematical. The change, if it ever takes place, will occupy many years, and when it has taken place the town may be described as being supplied with a system of subterranean retorts so arranged that the fluids passing off give large volumes of gas, which, being carefully collected, are then by means of the house drains, which act admirably as chimneys, is conducted into the very heart of our dwellings.

24. On such grounds I am distinctly opposed to the English system of house and sewer connections. Let the drains be taken to the outside of the houses, laid, properly trapped and maintained by the Municipality, *but let them stop there*; if house connections are to come let them do so as each owner provides a set of proper appliances which he is able to keep in proper order, but do not let us embark wholesale on a course, the expected beneficial results from which are, to say the least of it, extremely problematical, while on the other hand possible evil results are by no means uncertain.

J. A. JONES.

Appendix No. 2.

NOTES ON THE SANITARY CONDITION OF MADRAS, AND SUGGESTIONS FOR ITS IMPROVEMENT.

I have been asked by the committee to add to the report notes, with reference to the sanitary condition of the City. These must necessarily be limited in scope, as the committee has dealt with the important questions of water-supply and drainage, whilst I have been informed by Mr. Jones that he means to discuss the following subjects:—

(1) Light railways, and disposal of rubbish;
(2) Improvement of plant and appliances;
(3) Cattle depôts.

Any allusions therefore made to the various subjects thus discussed will be confined, as far as possible, to suggesting modes for adopting the principles set forth.

I have to apologize for frequent allusion to my "Report on the Sanitary condition of the City of Madras, during the epidemic of cholera, 1881-82"; the changes effected within the Municipality since that period are so few, or, at least, so little radical in nature, that certain subjects now discussed do not require to be treated from any other than my original standpoint.

The Financial and Sanitary Policy of the Municipality.

Effort by Municipality hitherto not systematic; hence no reduction of mortality following sanitary works.

When Chennapatnam first came into existence, apparently no Health officer dictated as to the best site on the five miles strip at disposal; nor did a prophet caution the man who erected the first hut that the alignment of buildings was of importance, with reference to a future population of 400,000. The omission of attendance at the ceremony of foundation of the City by both functionaries has had through many generations a disastrous effect upon the health, pockets, and temper of tax-payers; not only have the sanitary wants of an increasing population had to be dealt with, but radical sanitary defects inherent to a faulty site crowded with buildings erected haphazard have had to be encountered. But sanitary efforts thus elicited have not been systematic. There has ever been a tendency to undertake improvements piecemeal consequently, no scheme has been worked out in its entirety, or to an extent that it could be expected to yield its full hygienic value. Necessarily, however, so far as the introduction of a public water-supply is concerned,

With the exception of cholera and small-pox mortality.

certain appreciable benefits have resulted; there is less liability to epidemics of cholera in the areas supplied. The enforcement of vaccination has likewise been followed by a marked decline in the mortality from small-pox. But whilst decrease of widespread epidemics of these special diseases has been attained by these measures, there exist insanitary conditions of so evident a type as to preclude the possibility of a decline in the death-rate from general causes. As an instance of this halting

Instances of spasmodic sanitary efforts.

practice, I would ask it to be remembered that after two experts had reported upon schemes for the drainage of Madras, the question of the sewerage of the whole City was deferred, whilst a partial scheme, designed by a third officer, was applied to Black Town. A water-supply was introduced, but the water was delivered in an unfit condition for drinking; it was, moreover, imperfectly protected from contamination at its source, and during transit. After the lapse of many years, it has been but partially extended, and this without regard to possible future requirements. Similarly, in one part of the town may be found an approach to the "pail system" of conservancy, in another a mode which in all senses of the word is best described as "mixed," seeing that both night-soil and rubbish are dealt with simultaneously; whilst, in a third, there is probably little attempt to carry out any system of removal whatsoever. In making even such arrangements as exist, the staff, the power employed, and the apparatus are not in accordance with ordinary calculations of requirements. That such efforts have been made shows there has been no want of will to meet sanitary demands; but it is evident there has been a vast want of appreciation of the necessity of remembering that unless a sanitary scheme be carried out in all its details, its total value is so discounted that it may in practice be of little real utility. In no case is it more true than with regard to sanitary schemes, that "the strength of the whole chain is that of its weakest link." Take, for example, the scheme for the drainage of Black Town. The committee have expressed their opinion as to the sphere and limit of its usefulness, but have found it desirable to point out that the full value of this scheme is not at present obtainable.

In short, it may be assumed as a fact that from the date of its existence, as the few native huts belonging to "John Company Bahadur" to this day, there has yearly been a steady, although happily of late, a decreasing daily addition of solid and liquid filth to the soil of this City, as a result of the absence of any complete ar-

Contaminated soil, as the result of long-continued imperfection of conservancy and drainage.

rangements either for rubbish or night-soil conservancy, or drainage. Thoughtless administration also, in former days, sanctioned the filling of excavations and tanks with refuse of the worst type, and their utilization for the disposal of sewage. Consequently, many of the older parts of the town stand upon highly impure soil. Indeed, explorations of the soil reveal the fact that, as an effect of accumulations so caused, certain parts of the town are some feet higher than of old. Borings conducted by Major Tulloch demonstrated the presence at frequent intervals of what he—using an euphemism—described as "made soil."

A sub-soil water stratum, subject to wide fluctuations.

To this unfortunate factor of an impure sub-soil—the result of want of human precaution—must be added the natural influence of the widespread and rapid fluctuations of sub-soil water, of which there is an inexhaustible sheet below the whole town. An impure sub-soil necessarily implies impure well water, which is still largely used in the town. When beyond these circumstances, it is remembered that houses are arranged upon the site without due regard to perflation and that,

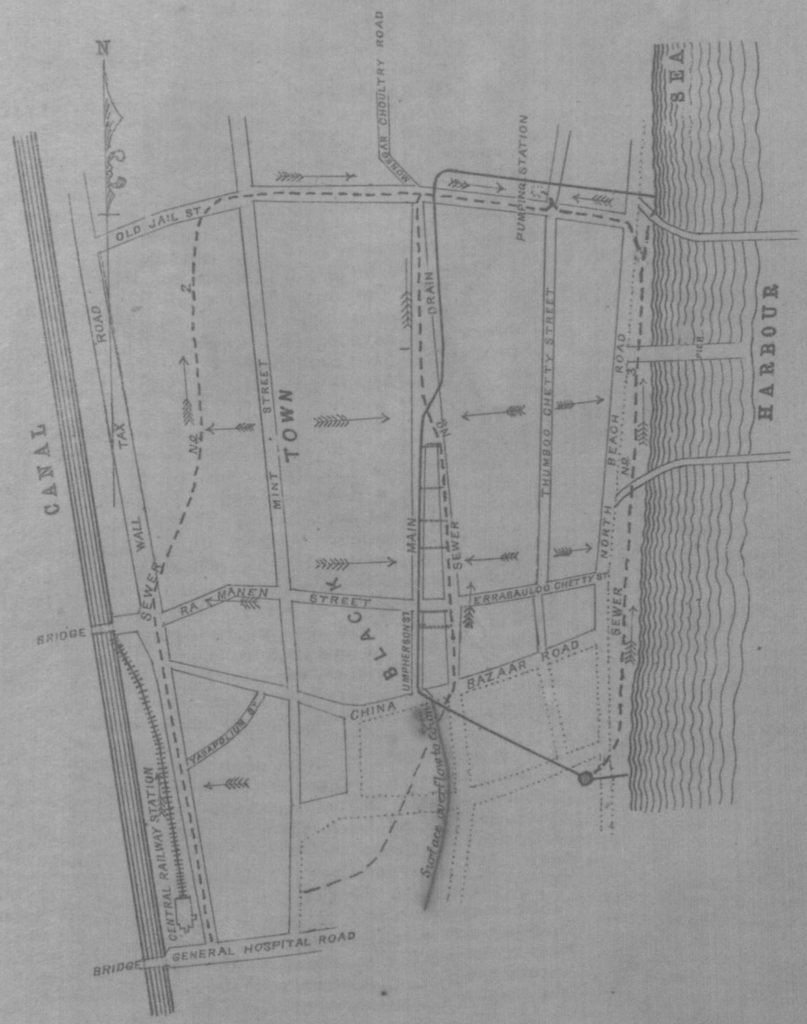
These combined conditions sufficiently account for high mortality.

individually considered, average dwellings are of very bad construction as to sanitary arrangements, and are overcrowded, there is not much room for speculation as to cause of the long-continued and high rate of mortality, which, when added to that incident to an epidemic of cholera, lately caused a temporary public panic.

These are mere generalisations, it is true, but they point to the absolute necessity for a complete alteration of the sanitary and financial policy of the Municipality. Having ascertained to the best of their

Principles which should guide the Municipality as to sanitary efforts and finance in connection therewith.

ability what sanitary improvements are requisite, their borrowing powers should be employed once and for all to obtain money sufficient to carry them out. Improvements should then be effected *systematically* in each area; thus, the error of attempting removal of refuse matter and applying an imperfect system of night-soil collection, and of extending a water-supply, and neglecting to make arrangements



Litho., Survey Office, Madras, 1891.
Reg: No. 334: Copies 118

Proof of justification of taxation for effecting sanitary improvements, provided the schemes are sound.

for its removal, and of appointing a Health officer, and making no provision for a subordinate sanitary staff, need not be repeated. Not until arrangements on each area are in this manner made as complete as sanitary and engineering science can make them, is it possible that any material reduction in the mortality from ordinary disease can result. From what little I know of the Madras Municipality, I am inclined to believe that the Commissioners have ever been timorous as to sanctioning any large expenditure; but it is my duty to point out that, provided sanitary schemes are of such a nature as to be obviously calculated to improve the public health, the procuring of funds by taxation of the present and future generations is not only justifiable, but can be well borne; statistics proving that not only the health but the wealth of a people undergo improvement when important sanitary works have been effected are trite, and are to be found broadcast in literature.

Necessity for a law enforcing improvements in private dwellings to attain the full hygienic benefit of public works.

Unfortunately, as to the execution of sanitary works in the present state of the law, there is possible a vast hiatus between efforts effected at the public expense and requisite adaptation in private premises, by which alone, especially with respect to drainage and conservancy schemes, the full benefit of public expenditure can be reaped by the inhabitants. This difficulty must be met by the possession of clauses in the Municipal Act, demanding, in the interest of the general public health, that reasonable improvements shall be executed in dwellings at the expense of the owners, or of the Municipality where poverty forbids the possibility of the expenditure being borne. It is to meet this essential requirement that the Public Health Act of England empowers the local bodies who administer it to constitute a fund from which, under their supervision, money can be drawn for the purpose of effecting sanitary improvements—recoverable upon security of private house property in easy instalments and at small interest, in the manner of a rate. Without some such provision, it is impossible that much advance in the general sanitary condition of the town can be made. I would strongly urge the desirability of such a fund being formed at once, and would suggest that in handing over a sum of money either as a loan or free gift to the Municipality for this purpose, Government would render a permanent and incalculable benefit to the people.

A "private improvement expenses fund" to be formed by Municipality to meet requirements.

BLACK TOWN MAIN DRAIN.

The Black Town drainage scheme, which it is understood has been completed, contemplates the receipt of refuse water, a certain amount of storm-water, and a total exclusion of fœcal matter. The fact is, however, that by reason of imperfection in the house connections and absence of satisfactory arrangements for the collection and disposal of night-soil, this system is called upon to fulfil duties for which it was never destined; and consequently, as remarked by the committee, such sanitary value as it possesses is not fully realized by the inhabitants. I consider of similar origin as to causation are the complaints made by the general public as to mal-odours from the main drain, which discharges to the pumping well near the Fort. The main drain is one of the brick and mortar underground structures of ancient Madras; it is unfit for the purpose of receiving sewage. Permeation of its walls by sewage is probable, especially when it is nearly full, as it is for considerable portions of the day. It might, however, well fulfil the function of a drain to guide storm-water to a convenient outlet. Sewer No. 1 runs parallel with it in a part of its course. This sewer is of modern make, and is intended for the discharge of the sewage from the open drain system of Black Town to Ráyapuram for disposal on the farm by pumping. There is also an overflow into the Cooum near the China Bazaar. Now, knowing the difficulties which beset the "open drain system" as to the separation of storm from refuse water, and the convenience which the position of this drain offers, and bearing in mind its unsuitability for the purpose of conducting sewage, the Engineer, Mr. Jones, who executed this scheme, never intended it should serve any duty but that of receipt of overflow due to the addition of storm-water. What, however, actually occurs in this system is that at the period of maximum receipt of sewage, irrespective of rainfall, Sewer No. 1 gradually "backs up" till it has to find relief in overflows which communicate with the main drain; at the same time, the overcharged open drain of the China Bazaar near the head of Sewer No. 1 also "backs

The Main Drain an unfit receptacle for sewage.

The drainage outlets are overtaxed during period of maximum diurnal flow.

Consequently, irrespective of rainfall, overflow occurs into the Cooum, and into the main drain, which is unfitted for receipt of sewage.

up," and overflow occurs into the Cooum in a considerable stream. Simultaneously, the main drain is so gorged that sewage, motionless as to forward movement, rises to the springing of its nearly flat arch. Inspection at the pumping station at Ráyapuram shows that sewage water rises at times nine feet over the invert of the sewer, which is but one foot above the bottom of the pumping well, the sewer itself being of three feet diameter. Moreover, at the time of this "backing up" both the pumps at the Fort station, that is, at the main drain outlet, and at the Ráyapuram station, the outlet of Sewer No. 1, are in full work. It follows, therefore, the system is overgorged to an extent that the area of the open drains intended for receipt of storm-water at the rate of one-fourth inch per hour for the distance drained is more than occupied by pure sewage; for my inspection was made during a period when there was no rain. It is possible that certain connections of a former period, of which I have no information, exist with the old main drain near its head, which necessarily, in the absence of an extension of Mr. Jones' system, may permit of direct receipt of sewage; but my inspection proves that a large proportion of the sewage that reaches the main drain is from the overgorged Sewer No. 1 of modern structure. That such conditions should be allowed to continue seems absurd. The presence of a recently-constructed drainage system in Black Town should at least guarantee that no undiluted sewage from that area should reach the Cooum; and further, there should be no necessity whatsoever for the presence of a pumping station at the Fort end of the main drain, and for the nuisance which so results. This drain should be reserved exclusively for the reception of overflow during storms, which would find a free outlet inoffensively without the aid of pumping. This state of affairs demands early attention, the pumping power now used at Ráyapuram being much below present requirements. Again, there may be special reasons connected with the repair of Sewer No. 2, why the main drain is receiving so much sewage at the present time, though this is not likely with regard to the Fort outlet (see accompanying tracing). Whatever the cause, however, there can be no doubt as to the conditions to be met. These are that the open drains system of Black Town should discharge exclusively into a ventilated sewer, or sewers, of the modern impervious type only, and not into the old-fashioned square brick drains; these should be reserved solely for the receipt of storm-water. The sewer, or sewers, requisite for conveying the sewage to Ráyapuram should be of a capacity to effect discharge at the pumping well there, without the possibility of the occurrence of "backing up," and the pumping power there should be capable of dealing with the collection of pure sewage fully, even during the period of maximum flow. I am not unaware that sewers are at times used as "sewage pens," although doubtless always from necessity; the question here, however, is not one of *temporary storage*, but of a system that is so gorged for part of the day that overflows, which should only be called into use for the discharge of storm-water, are daily permitting the overflow of pure sewage in undesirable directions. If these conditions were fulfilled, there would be no discharge into the Cooum otherwise than of overflow during rainfall; and the main drain would not only be free of sewage, and, therefore, available for storm-water, but would be of use in preventing wide fluctuations of the sub-soil water, if arranged so as to have tile drains led into it at intervals.

If the whole drainage system fulfilled requirements, the pumping station near the Fort would not be required.

The conditions to be subserved.

Results that should be attained.

The cleansing of open drains.—It is essential that for cleansing open drains some simple apparatus be contrived, whereby collection can be accomplished without throwing the filth on the roads in the first instance, as at present managed. I need hardly state that such a custom is most insanitary; and, indeed, is productive of that very contamination of soil which it is the object of a drainage system to prevent. Various arrangements that might combine cleansing and collection could be made at the expenditure of a little thought by an Engineer; but probably the provision of an iron pan, mounted on wheels with moveable tyres, guided by a long handle, so as to run directly over the drain, and leaving holes on its lower surface to permit the return of fluid sewage would meet requirements fairly well. Each drain-cleaner should be furnished with one of these simple contrivances, whilst a "Richardson and Cruddas' conservancy bucket" in which the collection from these drains pans should be thrown for removal should be placed at convenient positions in each drainage section.

A mechanical contrivance for prevention of soil contamination during cleansing of "open drains."

ROADS AND THEIR CONNECTION WITH THE CUTTING OFF OF SUB-SOIL AIR.

It is a fact universally recognized that habitations upon an impure pervious soil, having below it a sheet of sub-soil water subject to wide fluctuations, are sanitarily dangerous; of this description is essentially the soil of Madras (see preceding remarks). It is to the existence of this factor that much of the extraordinarily virulent fever of this city, usually classed as simply "malarial," must be ascribed. I have had a fair amount of experience of malarial fevers of different localities; but I have always given that form which is found in the filthiest parts of Madras the palm for being the most insidious and obstinate of any; the fever has malarial characteristics, and therefore must be so classed, but it must be the offspring of a malarial germ rendered markedly virulent by cultivation in an organically filthy soil; or, at least, of a germ that finds unusually favorable conditions for displaying its poisonous properties in constitutions that have been subjected for prolonged periods to evil hygienic circumstances. The remedy universally recognized in dealing with inhabited sites of this nature is to attempt to reduce the extent of fluctuation of the sub-soil water, and to cut off sub-soil air by the provision of an impervious surface.

The type of malarial fever found in Madras is the product of a filth-laden soil.

Nature of remedy required.

A large number of houses in Black Town are more or less effectually—both in the interior and in the court-yards—paved with bricks or flags. If the streets could be rendered impervious and the wells, of which the linings are not capable of air exclusion, were ultimately shut up *pari passu* with the extension of the water system, a considerable part of the total area would be cut off from the sub-soil air, and there can be no doubt that the attainment of such a condition would be followed by beneficial results. To effect this improvement the provision of impervious roads must be an important factor. It seems to me that two important objects can be met, by the abolition of laterite roads and the substitution of wood-paved roads on a bed of concrete, such as now employed in the greater part of London. In the first place, the "open drains" would no longer be subject to having their flow blocked by road detritus as at present, and, in connection with the extension of impervious surfaces within private premises, the cutting off of sub-soil air would be attained efficiently and economically. In Kurrachee, three years ago a wood-paved road of this character was laid in a spot where it could be well tested by traffic. The blocks were of Babul wood, which is cheap in this Presidency. I have since inquired of the Municipal Engineer of Kurrachee as to the results of this experiment, sanitarily and financially; in reply, he has kindly informed me that the road has proved "in every way unobjectionable." The possession of wood surfaces strikes most observers at first as likely to be insanitary on account of possible absorption of organic matters. The conditions under which the wood is prepared and laid, however, do not lend themselves to this result, and this objection has been finally dispelled. There can be no doubt if wood roads can be proved economical when subjected to the heavy traffic of London, that in Madras they would be practically unwearable.

The provision of impervious surfaces desirable.

Wood-paved roads on concrete would aid materially.

These roads have proved successful in Kurrachee.

They are sanitarily and economically unobjectionable.

SUGGESTIONS AS TO CONSERVANCY.

Common nuisance very frequent.

Nuisance.—The use of open drains after the manner of latrines being most common by the inhabitants, it is desirable that the police should be specially warned to carry out the requirements of the law.

Necessity for revision of methods employed in Black Town—having special regard to peculiarities of the drainage system.

Collection of night-soil.—In Black Town, in the area drained by Mr. Jones, each house should at once undergo careful inspection, and the arrangements for preventing night-soil mingling with the refuse water by reason of flushings of latrines, or unsuitable forms of latrines, should be remedied *in each case*. After close inspection, I found no arrangement that can be said to satisfactorily fulfil these requirements in any native house. Drains in the interior of houses are almost universally badly formed and require revision.

The "pail system" of conservancy.

Collection of night-soil.—Within the area served by the completed drainage scheme, this should be managed under the "pail system," that is, each pail should bear a distinctive mark, so that after having been taken to the receiving depôt, it should be returned cleansed, a duplicate being placed at the house in the meantime.

Pails should not be of the English pattern.

This system—at least the work of removal from the premises—should be carried out completely by toties in Municipal employ. This is a *sine quâ non*. The pails should not be of the bulky size used in England; but be no larger than the capacity actually requisite, having regard to the bulk of the contents intended. Calculated, say, for an average of five persons per household, these pails would be very small. The lids should be close fitting. These pails would not therefore be used for placing below seats, &c., but simply for collecting night-soil from suitable latrine surfaces, or other receptacles within houses. Urine, as now, must be received into the open drains.

Combined night-soil and rubbish collection not suitable for native population.

In some towns, rubbish and night-soil are removed in one pail; but having regard to the habits of natives, I think separate removal of night-soil and rubbish is essential.

Rubbish collection.—Each house should be provided with a suitable moveable receptacle for rubbish. This receptacle should under penalty be exposed for removal at the edge of the premises on the approach of a rubbish cart at a definite hour, notified by the ringing of a hand bell by the cartman. Rubbish being thus provided for, there should be no dust-bins in the streets.

No dust-bins should be allowed.

Future conservancy of parts other than Black Town.—It would be advisable to pursue the system of rubbish collection described in the preceding paragraph throughout Madras, conjoined with the mode of removal, which Mr. Jones recommends in his notes. The "pail system" of night-soil conservancy should also be pursued in suburban portions, not within the areas to which the new drainage system will extend.

Future night-soil collection.—Where, however, the future drainage system is employed, in all cases the "water-carriage system," that is, removal of fœcal matter by sewers, should be adopted as at once the most cleanly, economical, and efficient.

Latrines, public.—In the meantime, I think it is most desirable that latrines of the present pattern, which are in most cases intended for the collection of fœcal matter without admixture, should be abandoned where feasible. For example, localities in the neighbourhood of Sewer No. 1 and No. 2 in Black Town could be served by public latrines on the water-carriage system, provided the former were attended to as suggested in the preceding remarks. Elsewhere, correctly formed latrines arranged for "simple removal" should be erected. The greater part of the surfaces of such latrines should be formed of glazed stone-ware and they should be lined with white-glazed bricks throughout. Where on account of the presence of underground sewers in the remaining parts of Madras in connection with the future system the "water-carriage system" is possible, all latrines should be formed accordingly. Where sites are not readily available, these can be made underground with advantage.

Wherever possible, the "water-carriage system" of removal of fœcal matter should be pursued.

Latrines of a semi-private nature on hire.

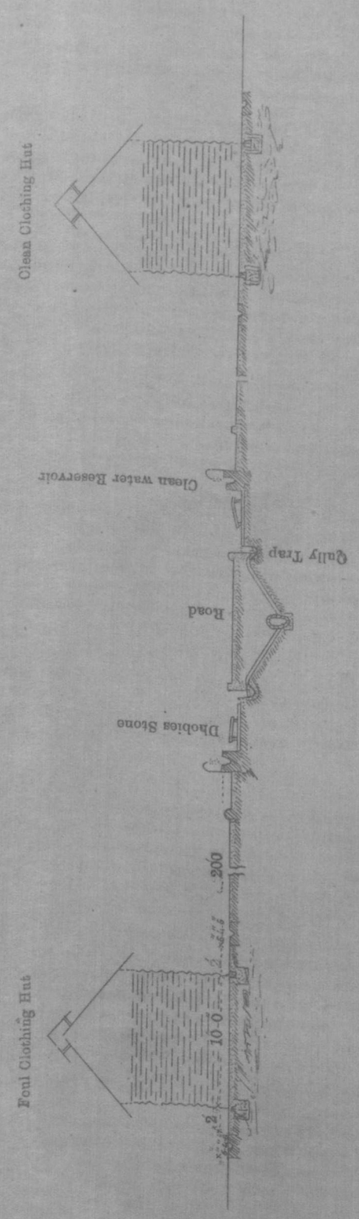
Semi-private latrines.—I consider it would be advantageous to offer the public latrines of this character, in places where vacant sites sufficiently near dwellings permitted of their being erected. These could be arranged so that they could be cleansed by Municipalities at a small monthly rental; they should be retained strictly for private use by giving each householder hiring one, a key.

Modern appliances render the adaptation of the "water-carriage system" to native houses a matter of no difficulty.

It may be thought that difficulty may be experienced in adapting the "water-carriage system" of removal of excreta to native habits. As a fact, however, their habits lend themselves to such an arrangement, and during the past few years such absolutely simple *automatic* arrangements have been placed in the market for flushing water-closets by means of refuse water, that the problem presents infinitely less trouble in working out than in preventing the mingling of fœcal matter with the refuse water in "open drain systems," where this method of separation is essential. I have handed to the President simple plans showing such methods.

The custom of ceasing conservancy efforts on Saturday is to be deprecated.

The half-day's rest to the Conservancy establishment.—The Municipality is in the habit of permitting a half holiday to the whole of the conservancy staff from the overseers to the cess-pool boys. Where is also, I believe, some slight (if not permitted) relaxation of work on Sunday. Whether this be so or not, it is evident that the granting of a half-holiday to a conservancy staff is an absolute absurdity. There is no reason to believe that either the staff or apparatus employed is more than sufficient to cope with the daily increment of filth, and to



NOTE.—Circular separate corrugated iron sheds 10' diameter, interior painted with white silicate paint.

Suggestion for a Public Wash House

W. G. KING

8th November 1890

Litho., Survey Office, Madras, 1891.

Regr. No. 333; Copies 115

thus favour non-removal is unjustifiable. If men of this class require a half-holiday weekly, there should be no difficulty in arranging that a certain number be allowed off duty daily.

Perflation of inhabited areas.

Perflation of the inhabited area of the city.—The Municipality should guard jealously all open spaces still in their possession and not sanction building upon them. It is needless to say that habitations are now greatly overcrowded upon the site, and that to obtain better perflation should be an object held systematically in view.

The old Fort wall to be razed.

The old Fort wall which runs near the Monegar Choultry slaughter-house is not ornamental, and must be injurious in preventing perflation. I would advise it be removed. There are doubtless many ways in which the brick and debris would become of service to the Municipality or to the Harbour Works.

The casuarina plantations.

The casuarina plantations on the sea front have been much abused of late. They have doubtless been allowed to grow too thick; but, if thinning be attended to, and especially if it were possible to have complete vacant lines at intervals even if diagonal (which would retain the purpose of concealment of troops to a considerable extent) they can hardly be objected to with more reason than the neighbouring dwellings. They should be surrounded with barbed iron wire-fencing, to prevent the entrance of persons bent on committing nuisances.

Red Hills tank imperfectly protected from contamination.

Water-supply.—At present, notwithstanding the existence of a special staff at the Red Hills tank, large numbers of cattle are allowed to enter the water, and men and boys wade in it for fishing purposes. The propinquity of certain villages is also not conducive to the retention of purity of the body of the water. The whole of the surroundings of the tank should be carefully surveyed and where it is thought the position of villages is likely prove inimical, they should be removed or, at least, the drainage from them should be diverted for filtration, before it be permitted to gain entrance. But this mode should be allowed only where no other alternative is left. Similarly, a sanitary survey and measures founded thereon with regard to the diversion of drainage from villages should be arranged for, along the banks of the river Kortalayár which feeds the tank.

The river Kortalayár supplying tank must also be protected.

Danger of contamination of water from careless disposition of pipes, as now practised.

In my report of 1882, I pointed out the danger that must arise from leading pipes in impure sub-soil, and near places where air contamination might occur. This has been taken no notice of, and I find that the favourite place for erecting drinking fountains is immediately over open drains, the supply pipes being conducted below the old fashioned pervious drains. Consequently, there is danger of the entrance of foul air through leaky or open valves, on the exhaustion of water suddenly causing a vacuum; similarly under the same circumstances, or even without a vacuum being caused as proved by Dr. Buchannan, in connection with an outbreak of typhoid fever, matters from foul soils can enter pipes even when supplied on the "constant system," following certain physical changes which I need not detail. Although supplied on the "constant system," Madras, at the present time, runs all the risks of an "intermittent method," in that the pipes are subjected to rapid declines of pressure, and occasional exhaustion following demand in more favored parts. Pipes are allowed to be taken into houses to a height where it is known that water only for a certain part of the day can arrive—thus effectually arranging for entrance of air from inhabited and, it may be, foul positions. Still more dangerous is the practice pursued by the Municipality of placing flushing pipes directly *in* drains. These pipes should be at once removed, and a mediate mode be employed. If, as I hope, Madras will receive its water in future under high pressure, these drains and the streets could be best flushed from fire hydrants. A very open defence of precaution in this direction is shown in the existence of a pipe, which passes directly through the main drain in the China Bazaar. Under such conditions, the poisoning of the whole water system by choleraic, or other disease-bearing matter, is possible.

An analysis of water-supply should be published monthly.

The Municipality should be required by a clause in their Act to publish monthly an analysis of the water supplied to the town, and, for this purpose, and for the conduct of examinations of food-supply, a well-fitted and convenient laboratory should be provided for the Health Officer.

The insanitary uses to which private clothing may be put by "Dhobies."

Clothes washing.—In my report of 1882 "on the sanitary condition of Madras during an epidemic of cholera" which then prevailed, I specially drew attention to the filthy and dangerous conditions under which washing of clothes of Europeans and Natives is carried out. I, at that period, had seen the sick and the dead of cholera on the floors of rooms used for storage of clothing. On one occasion, I found the clothes of the then President of the Municipality in the house of a man, whose children were attacked with small-pox. Mr. Stephenson, the Assistant Engineer to the Municipality, discovered a still more glaring instance of danger, to which the public is subjected. He ascertained that the shroud on a corpse dead of cholera, was part of the house linen of an European official. I need not dilate further on this subject. It is essential for the safety of all classes of the community, that the precaution be taken to prevent the possibility of the diseases of the washerman's hut being passed on to the employers and I may well add *vice versâ*; for I remember during that epidemic, I was particularly struck by the careless behaviour of educated members of households, who allowed the clothing of those sick of cholera to be sent to the dhobies to be washed, without either washing or disinfecting them in the first instance. I therefore suggested at that time that dhobies should be licensed. But, I was not a little surprised when circumstances brought me back to the duty of again inspecting parts of Madras, to find that the power then granted has not been exercised. Dhobies have licenses issued to them, it is true; but this has been regarded as a formality to be gone through, without the sanitary condition of the premises being corrected. This matter requires rigorous management in the interests of the public health. I would suggest further that it would be of great advantage for the Municipality either themselves, or through a contractor, to cause the erection of public wash-houses. The necessary powers are provided in the Act. Such houses need but be of the simplest construction. They should be strictly on the *separate* principle, and I would suggest that the washing places should be such as shown in the accompanying diagram. On each side of a very simply-constructed open-air washing place, are shown positions for small circular corrugated iron houses. Each dhobie would have two of these—that on one side of the washing place being for storage of dirty clothing and the other, on the opposite side, for clean. The wash-houses would, of course, have to be constantly watched, and each dhobie should have a private key. The ironers might be provided with a corrugated iron-shed, to be occupied in common, but having divisions completely separating one man's work from the other.

Unfair treatment of dhobies by their employers.

Licenses are issued to dhobies, without sanitary requirements being enforced.

Public wash-houses are requisite.

Water in abundance can easily be obtained for public wash-houses.

It is probable that water for the supply of these "dhobie khanas" could be arranged for from the public system for some years. If not, there is no part of Madras where the sub-soil would fail to yield an inexhaustible amount of water, if pumping power be applied by means of steam engines in connection with tube wells. Payment for the use of these places might be exacted from the better classes, whilst inferior, but sanitarily good, accommodation could be allowed free of charge for the poorer, as determined by a consideration of probable income. Such measures would prove no hardship to dhobies, but, on the opposite, a great relief, as they have at present to carry their clothing backwards and forwards very long distances, and have often to pay heavily for the use of bleaching grounds. The names of all customers should be registered, and bye-laws should be framed by the Municipality for securing that no danger be incurred from infectious diseases.

Names of dhobies' customers to be registered.

Bathing ghâts.

Bathing Ghâts.—Tanks used for bathing should be closed, where it is not possible to provide for ingress of fresh water frequently, and its egress when defiled. Where such arrangements cannot be made, if the water were otherwise suitable, platforms should be made at the sides, and the waste water be led either to sewers or to land filters.

Drainage in connection with irrigation.

Irrigated land.—No irrigated land should be allowed within municipal limits, without it being shown to the satisfaction of the President, in consultation with the M. O. H., that due provision has been made for the removal of all water not taken up by the soil, within the area on which cultivation is proceeding under irrigation, and it should be further provided that the President may issue orders to the owner to under-drain any land, or to make surface drainage of such a character as may be thought requisite, for the prevention of undue moisture of the soil or sub-soil in the vicinity of fields under irrigation or otherwise.

Incompatibility of latrine, of latrine cart depôts and slaughter-houses.

Slaughter-houses.—The Municipality should be advised to no longer allow the existence of a slaughter-house and night-soil cart depôt to be side by side, as at Monegar Choultry. Without exception, the arrangements as to provision of water-supply are dangerous within municipal slaughter-houses, whilst minor sanitary requisites are indifferently accomplished.

Filthy conditions of bread-making.

Bakeries.—The Municipality have failed in this matter, as in the case of dhobies, to carry into effect those clauses of their Act which, I believe, were inserted, as a result of the representations made in my report of 1882, on the filthy conditions in which bread was manufactured in this city. I visited several of the bakeries that I had seen at that time, and found them in their pristine state of filth. Apparently, the Commissioners have regarded the giving of licenses not as a check upon the sanitary condition of such places, but as a measure for extra taxation. I have handed to the President of the Committee extracts from the Factory Act of 1883 (46 and 47 Vic.) which might form a guide in making further legislation in this matter. The following is a quotation from my report of 1882:—

Erroneous interpretation and exercise of power of discretion as to the granting of licenses to bake-houses, &c.

Model for correct legislation as to bake-houses.

"This is not an agreeable subject to approach. I visited numbers of bakeries in Black Town, and in places more civilized whence European tables are supplied. Filth and filthy habits were conspicuous in all. Some of the places are perfectly dark—the work being conducted by a 'dim religious light' that would effectually prevent the kneader of dough knowing whether he was mixing an excess of cockroaches to the proportion of flour. A well, whence the water-supply is drawn, side by side with a latrine, was a common object. But nothing could be more repulsive than the mode pursued of wheat grinding. Huge millstones are worked by hand labor: two men sit facing each other stripped to the waist having their feet closely hid in the flour, whither streams of perspiration, testifying to the arduous nature of the employment, form an ever-increasing and thickening confluence. This is not an enticing picture to a bread-eater; yet, it is universal in Madras. . . . . " I see no way of making much improvement in these matters, by attempting to supervise details of manufacture. The Municipality should be permitted to summarily order bakeries to be closed, until satisfied that provision has been made to conduct them in a manner consistent with ordinary cleanliness and sanitary dictates. Appeal might be allowed to a Magistrate, when, if reasonable ground appeared to prove simply filthy premises and absence of *proper provision* for cleanliness of manufacture, without necessary reference to the mode of bread-making (which would be at all times difficult to demonstrate) no damage for loss should be allowed, if the case were thrown out.

Persons who are fastidious as to partaking of bread moistened by "honest sweat" of the Madras cooly, should unite to form bread manufactories worked in a cleanly manner.

Insanitary conditions of milk-supply.

Dairies.—The following remarks appeared in my report of 1882 with reference to the subject of cow-houses, &c. On this subject some attention has been paid by the Municipality, so that in certain localities improvements have been affected, but practically the description given is as applicable to-day as eight years back:—

"But the little space provided in dwellings is not infrequently shared by cattle, with barely room for moving; half-a-dozen cows, with their calves, may be found standing in the midst of their own excrement—the accumulation of weeks. The walls are generally ornamented with bratties, which, on drying, add to the general stench. These are the dairies whence the milk-supply of Madras is obtained! The conditions resulting from the crowding of cattle are, necessarily, neither beneficial for man nor beast. The contamination of milk is everywhere granted as a medium of spread of various diseases. The application of an Act to meet requirements of dairies has for some time past been deemed desirable in England; without argument as to the advantages to be derived, which must be self-evident, I would point out that it would be eminently useful to apply the same Act to the Town of Madras—the present clauses in the Municipal Act being insufficient. Equally strict rules are essential in preventing insanitary conditions arising in cases where cattle are retained for private use in or near dwellings."

Manifest danger of milk-supply not being under correct sanitary supervision.

"Bratties" as media of spread of diseases.

A special regulation as to the disposal of cow-dung during epidemics is also desirable. "*Bratties*" should be capable of proving an excellent medium for the distribution of infectious diseases, when made from material that is derived from houses where such affections prevail. Elsewhere, I have seen persons suffering from cholera laying in cowyards amongst the accumulations of dung, into which choleraic discharges streamed. Made into "bratties" by mere sun heat, and then subjected to moistening and plastering on the floors and walls of dwellings, it is not difficult to conceive that disease germs are placed under exceedingly favorable conditions for propagation. It is hence of importance, in view of the peculiar habits of the people of this country, it should be ruled that manufacture of "bratties," or sale of cow-dung, from an infected house should be punishable, and that the owner should be bound, as suggested on another page in the case of human excreta, to follow special directions of the Municipality as to disposal. I have handed to the President of the Committee rules for the better administration of dairies founded upon the "Dairies, Cowsheds, and Milkshops order of 1879 issued by the Local Government Board" which might be incorporated with the bye-laws of the Municipality with advantage. It would be an excellent plan to form public gowlee houses, such as I believe are now used in Calcutta and Bombay. I advise the Municipality to seriously consider the subject.

Model for legislation as to Dairies and Cowsheds.

Insanitary conditions incident to preparation of "boiled rice."

Rice-boiling.—The filthy condition of the Tinnevelly settlement and other parcherries of the same neighbourhood, where rice-boilers follow their vocation, is a standard subject of discussion whenever reference is made to the sanitary condition of Madras. All attempts at improvements by the Municipality which have been frequent, have apparently failed owing to unusual difficulties as to the vested rights of owners. I trust that should the inquiries of this Committee lead to attempts to revise the Municipal Act, care will be taken to provide very full powers for dealing with this subject. I would point to the "Artizans and Labourer's Dwelling Improvement Act" and especially to the useful amendment of 1882, as forming guides to the nature of powers required. The following are extracts from my report of 1882, on this subject; the conditions are practically unchanged:—"The paddy is allowed to soak for days together in filthy water that has been *previously used*, and which is in a condition approaching fermentation. The result is that the grain undergoes partial germination and fermentation, according to the attending circumstances, or length of process. There is thus produced an enlarged grain, which gives bulky measurement. It is to attain this effect, that the operation is knowingly carried out. It is then boiled. The word 'boiling' does not however, literally express the mode pursued, the degree of heat employed being usually below the point, but as doubtless sufficient to check further change. Being removed from the boilers, the paddy is spread to dry upon earthen floors upon which, as I formerly told you, filth can easily flow, and upon which cholera excreta have been known to be deposited." . . . .

Model for legislation for dealing with unhealthy areas and dwellings.

Setting aside the matter of improved conservancy to which I have already referred in my letter of the 22nd instant, there remains the fact that there exist special reasons why surface drainage should be attended to in these localities. From a consideration of the peculiar occupation of the people and the fact that they are massed together, it will be seen that an unusual amount of water has to be got rid of. The water which has undergone the use described is of itself liable to rapidly become decomposed, and must necessarily tend to produce like effects in any organic matter with which it may come in contact. If these statements be granted it is seen that there are presented the most favorable conditions possible in these neighbourhoods for the propagation of disease generally, and of cholera in particular; namely, a soil contaminated with excreta, urine, and organic matter derived from decomposing rubbish, soakage of refuse water conveying material peculiarly apt to favour fermentation, the presence of crowded houses forbidding perflation, inhabited by beings morally degraded by prolonged contact with filth; and the use of shallow well water* obtained from a contaminated soil and deficient in protection from direct accession of impurities. Statistics of mortality during the present and former epidemics of cholera sufficiently demonstrate the effect of such conditions. . . . .

The areas inhabited by "rice-boilers" in a markedly insanitary state.

* Since 1882, Red Hills water has been brought close to the Tinnevelly settlement, but the people still use shallow well water, the wells not having been filled in.

Special and speedy measures requisite.

I would therefore recommend that in the instance of localities frequented by paddy boilers, speedy and special measures should be taken by the Municipality to carry out surface drainage.

Dwellings.—The following is an extract from my report of 1882:—"Much is heard in Madras of the stench of drains and dirt of streets, but few of the inhabitants are aware of how thoroughly such matters are excelled by conditions discoverable within the dwellings of the poor. Judged by the street aspect of most of the houses of apparently well-to-do natives they do not, on the whole, compare unfavorably with the cottages of the poor in England. But, what is thus exposed to view, is little more than the entrance hall of a mass of buildings to the rear. As a rule, there are subdivisions of but a few feet square, forming collectively a narrow passage—both ends being closed either by houses or by a blank wall at one side and a house on the other. A depression worn by the throwing of water serving as a gutter—a well without protection of any description—and an uncovered space in a convenient corner sheltered by a broken tatty as a latrine usually complete the list of household sanitary details."

Insanitary condition of average native dwellings.

A fair average size for each subdivision of the house is 10 ×12 feet; there are generally no windows, nor indeed would there easily be found room to make one. A lamp is requisite if it be necessary to have light for any purpose. Each such room has its separate door and accommodates a husband, wife, and an endless string of children. For places of this description, a rental of 12 annas to 1 rupee is charged monthly by the owner, who usually lives in the house facing the street.

The above by no means depicts an uncommon type of dwelling; it is the ordinary Madras house in which persons from the rank of a clerk on good pay down to peons live. The habitation of the cooly is a very different matter. If it be of a superior make, it is a mud structure insufficient to afford standing room; but a little more space and better ventilation are gained when cajana leaves are employed. Still it rarely exceeds 12 feet square. Of this latter style, the accompanying diagram of Anacacharry Parcherry will convey some idea. In groups so closely packed as to forbid perflation, such houses form the so-called parcherries, which are to be found at every turn in Madras. They rarely possess drainage, and a large number are not even provided with latrines. The consequence is that every nook and corner, and whole roads, are literally strewn with fæces, whilst refuse water being unprovided for completes the filthy condition of soil. . . . .

"*Suggestions.*"—Parcherries have grown and are overgrowing unrestricted to a great extent, from want of due supervision in sanctioning buildings; notwithstanding that the provisions of the Municipal Act in this matter are excellent. It is probable that, in the absence of a proper sanitary staff, too much weight has been given to the opinion of overseers who, having other work to attend to, do not recognize that the settling of questions of ventilation or latrine accommodation is of the slightest importance. Houses of a poor class are essential in a large population; but, it ought to be an easy matter to see that they are arranged in a better manner than is daily permitted in Madras. These remarks, however, apply to parcherries. More power is requisite for the superintendence of the larger number of buildings referred to in the preceding paragraph. The overcrowding and the filth, incident to allowing houses of this description to be erected, are disclosed in appendix F (*a*). To convey a correct idea of the form of these places, I have selected "Ibramjee Alli Street" as a specimen, and have caused a plan of it to be prepared, which is herewith submitted. A glance at this will show that considerable ingenuity has been exercised in excluding the faintest suspicion of air in motion. . . . . The inhabitants of such places recognize fully the insanitary circumstances, the want of privacy, and the debasement of morals, which result from their being thus brought together. Wherever I have been, these facts have been, in a tone of bitter complaint, spoken of by the tenants themselves. Why then, it may be asked, do persons who object to these conditions live in such places. Well, they cannot afford above the rent I have stated, viz., from annas 12 to Re. 1 per mensem, and they must, therefore, live in dwellings obtainable at that price. It is for the legislature to see that (1) their poverty be not taken advantage of by unscrupulous persons and (2) that they do not become a danger to themselves, or to

Mental and bodily debasement resulting from the habitation of insanitary dwellings.

Madras Shylocks.

the public, by failing to fulfil sanitary requirements. In the first point, lays the truth of the existence of these extraordinary habitations. It is an established custom in Madras for every man possessing a house, having a little vacant space at the rear, to look forward to the time when, by investing a few rupees in erecting a human den, he ensures to himself a heavy and safe interest; these household properties are literally "lodging-houses." It is obvious it requires no strained estimate of political economy, to demand that the man who crowds human beings with places that a Veterinary Surgeon would pronounce unfit for the health of a good class of dogs, should be called upon to make his gain under restrictions, that shall prevent his actions proving a peril to the public health. Such a contingency is provided for in the "Registered Lodging Act," suggested by the Society of Medical Officers of Health of London. I attach a copy of this (*vide* Appendix D) roughly modified, so as to give an example of what is desirable in this direction in Madras. By the operation of such an Act, a very large number of houses—the sanitation of which would at all times be most difficult of management—might be easily supervised. Beyond the point secured by the clauses of the suggested Act, I consider it a matter of importance to lay down, as a fixed condition of allowing houses to be sub-let as lodgings, that one end (by preference the street end) be completely opened, instead of, as at present, the whole interior being concealed from view and deprived of perflation by the owner's house, or a blank wall."

Houses of the class described should be classed as "Registered Lodging Houses," and special supervision be enforced, the onus being thrown chiefly upon the owner.

Whether as a result of the conditions under which these places are tenanted they are capable of being classified as lodgings or not, it is, I think, of the greatest importance that some measure should be undertaken for the compulsory opening up of the enclosures, which these dwellings really form. They are nearly all built in squares; one side at least, and if possible two, should be opened up. I see this proposition, which I laid before the Municipality of Madras in 1882, and which was ignored, it is now proposed by the Health Officer of Calcutta to enforce in connection with the Building Act, which is now under discussion there. Of course, such an action would cause expenditure for compensation; but I am certain its efficacy would soon make itself apparent. It has been proposed by certain persons to cut thoroughfares through Black Town, so as to secure better perflation; but it is evident that even should this be managed, the result would be very small, so long as these square-built enclosures were allowed to remain undisturbed.

Being built in squares perflation is impossible; compulsory opening for perflation essential.

Whether the closed sewer system or open drains be used, it is equally manifest that house connections cannot be made satisfactorily if executed stingily, or under the supervision of private contractors. These connections should therefore be carried out by the Municipality, and be treated as to expenditure under "private improvement expenses," for which object I have already suggested that Government should be advised to give a loan, or gift of money, for the purpose of founding a fund recoverable upon security of the premises treated, throughout periods extending up to thirty years. In this connection, I would direct attention to the recent action of the Local Government Board of England, in providing an inducement for the sanitation of dwellings by remitting, "as assessment to inhabited house, duty of any house originally built, or adapted by additional alterations, and used for the sole purpose of providing separate dwellings for persons, at rents not exceeding seven shillings and six pence per week, and occupied only by persons paying such rents," provided a certificate is produced from the Local Medical Officer of Health, "to the effect that the house is so constructed as to afford suitable accommodation for each of the families' or persons' requirements." A rule of this nature by which the house-tax could at least be lowered, on it being shown that proper provision has been made for the numerous families which these square enclosures contain, would undoubtedly be followed by good results.

House connections with sewers or drains should be executed by the Municipality, and cost be recovered as a rate under provision for "private improvement expenses."

Inducement to securing sanitary improvement of dwellings by reducing house-tax, on production of certificate by the Medical Officer of Health.

Markets.—The market arrangements in Madras have for many years been recognized as extraordinarily defective, in consideration of the importance of the city as the Presidency capital. Much stricter supervision as to the quality of meat-supply is requisite, and the obnoxious and cheating practice of "blowing" the meat, which is pursued freely, should be provided against by law. The central market is not only in itself, as to arrangements, inappropriate, but forms the loitering and feeding place of a very dirty class of people. I believe that the Municipality would find no difficulty in getting private persons or

Filthy practice of "meat-blowing" very common.

New markets.

companies to undertake the erection of suitable markets, if sufficient encouragement were forthcoming. I do not wish to enter into details more than possible; but I would remark that the possession of latrines in the interior of markets in this country is objectionable; urinals, carefully attended to, only should be provided.

Latrines in markets objectionable.

Medical Officer of Health and Sanitary Staff.

As the Medical Officer of Health has lately found it necessary to retire on account of ill-health, induced by over-work during the late epidemic, it is desirable questions connected with this appointment be discussed. The Municipal Act, as now revised, was, I believe, modelled on the Bombay Act, which again imitates closely the Public Health Act of England; but, for some unknown reason, the position of the Medical Officer of Health was made such that it would be possible for any representations he might make to be taken little notice of. Under section 44, this officer has been classed with overseers and other subordinate servants, whose entertainment and dismissal rests with the President. This should not be the case. The Medical Officer of Health must doubtless occupy a subordinate position to the President; but the Act should be so framed as to ensure that his opinion shall at all times be duly weighed by the President and Commissioners, without his feeling that a difference of opinion might lead to his being considered unsuitable for the appointment! Thus, in the Bombay Act, it is laid down—"The Executive Officer of Health shall act in subordination to the Municipal Commissioner, but in all matters of importance affecting the public health generally, the Municipal Commissioner *shall* consult the Executive Officer of Health, and in the event of the latter officer differing from the Municipal Commissioner as to any order or orders issued, or proposed to be issued regarding any such matter, he shall submit his views to the Commissioner in writing for the consideration of the Town Council," &c. Again, in all matters affecting sanitation such as the hygiene of dwellings, trades of an offensive nature, &c., &c., it is carefully laid down that the Municipal Commissioner shall not act upon his own responsibility but "in consultation," or upon a "certificate furnished" by the Medical Officer of Health. This is as it should be; if a Health Officer is engaged, it is obvious it is because the Municipal President is not supposed to have received that special education, which would fit him to carry out the work unaided. To secure, further, that his voice should at all times be heard in matters connected with sanitation, the Medical Officer of Health should be a Vice-President of the Municipality for Sanitation and Vaccination, and should be entitled to vote at meetings. As regards salary, it is necessary for the Municipality to remember that hygiene is now as special a branch of medicine as mining is of engineering. We are accustomed in this country to regard a knowledge of hygiene as the necessary accompaniment of medical education; because, as it happens, every Medical officer in the Indian Medical Service has undergone a special training and examination in hygiene before coming to this country; but when private practitioners are thought of, it is desirable that it should be demanded of them that they possess a degree or diploma in Public Health, that would entitle them to charge of a county or of a town of over 50,000 inhabitants in England.* It is not likely that the requisite class of medical men could be obtained on a salary of Rs. 500, especially if classed under section 44 of the Act, as a subordinate servant subject to dismissal of a summary nature. If the Municipality cannot afford a higher salary, it would be advisable that Government should give aid, in consideration of the large number of Government officials forming part of the population, and of the presence of troops. A precedent is to be found in the ruling of the Local Government Board of England according to which Medical Officers of Health in the larger charges are paid partly by Government, and partly by the Local authorities concerned. Government might, for example, pay a portion of the salary *indirectly*, if the officer gave lectures as Professor of Hygiene in the Presidency College, and was Superintendent of the Hygiene of the Museum of Hygiene—both of which measures were suggested by me in my report of 1882 (see extracts quoted elsewhere). If thus aided by Government, the Municipality could no doubt get a specially-trained man from England, who has already distinguished himself in public health work there. The employment of such an officer has evidently yielded satisfactory results in Calcutta.

Present status of Health Officer inappropriate.

It should be ruled that whilst the Medical Officer of Health should be in subordination to the Municipal President, the latter shall consult the Medical Officer of Health and that the opinion of this officer be not overruled otherwise than after a hearing by the Municipal Commissioners.

Medical Officer of Health should be Vice-President for Sanitary and Vaccination services.

A degree or diploma in Health requisite.

* Local Government Act, 1888, section 18.

Salary now given insufficient.

Government might aid Municipality indirectly by making the Medical Officer of Health *ex-officio* Professor of Hygiene in the Presidency College and Superintendent of the Madras Museum of Hygiene.

* See also General Order of Local Government Board, England, No. 15 of 20th July 1883, and G.O., No. 5 of 16th March 1880.

With regard to the duties * to be expected of the Medical Officer of Health and his staff, I cannot do better than refer to my old report: in this I advised that the special peons of the Sanitary officer's establishment should have power of arrest. In doing so, I was aware that the recommendation would not commend itself to legislators, as being against principles at present recognized. Knowing now that it is futile to press this question, I would, instead of the thirty sanitary peons armed with power to arrest, simply suggest that thirty men of the local Police force should be paid by the Municipality, and should be attached for short tours of duty to the Sanitary Department. They would, as to discipline, be controlled by the Police, but their duty would be to accompany Sanitary Inspectors, and, whilst with them, take action in arresting for common nuisance, wilful exposure of the person when suffering from infectious diseases, careless disposal of infectious matter or clothing, &c., &c. With the exception of the question of arrest, I do not think it requisite to modify the opinion formerly given on these matters; and I think it may be safely said that when I pointed out that it was essential that a distinct Sanitary staff should be placed at the disposal of the Health Officer, and that he should not be called upon to directly control the Conservancy Department, the principle laid down was sound; at any rate, the pursuit of an opposite course has produced the poor results that might be expected:—"The Madras Municipality is by no means singular in affording an example of imperfect sanitation, when efforts are not guided by a specially trained staff; the united experience of every large town throughout the civilized world, where any form of Municipal Government has been attempted, points to the same conclusion. It is a matter for astonishment that an Act such as the Madras Municipal Act for 1878, could have been passed, without its being forced upon observation that the presence of a Medical Officer of Health was essential for the safe conduct of the sanitary clauses elaborated. It is desirable that the mistake which has been committed, should be remedied as soon as possible. In appointing an officer, care should be taken that his influence, as secured by salary and status on the Municipal Board, should be such as to guarantee that, if his suggestions can stand the test of discussion, they should be carried into effect—not "pigeon-holed.". .

A distinct staff having health duties *only* should be attached to the Medical Officer of Health; any attempt at economy by calling men "Sanitary" overseers, who really perform the arduous duties of Conservancy overseers, has, in the past, and must in the future, render the Medical Officer of Health practically powerless for good.

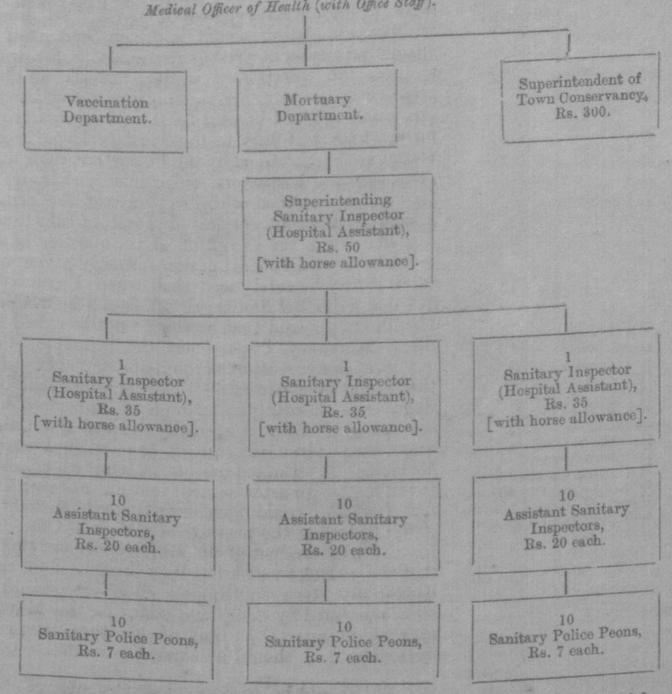
Duties of Medical Officer of Health.

He should be recognized as the adviser of the Municipality *upon all matters that may affect health directly or indirectly*, and all details that may reasonably be thought to bear upon this matter should be referred to him for opinion, *before action is taken*. To this comprehensive duty might be added the control of the Vaccination and Mortuary departments. Every matter immediately connected with dwellings and their inhabitants should be under his supervision. No building should be allowed by the Municipality, without a certificate from the Health Officer that the site and plan are approved. Certain powers should be given him to call upon householders to alter house-drains, and house-latrines, after suitable patterns. Overcrowding should be attended to under his directions, according to the suggestions made under the head of "dwellings." Ample scope for such functions is already afforded by the Municipal Act, the only necessity is to get some one with the time and knowledge of such specialities, in order to undertake their execution. . . . .

Subordinate Sanitary staff essential.

Experience with my temporary staff shows that energetic men can accomplish house-to-house inspection at the rate of at least one hundred a day, and superintend the remedying of striking nuisances, besides submitting reports of the same, and attending to removal of choleraic excreta in parts distant from those under actual inspection for the day. When nuisances have decreased and when there is no epidemic, no doubt one hundred and fifty could be looked after daily. Now, one hundred and fifty Madras houses, such as crowd Black Town, contain at the least four families each; thus, a very large population would come successively under the observation of the Sanitary staff. I would suggest the number of men be such that each house throughout Madras could be entered into at least once a month. This would demand sixteen men, but there would necessarily be many houses where inspection would only be required at rare intervals, if at all, and others where it would be desirable they should come under observation once a week, or once a fortnight, calculated in this way, allowing a third for each mode of supervision, it would appear that between thirty and forty men would be requisite. I assume the smaller number as sufficient in the absence of epidemics. This

staff might, therefore, be composed of this number of assistant Sanitary Inspectors forming the executive, with the addition of certain others necessary for supervision as follows:—



The number of men being approximately adjusted, they should be placed absolutely at the Health Officer's disposal and not be assigned to certain areas, so that undue familiarity with the inhabitants might be prevented; the Health Officer would increase or diminish their number in localities, as required from time to time.

If Medical Officer of Health be rendered responsible for the working of the Conservancy establishment, he should be supplied with a Deputy to relieve him of routine duties.

It has been proposed that the Night-soil Department should be handed over to the Health Officer, but provided a proper system is brought into action. I consider its government would fare better at the hands of an Engineer staff, mechanical details being involved; if, however, it be regarded as desirable, it would be requisite that an educated European or Eurasian, on a salary of about Rs. 300, should be employed, as Superintendent of Town Conservancy, directly responsible to the Health Officer, so as to relieve him of any but administrative duties.

Staffs having mixed sanitary and conservancy duties are useless.

It may be said that the Sanitary staff ought to be capable of looking after the duties I have mentioned, as well as, at least in some part, supervising the conservancy. This is impossible; either there should be a distinct Sanitary staff, or none at all. A man whose duty it is to watch side-men and toties, must have his whole time fully engaged, if he fulfil his work honestly. But the existence of a Sanitary staff might be some argument with regard to employment of a comparatively small number of peons for conservancy; as, premising the "pail system" in proper working order, their having to supervise households would have much influence in ensuring correct working, by their seeing that the proper time and mode of removal from dwellings of excreta are adhered to. But, I think it would be a fatal error to suggest that the Sanitary staff which I have sketched, should have duties rendered less defined, by ordering them to give direct help to the Conservancy establishment."

A Special Magistrate required.

A Special Magistrate should be appointed for the next two years to try petty nuisance cases, and infractions of Sanitary laws. This official

should not be too tender-hearted, though I would not wish him to be what a Magistrate should not be—unjust; but, experience shows that every effort to enforce Municipal law may be stultified, when a Magistrate is determined to sympathise with the filthy habits of men simply because they are poor. As a fact, it often pays a man well to constantly ignore Municipal law, and, as long as this is the case, the inhabitants will not obey—and sanitary efforts will be constantly frustrated. Nothing can be more disheartening to a Municipal staff to go to the trouble of prosecuting certain persons in the interests of the public health, and to find, after days of attendance at court, that glaring delinquencies are punished by fines that excite ridicule even in those upon whom they are inflicted. Unless the Magistrates so deal with infractions of Municipal law, as to cause the most ignorant to have as much respect for it as they have for sections of the Penal Code dealing with property, it is unlikely that correct sanitary conditions can be attained.

SUGGESTIONS FOR ALTERATIONS OF EXISTING CLAUSES OF ACT No. I OF 1884.

Section 44.—Remove the name of the Health officer, and deal with the appointment in section 37, making Health officer also Vice-President.

Provide for part of salary being paid by Government, by stating that the Health officer of the Municipality shall be *ex-officio* Professor of Hygiene and Superintendent of the Madras Museum of Hygiene.

Section 62.—Provide for a sufficient office and laboratory for the Medical Health officer.

Section 83.—Provide for special meetings in three days after requisition by Medical Health officer, with reference to presence or threatened presence of epidemic diseases.

Conduct of business—Section 70 *et seq.*—With reference to Medical Health officer, modify, and insert section 47 of the Bombay Municipal Act.

Section 84.—Provide that timely notices of preparation of budget shall be made, so that the Medical Health officer may have an opportunity of presenting his propositions.

Section 91.—Medical Health officer shall present yearly a report.

Section 122.—Exempt building of certain value, provided the owners can produce Medical Health officer's certificate as to sanitary condition (*see* note on dwellings).

Section 182.—Provide that toddy and liquor shops be entered by the Medical Health officer at any hour, and that sanitary conditions of premises be necessary before license be granted.

Section 212.—Insert clauses as to publication of an analyses of water, monthly.

Section 216.—Provide that President may direct that the line of the water conduit from Red Hills be crossed only at certain parts by carts.

Section 219.—Insert after the word "lake or reservoir," "and over any water-course or water-shed supplying such lake or reservoir." Provide that the local authority through whose district the stream passes, "*shall* exercise measures to the satisfaction of the President, in consultation with the Medical Health officer, subject to an appeal to Government, for the prevention of the entrance of "solid refuse of manufactories, manufacturing processes and quarries, rubbish and cinders, and any other waste or putrid solid matter, (2) sewage, (3) poisonous, noxious or polluting liquids from factories and manufacturing processes, (4) poisonous, noxious or polluting or obstructive matter from mines."

Section 230.—After "pollution by surface," insert "or sub-soil drainage."

Section 231.—After President, insert, "in consultation with the Medical Health officer," and leave out conditional clause "and after

such notice, &c., the water of such well, lake or reservoir is used for drinking."

Section 244.—After the words "erected on each side," state, "such other information as may be required by the bye-laws." After the words, "if the President," insert, "in consultation with the Medical Officer of Health."

Section 250.—Insert—suitably modified—the following rules adopted by Water Companies in England: "No pipe will be suffered under any pretence whatever, to communicate directly with the basin and trap, or otherwise than with the cistern or service box of a water-closet or soil pan; and the same shall be so constructed and used as to prevent the waste or remove consumption of water, *and the return of foul air, and other noisome impure matter into the mains or other pipes* of the Company. No pipe should be laid through, in, or into any slough, drain, ash-pit, manure hole, or other place, from which, in event of decay or injury of such pipe, the water of the Company might be liable to become fouled, or to escape without observation, or without occasioning the necessity of immediate repair. In every case in which any such slough, drain, ash-pit, manure hole, or other place as aforesaid, shall be in the unavoidable course of the pipe, such pipe shall be passed through an exterior cast-iron pipe or box of sufficient length and strength, and so bring any leakage or waste within the means of easy detection."

"Every person supplied with water by the Company who wilfully or negligently suffers any pipe, valve, cock, cistern, water-closet, or other apparatus to be out of repair or so used as that water supplied to him by the Company is wasted or misused *or as to allow the return of foul air or other noisome impure matter to return into the pipes* belonging to the Company, or connected with the main or pipes of the Company, shall, for every such offence, forfeit to the Company a sum not exceeding £5."

Section 265.—*Direct* that within two months from date of coming into force of Act, Commissioners shall prepare for sanction by Government suitable bye-laws as to buildings.

Section 267.—After "President" add "in consultation with Medical Health officer."

Section 273.—Provide that if a house has a drain "*though sufficient* for the effectual drainage of the house is not adapted to the general sewerage system of the district," or, is in the opinion of the President otherwise objectionable, the President may, on condition of providing a drain as effectually close it and do any work, &c. (precedent section 24, Public Health Act, 1875).

Section 271.—Omit the words, "a range or block of six or more huts."

Section 280.—This is indefinite as to possible contention as to existing latrine, &c., hence, a provision should be made that the President may direct, where it appears in the report of the Medical Officer of Health, that a "sufficient" latrine or water-closet does not exist, or that it is not adapted to the general sewerage system of the district, or that no latrine or water-closet exists; such form of latrine or water-closet, and drains or pipes to render their purpose effectual, shall be built, as he may think fit, and that alterations and demolition of walls, court-yards, &c., requisite for the suitable accomplishment of such works shall be effected (as a precedent, see section 36 of Public Health Act).

Section 288.—Add after "such permission shall in no case be granted, if the projection is likely to cause public inconvenience," or, in the case of a structure intended to remain more than five days, may obstruct light or perflation of the street generally, or of individual houses.

Section 309.—After "night soil" add "rubbish."

Section 310.—After "such a moveable private receptacle" add "or receptacles."

Section 311.—After "receptacle" add "or receptacles."

Section 317.—After "whoever puts" add "wilfully or negligently."

Section 322.—After "President," add "Medical Officer of Health."

* See also "The Labouring Classes Lodging Houses Act," Vic. 1851. "The Labouring Classes Dwelling Houses Act," 1866 and 1867. "Housing of the Poor Act," 1885.

Sections 322 *and* 324.—Modify and adopt the "Artizans and Labourers * Dwellings Improvement Act." (*I consider legislation of this character essential*).

Section 326.—See my note * as to irrigated lands, &c.

Section 329.—President should be empowered to give not only notice to individual owners but should issue a "general notice," directing all persons by a date to be named, to have hedges trimmed to a height not exceeding four feet, and to lop all branches of trees up to ten feet from the ground.

Section 330.—Instead of "likely to be dangerous to the public health," state, "if the water be in a seriously impure condition."

Section 331.—*Provide* for expenditure in restoring the original *status quo*.

Section 332.—Add to list, "places used for preparation of flour, ice manufactories, and places of sale or storage of ice, manufactories of aerated waters, or other waters sold for drinking, arrack and toddy shops."

After "President," add "in consultation with the Medical Officer of Health."

State that within two months of coming into force, bye-laws for the correct administration of dairies, and bakeries, and slaughter-houses shall be submitted for sanction of Government.

Suggested additions to Municipal Act.

Add to, or modify, *Section* 231, so as to include possible source of pollution, thus:—"the owner of a source of water-supply which by custom or express permission is used by the public, shall make such structural alterations or additions for the purpose of preventing liability to pollution, as the President, after consultation with Medical Officer of Health, may consider expedient; or the President, if satisfied that the source of water-supply be so situated with reference to possible modes of pollution, or, if the structure be such as to permit of pollution, shall direct permanent closure, or limit the water to such manner of purpose as he may deem expedient."

Add powers to control the building of new wells so as to give sanitary protection, thus:—"Persons desirous of sinking new wells shall seek the permission of the President, and furnish for his information plans, specifications, and estimates, in duplicate. If these be approved by the President, in consultation with the Medical Officer of Health, permission to proceed with the work may be granted; but, if it appear to the President that any alteration as to material employed, form, or general arrangement, be requisite, either for sanitary reasons or for protection of the public; the person proposing to carry out the work shall sign an agreement to the effect that the modifications demanded shall be made; should the work then be proceeded with, and it be ascertained that any part of the structure, as approved by the President, has been omitted or that other than approved material has been substituted, the requisite alterations shall be carried out at once by the President, and the expenses be recoverable as a debt to the Commissioners."

Provide against spread of animal diseases, *especially against anthrax*, which is dangerous to man, thus:—"When the President shall have declared that any disease of animals is either infectious or contagious to human beings or animals, and shall have posted in public places a notification to that effect, together with a description of the disease in the vernacular, the occurrence of cases shall be reported by the owner, or his agent in charge of the cattle, to such authority as may be named in the notice within four hours."

(2) *Provide* for separate removal and destruction of litter by fire, or otherwise, as may be directed, and for burial or destruction by fire of carcases of diseased animals, in such manner as may be directed, at the expense of the Commissioners.

(3) *Provide* for a special and heavy penalty for removal of a carcase dead from anthrax for any method of disposal, otherwise than as directed by the President; for the cutting of the skin for any purpose, otherwise than under qualified medical or veterinary authority, and for

selling or carelessly disposing of the skin. (These details are *essential* in the interests of human life).

Provide for protection from contamination of milk.—If at any time diseases exist among the cattle in the dairy or cow-shed, or other building or place, the milk of a diseased cow therein (*a*) shall not be mixed with other milk; and (*b*) shall not be sold or used for human food; (*c*) and shall not be sold or used for food of swine or other animals, unless and until it has been boiled.

It shall not be lawful for any person following the trade of cow-keeper, or dairyman, or purveyor of milk, or being the occupier of a milk-store or milk-shop, to use a milk-store, or milk-shop, in his occupation, or permit the same to be used, for any purpose incompatible with the proper preservation of the cleanliness of the milk-store or milk-shop, and of the milk-vessels and milk therein, or in any manner likely to cause contamination of the milk therein.

The keeping of animals by private persons.—"It shall not be lawful for any person to keep within Municipal limits or in or near occupied dwellings, any animal when in the opinion of the Municipality, there are reasonable grounds to believe the place in which it is at any or all times retained by the owner, or keeper, is deficient in cleanliness, lighting ventilation, drainage and water-supply; on receipt of a written notice to the effect that the Municipality regard provision for any or all these conditions deficient, the owner or keeper, shall within forty-eight hours remove the animals specified in the notice from Municipal limits unless and until the owner, or keeper, makes provision for the fulfilment of sanitary requirements to the reasonable satisfaction of the Municipality."

Food and its adulterations.—It should be provided that "no article of food shall be treated so as to render it injurious to health, with the intent that the same may be sold in that state;" *and to the prejudice of the purchaser* "of any article of food or drug, which *is not of the nature, quality and substance asked for*." "This would not only give much protection to the public as to ghee, which is much adulterated in Madras; but also to milk, patent drugs, &c. The quantities and conditions under which articles are to be received for analysis should also be laid down in the bye-laws.

Infectious diseases.—The powers given to the Municipality are very complete. I would, however, suggest the following additions to the Act:—Power to provide temporarily shelter for families, whose houses are in processes of disinfection, on account of infectious diseases; power to close schools on a certificate being furnished by the Medical Officer of Health, to the effect that he is of opinion that this step is necessary, either with regard to the abatement or prevention of epidemics; alterations of the permissive clause as to provision of apparatus for disinfection of clothing and of places for washing, and the use of the word *shall* instead of "may." Notification of infectious disease under Section 368 should undoubtedly be extended to the "occupier of a dwelling." Natives can just as easily recognize such simple diseases as cholera, small-pox, and measles as Europeans, and there can be no object in limiting compulsory notification to medical practitioners, when they are practically non-existent.

General Remarks and Recommendations.

Finally, I would, with reference to prevention of epidemics in the town of Madras, take the liberty of repeating the advice given at the end of my report of 1882. I would especially, in the interests not only of Madras but of sanitary advance in the presidency generally, draw attention to the suggestions contained in paragraph 5, as to the establishment of a chair of Hygiene in the Presidency College, and of opening a Museum of Hygiene of the type now attached to the Sanitary Institute of Great Britain as "Parkes' Museum," which is fulfilling a most useful function in familiarising the public with various sanitary contrivances. By these measures, men of general education, who now are looked to for the effecting of sanitary administration as members of local bodies, would be reached, and an enormous impetus in sanitary advance would occur throughout the presidency:—"To sum up; the

experience that the course of the epidemic seems to force upon me is;—(1) That wherever insanitary conditions exist, such as soil containing decomposing organic matter, dwellings inhabited by human beings provided with poor air-space, inferior food and impure water, that a predisposition is acquired by those under their influence; and that (2) in this way may be accounted for the escape of the better kept portions of the town, although, here and there, in their midst—in parcherries, and the houses of the poor—cases appeared; that (3) the existence of open public wells added to the danger of acquisition of mere predisposition from any of the causes abovementioned, by permitting direct introduction of choleraic poison into drinking water; and that (4) in such neighbourhoods when these combined factors were in operation, the epidemic assumed formidable proportions. Thus, cholera introduced into a parcherry possessing the advantage of a pure and closed (protected) water-supply *e.g.*, pipe water) would be less likely to spread extensively, other insanitary conditions being equal, than in one possessed of open surface wells; *e.g.*, of one hundred persons who were attacked or died of cholera, 65·6 used well water, 18·7 only pipe water, and 15·6 both well and pipe water. The great desiderata in attempting the protection of the City of Madras might, in consideration of the foregoing conclusions, be classed as follows:—

A. The curtailment of media of spread (germ pabula or vehicles) and the prevention of acquisition of predisposition by the inhabitants, by the maintenance of a correct sanitary state, brought about thus:—

1. By preserving the purity of the soil.

(1) Correct conservancy, and drainage for refuse water, (2) prohibition of intramural burials.

2. By providing a pure water-supply.

(1) Pipe supply from Red Hills tank as the best available, (2) provided the surface for which it is collected be preserved from contamination, (3) and it be filtered before distribution.

3. By securing due perflation of dwellings.

By regulating with strictness the construction of dwellings, especially of the poor.

4. By maintaining a good sanitary condition of individual dwellings, (6) and of the food of the inhabitants.

(1) The enforcement of laws referring to both, (2) by the air of a special skilled staff [not a mixed staff as at present].

5. By encouraging the spread of knowledge of Hygiene.

(1). By establishing a Museum of Hygiene open to the public—with a short descriptive catalogue in the vernacular, (2) establishing a Lectureship on Hygiene in the Presidency College—to reach men of *general education*, instead of such knowledge being confined to medical men as a present, (3) giving special grants to schools, where scholars show a proficiency in knowledge of Hygiene.

B. The correct dealing with choleraic matter (destruction of disease germs).

1. Strict supervision and enforcement of sanitary precautions [prior to and] in each case. *From the moment of introduction to the complete cessation of the epidemic.*

(1). By the aid of a sanitary staff, large enough and sufficiently skilled to effect necessary measures, (2) by the provision of proper apparatus [for disinfection], (3) by the establishment of Committees of health and observation, formed of the inhabitants in conveniently sized sections of the town, before and during the prevalence of an epidemic; with the object of securing their influence upon their neighbourhoods, and of conveying early intelligence of attacks to the sanitary staff in the areas under their charge.

Madras,
8th November 1890.

W. G. KING, D. Ph.,
Surgeon-Major.

Appendix No. 3.

NOTE.

Certain Suggestions for improved Sanitation in the City of Madras.

The present methods and arrangements for the removal of rubbish and night-soil are, in my opinion, inefficient and unsatisfactory. The removal of rubbish is effected by about 255 carts, while for the disposal of silt, &c., there are 138 carts employed. For removal of night-soil, 57 box carts, 164 hand carts and 29 trollies are in use, but only in 1st, 2nd, 3rd, 6th and 7th divisions (and in some of these divisions only partially so) is there a separate collection. The present state of matters is due to the inability of the Municipality to find funds to allow of better arrangements, those at present existing having been for a long time recognized as susceptible of very considerable improvement. Madras is a city of magnificent distances, and as such places as rubbish depôts must be situated so as to be at considerable distances beyond the inhabited

portions of the town, the length of road to be traversed by a cart after it is full is out of all proportion to the length travelled over during collection. Bullocks, again, travel very slowly, and though they are suitably employed in collection, it is evident that much time, and hence much loss of power and efficiency, occurs by their having to travel long distances to the place of deposit.

2. Take, for instance, the case in which the collection is done over ½ a mile of street (the rubbish from which will nearly fill a cart), and the distance to the depôt is 2 miles. Now this latter distance has to be travelled twice for each collection, so that if three trips can be made daily, 1½ miles would be travelled over during collection and 12 miles after collection. The proportion here is 12 to 1½ or 8 to 1, that is to say, if the carts could empty at or near the point of collection, in such case only 1/9 the number of carts would be necessary.

3. This, of course, is not possible, but the more adjacent we can fix the place at which the carts can empty to the portion of the town in which the rubbish is collected, the greater will be the efficiency and economy.

4. This has long been recognised and in many towns in India the carts are emptied at a depôt close to the town into railway wagons, when one or two trains a day can take away the rubbish to great distances at a comparatively moderate cost when compared with bullock transit.

5. That there is a necessity for such a plan being brought into operation in Madras will hardly be doubted. Madras is a town which perhaps more than any other town in India requires mechanical aid to economically traverse its great distances.

6. There are four methods by which this mechanical aid can be obtained—

(1) By the use of existing railways.
(2) By the construction of light railways.
(3) By the use of canals.
(4) By the use of (2) and (3) combined.

7. The second-named plan will probably be found most suitable to the requirements of the city. Such railways could be best worked by the Municipality themselves unhampered by those rules which must necessarily be enforced on passenger lines.

8. For the northern portion of the town, including Ráyapuram, Black Town, Choolay, Vepery and part of Chintadripett, a line starting from the Salt Cotaurs near the Wall Tax road and proceeding along the canal to Sathankadu (where the Municipality have already a large area of land available and where waste land can easily be obtained) would seem the most feasible. The Salt Cotaurs would be a very central position; it is screened from the town, and Government, it is understood, are getting rid of their stock of salt at this place, which will then be available. The place is suitable in every respect. It is screened from view, its area is considerable, and it is on the bank of the canal along which the railway would run.

9. The selection of a proper site for the reception of the rubbish from the more southern portions of the town is more difficult. The town here is bounded on the south by the Adyar river, which it would be most expensive to bridge even for a light railway Here canal transit would recommend itself, except for the cost, which would be incurred by the necessity for raising the rubbish from the boats. I am, however, of opinion that the boat might be designed to carry the rubbish in light railway trucks and that these could be run up direct from the boat by a special arrangement at the final place of deposit. This plan would allow of the rubbish being sent south of the Adyar. As speed is somewhat of a necessity, a small launch would be required to haul the boats.

10. There is, however, a considerable area of cultivated land lying between the Mylapore tank on the west and the village of Mylapore on the east, near which there are very few houses of any description, and thither a light railway laid along the canal banks might convey the rubbish from Triplicane.

11. The remaining portions of Madras, which could not be economically served by these two lines, are mostly suburban and the rubbish consists largely of fallen leaves and vegetable matter; another outlet, however, suggests itself from Kilpauk, the light railway being meantime used for operations in connection with the construction of the new conduit for water-supply.

12. The construction of these lines would allow of the abolition of the many small rubbish depôts at present existing in too great proximity to the town, and of the formation of one or two large rubbish depôts.

13. These should be laid out on the trench and furrow system; sidings or branches from the light railways would run up between the furrows or ditches and the stuff from the wagons which would be "side tipping" would be thrown directly into the trenches. The sale of rubbish and night-soil should be prohibited for at least three years from date of deposit. There ought to be a covered area at each depôt for the temporary reception of night-soil during monsoon weather. The present practice of selling fresh soil and rubbish is to be strongly deprecated for reasons which it is unnecessary for me to enter into. The separate collection of night-soil during the night, if possible, from all divisions of the city is very desirable.

14. The contract system for the sale of rubbish is, I believe, a mistake. There is no security that either rubbish or night-soil is buried and not at once sold instead of rubbish which has been deposited for at least six months. The system may be more economical for the Municipality, but it is yet to be discovered what effect the system has on the health of the people. The derivation of a large income from the sale of rubbish is not always an unmixed blessing.

Improvement of plant.

15. It is a mistake to entrust the supply of carts to a contractor. The carts are never in fair order and under this system never will be. The rubbish and box carts in Madras are the property of a contractor, who hires them to the Commissioners for the year of his contract, at the expiry of which another man buys them and hires them to the Municipality. Under such a system high rates must be charged and loss must result. All plant ought to belong to the Municipality and be kept in order by the Municipality. A proper plant inspector is necessary for this work. The Municipality cannot afford to buy the carts and hence have to continue paying a sum of Rs. 12,600 yearly equal to a capital sum of Rs. 2,00,000. The contractor, however, repairs the carts, but even Rs. 6,300 or half the yearly payment represents 1,00,000, which is more than double the value of the 400 carts hired. The carts did once belong to the Commissioners; they were sold during a fit of retrenchment for the sake of economy; the economy, however, I believe, has not been effected, while efficiency has been very seriously impaired.

16. The Municipality is in much need of proper depôts for its bullocks. The depôts at present used are frequently the origin of the outbreaks of cattle-disease, I think, almost annually. This demoralises the staff, causes loss to the contractors and nuisance in the city and probably causes the spread of cattle-disease to the cattle of other persons. The present depôts are not paved, though in most cases drained, but not in such a way as to prevent the urine sinking into the ground on which the cattle stand. Well-built sheds thoroughly paved and drained are a necessity. A bullock contractor with a three-years' contract cannot be expected to provide proper places and so long as the present depôts are used so long will there be recurrent outbreaks of cattle-disease.

17. I estimate that the cost of carrying out the proposals I have made would be as follows:—

	Rs.
Loans—	
For light railways, including plant, say, 3 miles	1,80,000
Purchase of carts, at present the property of the contractor and repairs to them	55,000
New plant for extended collection of night-soil	20,000
Improvement of Municipal cattle depôts	50,000
New rubbish night-soil depôts, preparing land and erecting sheds	25,000
	3,30,000
* Annual expenditure—	
Interest on 3·3 lakhs @ 5 per cent. + 3·3 × 650, Sinking fund.	18,645
Working railways, loading and unloading	20,000
Annual repairs of carts to be purchased, 400 carts at Re. 1/8 per month	7,200
	45,845
Deduct payment for hire of carts	12,600
Do. labor at existing depôts	4,000
Total annual cost ...	29,245

J. A. JONES.

I concur generally in the views expressed in the foregoing note, but I think it would be worth while to try the experiment of destroying rubbish by fire in one of the numerous forms of "destructors," which have been introduced of late years.

It is probable that for the parts of the city within easy reach of the tramway recommended by Mr. Jones, removal by the latter would be the cheapest form of disposal, but it is possible that in the more distant parts the destructor would be more economical, and the experiment might be tried in a part of the town so situated that, if successful, the destructor need not be superseded on the construction of the tramway.

MADRAS, November 1890. (Signed) J. PENNYCUICK, Col., R.E.

* The cost of working the additional plant recommended not included.

APPENDIX No. 4.

From J. H. STEPHENS, Esq., to Colonel J. PENNYCUICK, R.E., President, Sanitary Commission, dated High Court Works, 27th October 1890.

May I be allowed to make a suggestion regarding the sanitary improvements to the Cooum river.

COOUM A TIDAL ESTUARY.

I. 1. To make this stream a permanent and continuous tidal estuary, it should be connected with the sea through the harbour. A branch canal can be easily and economically made from the river near Cupid's bow, where the road will have to be crossed, following the foreshore road up to the Fort and entering the harbour through the south arm about 500 feet east of the Beach road as shown in yellow in accompanying sketch plan.* The foreshore has receded so far between Cupid's bow and the south arm of the harbour to make this a work of great ease and no danger from the sea.

* Marked A A.

2. The Buckingham canal is made with a bottom breadth of 30 feet, but as this branch will connect the harbour with both the great northern and southern systems of canals, it should have a bottom breadth of 50 feet and depth of 3 feet below low tide. There is no question about levels, as canal boats navigate the Cooum every year when the bar is open. Any deposits of silt between the canal line and Cupid's bow will have to be removed annually, as is now done, to the canal line in the Cooum bed. Flood gates should be fixed at the river end of the canal, and all floods allowed to pass, as hitherto, through the old bar under the iron bridge. Before entering the harbour, the canal should pass through a settling reservoir, that is, a widened section of the canal, into which silt held in suspense will be deposited. Sand drift from the sea side can be kept down by planting convolvulus or sea wort, which has proved sufficient in other places.

3. In 1865 or 1866, I was told to take levels and sections of the Cooum from Amjikerry bridge or municipal limits to the bridge on the Avady road near Poonamallee. These levels should be recorded in the Superintending Engineer's office or Government office, as they were made at the request of Sir William Denison, the Governor at that time. The levels of the river in municipal limits are known. The drainage area is also known, so that its proper high flood section in the city is easily ascertained, and all unnecessary breadth should be filled in, as *the smaller the area tidal action has to spread over, the more effective will be its results.* All flat slopes to the sides of the river should be avoided, so as to leave as little as possible exposed surface of bank between high and low tides, to prevent any objectionable matter floating on the surface of river being deposited on the bank; all this should be drawn away into the sea.

4. The cost of this small but very necessary link in the canal systems of this Presidency will be about a lakh of rupees, which will include a screw pile iron lattice girder bridge, flood gates, &c. If it was necessary that the great railways of this country should be connected with the Madras Harbour, it was equally necessary that its extensive canal systems should be similarly connected. Old canal officers could not understand why this was not done. The last occasion I had to speak to one of these old officers (in March last) on this subject, he said that the utility of the canals was being suppressed to more readily push up the East Coast Railway project. I am, however, more inclined to think that it is due to want of proper representation from those who are now in charge of the canals. Any other route for this branch canal will be objectionable, as a deal of valuable land and property will have to be taken up, or more than one road crossed, which will make it very expensive.

5. Surface drainage will be in no way impeded by this canal. South of the Fort the drainage falls off towards the river. East of the Fort the area between the canal and Fort ditch will be so small that the rain water will be absorbed by the sand. From north angle of Fort to the harbour the natural line of drainage is again all westward. Sewer drainage will be dealt with separately in another paragraph.

ADVANTAGES OF CANAL.

II. The advantages of this canal will be—

1st.—That it will enable the flat bottom boats of the canal to enter on the still water of the harbour and unload direct into the ships.

2nd.—The Cooum will become a continuous tidal estuary. In 1876 to 1879, I had tidal registers kept at the entrances to the Coromandel and Kistapatam backwaters, about 25 and 90 miles north of Madras. Being so near to Madras, the difference in the tides there was

very similar to Madras. Those estuaries are larger than the Cooum, and yet the effects of the tidal action were felt in the most distant parts. The larger the connecting canal, the greater will be the rise and fall on the surface of the Cooum. The dimension of canal I have given will, however, I think meet all sanitary and trade requirements.

3*rd*.—The continual exchange of sea and river water will very soon make the Cooum water continuously like that of the sea, and the death and putrefaction of animal and vegetable life in it, which now follows every influx of fresh rain water, will be stopped.

4*th*.—The spoil taken from the canal can be used as a screen embankment* connecting the shore batteries. It can thus take the place of the casuarina topes without the sanitary objections which apply to the topes.

* Shown in sienna.

Objections.

III. The objections to this canal are—

1*st*.—That it will bring all the Cooum sewage into the harbour and defile it. If the river be examined, it will be found comparatively clean above Harris bridge. Below Harris bridge and up to the Penitentiary, all the sewage of thickly populated Chindarapettah is allowed to drain into it. This section of the Cooum is the principal cause of its pollution. Below the Penitentiary no sewage enters it. If the clean reach above Harris bridge is connected with the clean reach below the Penitentiary by a short clean cut as shown at D, the defilements of Chindarapettah will be avoided and the Cooum will no more be the main sewer it now is. This short new cut will also greatly reduce its area, which will be of much advantage in a tidal estuary. The land required for the new cut will be principally Government land in the Napier Park. Private property will be small native houses of not much value. Under any circumstances, the present system of drainage in Chindarapettah will have to be altered and improved. This new cut to the Cooum will always be an improvement to the river, as it will permanently remove it from the area of defilement.

2*nd*.—A large municipal sewer used to empty into the sea at the north-east angle of the Fort. Some few years ago a new drain was made on the foreshore parallel to the North Beach road,† into which the sewage from the old drain was pumped and conveyed to Ráyapuram. This new drain seems also to catch up the sewage from some other drains *en route*. It, however, was not made sufficiently large to carry away both sewage and flood water, but weirs were made in different parts of the new sewer through which storm-water was discharged on the foreshore. The result has been that during heavy rains, when other portions of the city are cleansed, a large quantity of vile black sewage, mixed with storm-water, is blurted out on the North Beach foreshore, defiling the best portion of Black Town. Without wishing to find fault, I may mention that this sewer was made on wrong principles, and without any reference to this canal project it should be altered. It is true that the London sewers discharge storm-water into the Thames. But they were not made on this principle—on the contrary they were made large enough to carry not only both sewage and storm-water, but a large margin was also left over to meet increase of population and area. These increases, however, came on so quickly that soon the capacity of the sewers was insufficient, and weirs had to be made in them to discharge storm-water into the Thames. The evils of this method have been acknowledged, and in some cases separate arrangements made for the storm-water. If a separate sewer or drain were made parallel to the present one to carry away the overflow storm-water, it will be a much needed improvement to thickly-populated Black Town. It is a work which is urgently required to prevent the defilement of the foreshore, and should be undertaken without any reference to this canal project. If this new drain were made, then separate arrangements will not be required to pass the storm-water from the sewers across the branch canal. If this new drain is not made, then a drainage channel will be required parallel to the new branch canal, collecting all the storm-water from the different overflows between the harbour and north-east angle of the Fort, and passing it under the canal at the lowest overflow.

The accompanying sketch plan shows the new canal and Cooum diversion in yellow. The screen bank between batteries in sienna and the objectionable foreshore drain in red.

† Shown in red.

Appendix No. 5.

From B. C. DUMPHY, Esq., to Colonel J. PENNYCUICK, R.E., Chief Engineer and Secretary to Government, Public Works Department, dated Madras, 29th October 1890.

With reference to propositions for purifying the Cooum, I beg to offer for your consideration an idea that has long ago occurred to me, and that is, to open a canal to connect Cochrane's basin with the sea. On the north of the harbour there is no more silt now than there was in 1885, while on the contrary land at Ráyapuram and Cassimode has been yearly encroached upon by the sea. Starting from this fact, I believe that a canal with a head sluice or lock of

suitable size and strength, built well to sea, with a sill 3 to 4 feet below L.W. mark, and of a sectional area equal to the Buckingham canal, will keep both the Buckingham canal and the Cooum clean by the rise and fall of the tides twice in twenty-four hours.

The alignment I would suggest for such a canal would be, from Cochrane's basin running north of and parallel with the road that runs from the basin bridge to Clive's battery as far as the Municipal pumping station and then north of the pumping station through the Harbour Works yard into the sea. Five roads will have to be crossed in its course, but the line is nearly all through over open ground.

I do not know what view you may take of my idea, but I believe it is the only way of keeping the Cooum clean all the year round. It is also possible that the canal may be found convenient for carrying away sewage from some of the high level drains in the town.

Appendix No. 6.

From A. CHATTERTON, Esq., to Colonel J. PENNYCUICK, R.E., Chief Engineer, Public Works Department, dated Madras, 1st November 1890.

I have the honor to forward the following proposals for the improvement of the river Cooum for submission to the Committee appointed by Government to report on the present insanitary condition of Madras.

During many months of the year the upland water flow is a practically negligible quantity, and any improvement in the condition of the river must be effected by the introduction of tidal water. The rise of the tide and the tidal capacity of the lower Cooum are so small that naturally the scour is insufficient to prevent the formation of a bar which effectually cuts the river off from the sea.

The proposals which I now submit are in part to remedy this state of affairs, and will have the effect of converting the Cooum into a semi-tidal basin. Briefly stated, the plan I would suggest is as follows. From the harbour to the river cut a channel to admit the sea water during the flow of the tide, close the northern and eastern branches round the island except in so far as it is necessary to leave a channel to direct the tidal waters into the Cooum to the west of the island and into the Buckingham canal to the north of the Cooum. At some convenient point on the channel from the harbour fix a regulating weir with movable shutters, so that the water from the river may be prevented from returning to the harbour during the ebb of the tide.

For the discharge of water during the ebb, it will be necessary to have an outlet direct into the sea. There are two sites available for this channel and each possesses distinct advantages of its own, but first I may state that I think it would be desirable to leave the existing mouth of the river undisturbed for the discharge of surplus water during periods of heavy rain though the new outlet would be of great value for the regulation of minor freshes and would add to the discharging capacity of the river in heavy floods. Further, it will be necessary to provide the outlet with movable shutters, which should only be opened from half ebb to full low water, so that the water in the Cooum basin above these levels may be discharged into the sea, whilst from low water to the next half ebb any water entering the river will be retained there.

Of the two sites the first is immediately to the north of the present mouth of the river and possesses the advantage that the water there discharged might be rendered useful in controlling the accretion which is taking place to the south of the harbour, and which, in course of time, may become troublesome. It may possibly be suggested that the scouring power of the water will be insufficient to maintain the opening far less to prevent undue accretion between it and the south arm of the harbour, but that such would be the case is, I think, very improbable judging from the mouth of the Adyar which is seldom closed before the end of February, at least two months after any appreciable quantity of fresh water has passed down the river. If this is the case with the Adyar, there should, I think, be little difficulty in keeping the outlet from the Cooum open when twice daily a considerable quantity of water will be passed through it, whilst there will be no inward flow which so greatly assists the sea in throwing up a bar before a river's mouth.

If, however, there should be a doubt as to the certainty of an opening being maintained to the south of the harbour, that uncertainty would disappear were the outlet placed to the north of the harbour where at present considerable erosion is taking place. Moreover, an outlet so placed would have the advantage of causing a frequent renewal of the water in that part of the Buckingham canal which passes through one of the most populous parts of the city.

The inflow channel from the harbour might easily be constructed of such a depth as to be capable of affording shelter to small craft during stormy weather and by the construction of a small lock, boats would be able to pass the shutters and proceed direct from the Buckingham canal into the harbour and *vice versâ*.

In thus briefly stating the outlines of the scheme upon which I think any works for the improvement of the Cooum should be constructed, I have avoided entering into details and estimates as these can afterwards be determined should the Committee consider the plan worthy of further investigation.

From Lieut.-Col. G. M. J. MOORE, President, Municipal Commission, Madras, to the Chief Secretary to Government, dated Madras, 23rd April 1891, G. No. 55.

I have the honour to forward an extract from the proceedings of a general meeting of the Commissioners held on 22nd April 1891, for such action as Government may deem fit.

ENCLOSURES.

REPORT of the Committee on the Sanitary Committee's Report, recently appointed by Government.

Proposed by Diwan Bahadur Ragoonath Row and seconded by Mr. J. A. Smith—

"That the report be adopted and submitted to Government for early orders."

Amendment by Mr. Gantz, seconded by Mr. DeCaster—

"That Government be respectfully requested to take immediate steps for the improvement of the condition of the Cooum, irrespective of the elaborate and costly scheme of the Sanitary Engineer, which must necessarily take much time to carry out. The Commissioners also respectfully urge upon Government the necessity for special legislation empowering the closing of that river and prohibiting fishing in it from March to July, or whenever necessary, in each year, as was suggested so far back as 1871 by G.O., No. 500, dated 18th April 1871."

The amendment, on being put to the vote, was lost.

The original proposition was before the meeting.

Amendment by Mr. DeCaster—

"That a recommendation be added to the report to the effect that the rubbish mixed with night-soil is an evil that requires immediate remedy and that the Commissioners be empowered to raise a loan to substitute a tramway service, for the cart service, for its removal to selected spots on the confines of the city for harmless deposit there."

The amendment falls through for want of a seconder.

The original proposition being put to the meeting was carried.

REPORT of Committee appointed by the Municipal Commissioners at their Meeting held on 3rd February 1891, to consider and report upon the Report of the Sanitary Committee recently appointed by Government.

Members:

Lt.-Col. G. M. J. Moore, *President.*
R. E. Ellis, Esq., *Vice-President, P.W.D.*
N. Subrahmanyam, Esq., Rao Sahib.
Diwan Bahadur R. Ragoonath Row Garu.
M.R.Ry. P. Theagaraya Chetty Garu, Rao Sahib.
" P. Rungiah Naidu Garu, Rao Sahib.
W. S. Gantz, Esq.

The Committee held three meetings and beg to submit as follows:—

Water-supply Scheme.—The Committee fully recognize the improvement in the Water-supply Scheme.

The main features are—

Using the new masonry tower which was built at Red Hills in 1886.
Constructing a settling tank at Red Hills.
Leading the water in a covered masonry conduit to Kilpauk.
Filtering the water at Kilpauk and storing in a covered reservoir.
Pumping and delivering to Madras from Kilpauk.

The scheme has many great advantages over the present water-supply.

The water will be drawn off from the Red Hills at a much more suitable position as the new tower is built in deep water, and the water thus obtained will be originally purer than at present.

Pumping at Red Hills will be less frequent, as the new channel is to be 6 feet lower than the present one, thus giving 100 days' more supply—a period which will, in all ordinary years, obviate pumping.

The supply allowed for, in this scheme, is double the present supply—a most important point—and all the water will be filtered at Kilpauk.

The question of its being waste of money to use filtered water for non-domestic purposes was raised—in this connection, the Committee would point out that the process of filteration is comparatively inexpensive—amounting to about 1 per cent. per annum on the cost of the scheme, and in addition to the advantage from a sanitary point of view, filtered water is not so likely to damage the main.

The question as to the form of the channel from Red Hills to Kilpauk is a difficult one, and is not only one of expense as it affects the rest of the scheme.

The proposed masonry channel is to be 5′ × 4′ and is to have a fall of 8″ to the mile, so that the level of the cill of the channel at Madras will be 21 feet above mean sea level.

If an iron pipe 4′ 6″ in diameter were used, it would require an inclination of 1′ 2″ a mile to deliver the same amount of water—starting at the same level as the masonry channel at Red Hills, the level of the cill of the pipe in Madras would be 17′ above sea level, or 4′ lower than the channel, entailing increased pumping which would cost about Rs, 4,000 per annum. The cost of such a pipe would be about 18 lakhs, such a large saving is an important advantage of the masonry conduit.

In para. 25 of the report it is recommended that a special officer be detailed for the work, but no mention is made of a Consulting Engineer's opinion.

However the work is carried out an Engineer and staff would be required for about 6 months to prepare the plans, and probably 2 years to carry out the work.

It is also recommended that the Commissioners should detail an officer to consider what improvement may be made in the present system of distribution.

This might be put in hand at once, but additional staff would be required.

A sum of Rs. 375 per mensem has already been sanctioned for preparing plans, &c., and this might be used for this purpose.

Until the scheme has been worked out more in detail, it is impossible to offer any suggestions or to criticise more fully.

With regard to 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.

Bearing in view that the improvement of the Cooum has for some time had the attention of Government, and that schemes are before it, it is not considered necessary to touch upon that subject further than to urge upon Government the great desirability of a practical solution of this great evil.

The Committee would strongly support the recommendations in para. 46 of the report as to the assistance by Government, the Commissioners not being in a position to meet the necessary expenditure, or to borrow money for the purpose.

With regard to the suggestions of Surgeon-Major King, the Committee consider it sufficient to say that they fully endorse, with one exception, viz., that wells built purely for agricultural purposes should not come under the provisions of section 265, the following remarks made by the Select Committee on the amendment of the Act:—

" . . . but we have also taken into consideration the numerous suggestions of Surgeon-Major King for the improvement of the sanitary condition of the city, and the Honorable Mr. (now Sir Richard) Barlow's original Bill which was drafted with a view of controlling the growth of parcherries. As a result of our deliberations, we have effected considerable alterations in certain sections, of which the first are sections 231 and 232. In regard to these sections, we agree with Surgeon-Major King that it is undesirable to restrict the President's power of closing sources of water-supply to cases where the use of the water for drinking can be proved, and the condition clause has therefore been omitted; but, on the other hand, we cannot approve of the proposal made by the Commissioners, and endorsed by Government, to withdraw from the President his power to enter, upon his own authority and without the sanction of the Divisional Commissioners, upon lands containing unsatisfactory sources of water-supply, as we consider that the effect of section 232 would be thereby considerably weakened. Concurring with Surgeon-Major King, we have extended the scope of section 265 to wells; it appears to us to be highly desirable that the construction of wells should be subject, as far as may be, to the same regulations as hold in the case of buildings, and we have therefore made it an offence to commence the construction or restoration of a well unless and until due notice has been given to the President.

* * * * *

" We have further, at the suggestion of Surgeon-Major King, brought manufactories of ice and ærated waters under the same regulations in regard to license as bake-houses (section 65 of the Bill). This completes the list of the more important amendments which we have effected in the sanitary sections of the Act. Surgeon-Major King has indeed suggested numerous other alterations, but we regard these either as more suitable for executive order, or as unnecessary or impracticable at present; we think, however, that the Commissioners might, with advantage to

the public, publish periodically an analysis of the pipe-water, although we are not prepared to accept Surgeon-Major King's suggestion and amend section 212 with the object of making this legally obligatory on the part of the Commissioners."

* * * * *

(Signed) G. M. J. MOORE, Lt.-Col.
(") N. SUBRAHMANYAM.
(") R. RAGOONATH ROW.
(") R. E. ELLIS.
(") P. THEAGARAYA CHETTY.
(") P. RUNGIAH NAIDU.

I do not think that any evil would arise from the provisions of section 265 applying to all wells.

MADRAS,
25th March 1891. (Signed) G. M. J. MOORE, Lt.-Col.

G.O., dated 11th March 1891, No. 349 M., Local and Municipal.

Read—again the following paper:—

G.O., dated 27th February 1890, Mis. No. 328 M., Local and Municipal.

Order—dated 27th February 1890, Mis. No. 328 M., Local and Municipal.

The Government desires that Mr. Jones will prepare and submit, with as little delay as possible, a detailed scheme for the improvement of the River Cooum with a view to preventing it in future from becoming a nuisance during the dry months of the year. Mr. Jones' previous proposals on the subject, which are printed in G.O., dated 2nd July 1877, No. 1811, are not sufficiently elaborated to be of value, and, moreover, appear to Government to be unsatisfactory in themselves.

(True Extract.)

(Signed) J. GROSE,
Ag. Chief Secretary.

To J. A. Jones, Esq.
" the President, Municipal Commission, Madras.

Read—also the following paper:—

From J. A. JONES, Esq., M.I.C.E., F.R.S.E., Sanitary Engineer to Government, to the Chief Secretary to Government, dated Fort St. George, 9th December 1890, No. 649.

I have the honor, in compliance with G.O., dated 27th February 1890, Mis. No. 328 M., Local and Municipal, to forward a scheme for the improvement of the River Cooum.

2. The papers sent herewith consist of—

(1) The report.
(2) Estimates.
(3) One large scale plan.
(4) One book of plans.

3. These very fully show the works which I consider are necessary to put the Cooum, between Munro's bridge and the sea, into the state it ought to be.

4. It will be found that there are alternative estimates for the work, viz.:—

	RS.
No. 1, amounting to	12,25,000
" 2 "	10,90,000

Both of these amounts, however, include Rs. 1,70,000 for plant—a railway line and a dredger—both of which will be useful for other purposes and may, after completion of work, be handed over to other departments.

5. The actual cost of the works proposed stands therefore—

	RS.
No. 1 estimate	10,55,000
" 2 "	9,20,000

6. The alternative estimates are based on two different designs for connecting the Cooum with the sea—No. 1 by the Cooum bar, No. 2 by a canal starting from St. Mary's bridge and passing round the west side of the Fort to the south arm of the harbour.

7. It has no doubt not escaped the notice of Government that statements have been made that, while Mr. Pogson's scheme (which, as far as is known, is still *in nubibus*, at least it is so far as I am concerned) for cleansing the Cooum is estimated to cost $1\frac{1}{2}$ lakhs, Mr. Jones' scheme is to cost no less than 10 lakhs.

8. I cannot claim for my scheme even half the advantages claimed for Mr. Pogson's; my scheme will cost more than a lakh and a half; it cannot be carried out in three months, nor will it allow of the drains being flushed with sea-water as they run up hill from the sea.

9. But, while I do not claim these advantages by its execution, I must point out to Government that the estimates which I send forward are for vastly more extensive works than the mere junction of the Cooum with the sea—*that* is a very necessary portion of any scheme, but it is at the same time a portion of the scheme the cost of which does not exceed one-sixth of the whole amount. The actual cost of opening the Cooum bar, or of forming a canal in connection with the harbour, amounts to about $1\frac{1}{2}$ lakhs, and while one can only surmise what Mr. Pogson's scheme is, I believe it must be of this nature. In any case there cannot be much difference of cost between one scheme and another in respect to the bare proposal for securing circulation in the Cooum.

10. While the estimates are to some extent approximate, they have been prepared in considerable detail, and the various items are not to a large extent dependent one on the other. Thus Government may propose to execute only the portion of the work up to Harris bridge, and even from this portion may omit, mean time, wharves, training walls, the extension of St. Andrew's bridge, &c., and merely execute the opening of the bar or formation of the canal, the dredging of the main and the filling of the north branch of the river. But while that is so, yet I would earnestly urge that the works in the lower portion of the scheme be sanctioned in their entirety if the scheme is sanctioned at all. The cost could be spread over three or more years, and even if the whole scheme is executed, the expenditure will not, I think, be out of proportion to the results which, I believe, will be attained.

11. Although I have advanced many arguments in my report to show that the north branch of the river ought to be filled up, there is a still stronger one, and that is, that there will be very great difficulty in disposing of the stuff excavated from the main branch, if that is not done, as the stuff would have in such case to be carried out to sea at a much greater cost.

12. In my report I have but lightly touched on the great advantages which would accrue to Madras by the closing of the north branch. An examination of the plans will show that, taking advantage of the extra ground added to the river, I have suggested a new race-course; this particular item naturally does not fall within purview of the scheme, but the improvement of the island does so, and I venture therefore to throw out the suggestion as to the race-course, because I believe that the Race Committee, in view of this improvement, might be inclined to move all their

meetings to Madras, and might be able to make a handsome contribution to the scheme as they could then get rid of Guindy. This question affects to some extent the proposal for raising the level of the island (as an island to be abolished), and hence my allusion to the subject.

13. The report, though comparatively short, is one which has for its preparation required considerable investigation on many points; but it does not, I fear, of itself justify the time taken in its preparation. It has had to be prepared at a time when many other pressing works had to be kept up to date, and the small staff at my command has been unable to get out the plans and estimates at an earlier date than that at which it is now presented.

14. I send the report forward with some diffidence, for I am aware that some of the measures proposed may lead to considerable discussion; and seeing the importance of the subject and that the amount of money involved is large, I would desire that Government will, before sanctioning or disapproving the scheme, consider the advisability of associating with me (I presume to suggest) the Chief Engineer and Captain Street, R.N.R., for a consideration of any point which to Government may seem to demand further investigation.

15. Except perhaps an improved water-supply—for drainage is very closely associated with the improvement of the Cooum—there is probably no other work which can be undertaken in the City of Madras which will, in a higher degree, tend to ensure not only better health but also greater comfort and enjoyment to its people. The river, a large portion of which is adjacent to one of the largest air spaces—Madras' most important play-ground, constantly reminds us in no uncertain tone of its filthy condition. It tells indeed that—

"The sewage that should feed the land
"Makes poison for the town;
"The stream, a sewer for the strand,
"To drink its ordure down,"

That is what the river has been called upon to do for years past. Improved drainage will prevent its being called upon to do that work in future, and the works I have in this report recommended will, when carried out, wash away, I trust, all remembrance of the treatment the river has received during the greater part of a century.

16. The reproach lately cast at the river by a writer in the *Madras Mail*, viz.:—

"Ignoring all that science proves
"Or sanitation teaches,"

will, I hope, be not much longer applicable, and the river, I trust, will soon be able to possess in truth, and not in ridicule, as at present, that name to which it, though many years ago, must have been rightly entitled, viz., "The Silvery Cooum."

17. As the scheme is one of perhaps more than local interest owing to some of the professional details, I trust the report may be printed and the plans lithographed.

—

ENCLOSURE.

The River Cooum.

SCHEME for its improvement within the limits of the City of Madras.

The River Cooum takes its rise some 29 miles to the west of Madras. At the Coratoor anicut, which is about 9 miles from the sea, the river has attained a length of 20 miles, and it receives in that length the drainage of 200 square miles of country. The maximum observed discharge at the Coratoor anicut amounts to 10,614 cubic feet per second. The length of the river from the Coratoor anicut to the sea is about 9 miles and the drainage area below the anicut does not exceed 15 square miles. The area drained within the City of Madras amounts to 8 square miles, so that on the river entering the municipal limits it has a drainage area of 207 square miles. The course of the river within the municipal limits is extremely tortuous. Its course with windings extends to 6·3 miles, while the distance in a straight line from the place where it crosses the municipal limits to its mouth is only 3·9 miles. At about one mile from its mouth it

is connected by a narrow cut with the Buckingham canal which occupies the valley of what used to be known as the North river, which river skirted the south of Fort St. George and joined the Cooum river near its mouth. In the plans to be found in "Orme," the cut, already spoken of, appears to have been different in position from that it now occupies, but there has always been a connection somewhere near this point, and that portion of the north river which skirts Fort St. George is now designated as a portion of the River Cooum. The Buckingham canal is in free connection with both branches of the Cooum, and during floods sends a considerable body of water down the Cooum. There is a lock on the canal at Shadayankuppam, 7 miles from Madras. Its purpose is said to be to keep the water high in the canal when the Kortalayár bar is open to the sea. It also limits the area of the flood discharges which affect the Cooum.

2. It has been proposed—*vide* paragraph 61 of report on Buckingham canal (G.O., dated 14th March 1883, No. 841 W.), to divert the drainage flow south of Shadayankuppam lock by a drainage channel and drain into the canal north of the lock. This can, I think, refer only to that portion of the canal between Cotton's canal and the lock mentioned, because on the other portion of the canal between Cotton's canal and the Cooum such an arrangement does not seem feasible. I am doubtful, however, if any portion of the arrangement has been carried out, and for the purposes of this report, I have considered the whole of the drainage south of Shadayankuppam lock as still entering the canal and finding an exit to the sea *via* the Cooum. The additional drainage area which has to be included on this account is that of about 8 square miles.

3. It may be taken therefore that on entering municipal limits, the Cooum drains 207 square miles and that at Law's bridge, just above its junction with the canal, it drains 207+8 square miles and below this point 215+8 square miles. These figures are not strictly accurate, as 215 square miles is the area drained to the mouth, less that brought in by the Buckingham canal, while Law's bridge is one mile from the mouth; again it has not been shown that all the drainage from the canal will enter by the cut near the Penitentiary and does not pass down by the north branch of the Cooum to join it just above its mouth at Napier bridge; the figures, however, given above are in excess and may, for the purpose of this report, be accepted.

4. Until I again refer specially to the north branch of the Cooum, my observations in the following paragraphs must be considered to relate to the main branch alone.

5. As before stated, the Cooum within the municipal limits is of an exceedingly tortuous character.

6. This circumstance causes the formation of large banks which are formed of course on the convex side, while the concave side is scoured out to considerable depths. The formation of these banks and consequent scours above the bridges necessarily endanger these structures, and on the concave side of the river just below the bridges, the bed has been scoured to great depths—*vide* Cooum sections Nos. 3 to 3-B.

The river, though partly a tidal stream for a part of the year, and during that time filled with sea water, is for the greater portion a mere lagoon filled with a mixture of fresh and sea water with no outlet, but liable to sudden variation on each occasion of rainfall.

7. The Cooum is in connection with the sea usually only for portions of the months of October to January. The following table shows the date of cutting and closing the Cooum bar during the last ten years:—

Year.	Month and date.	Particulars.	Number of days open.	Remarks.
1880	November 4	Opened	59	
	January 1	Closed		
1881 ..	November 12	Opened	40	
	December 21	Closed		
1882	November 16	Opened	62	
	January 16	Closed		
1883 ..	October 16	Opened	99	
	January 22	Closed		
1884 ..	October 19	Opened	95	
	January 21	Closed		
1885 ..	November 16	Opened	31	Closed of itself.
	December 16	Closed		
1886 ..	November 9	Opened	30	
	December 8	Closed		
1887	October 28	Opened	86	
1888 ..	January 21	Closed		
	October 30	Opened	82	
	January 19	Closed		
	October 15	Opened	15	
1889 ..	Do. 19	Closed		
	December 18	Opened		
	Do. 27	Closed		

The river has also usually during this period indirect connection with the sea *via* the Junction canal, the Adyar, the Buckingham canal and the Kortalayár bar, and during the hot season sometimes at high spring tides with the Adyar bar open that river may rise from ·50 to ·70 above mean sea level. When the Junction canal and the Cooum is lower than the Adyar, the gates of the lock which is placed at the junction of the Adyar and Junction canal are opened and a flow down the Junction canal to the Cooum takes place. The result, however, to the level of the Cooum is insignificant, as the water has to spread a considerable distance up the main branch of the Cooum itself, up the north branch and up the Buckingham canal for 7 miles. Similarly with the Ennore bar open and the Cooum and canal lower than the water to the north side of the Shadayankuppam lock with the lock open a similar action takes place. Looking to the infrequency of these supplies to the Cooum and the very slight result when the supplies do take place we may consider the Cooum for nine months of the year to be a mere tank or backwater without motion through it of any sort.

8. Throughout the summer months, though it seldom receives direct supplies of flood or sea-water, it is unfortunately continually receiving large supplies of polluted water; and the City of Madras, I calculate, passes into the Cooum (excepting the canal) through 21 sewers on the right bank and 13 sewers on the left bank—no less than 1,000,000 gallons of sewage daily. The Cooum is not, however, during the months its bar and the bars of the Adyar and the Kortalayar at Ennore are closed totally unaffected by the sea, for I have observed a very distinct rise and fall in the Cooum during the hot season; this I believe is caused by the sea-water finding its way inland through the substratum at high tides, and this water, when the tide falls, escapes into the Cooum from the adjacent surrounding land instead of returning to the sea.

9. The constant delivery of sewage into the river naturally renders it the breeding ground for all kinds of organisms, and the want of circulation in its waters and the consequent small exposure of the organisms to the air are circumstances eminently favorable to their production. As soon, however, as any very slight circulation takes place, such as may be caused by a shower of rain, the organisms are at once exposed in large numbers to the atmosphere and their oxygenation and consequent destruction which the late Dr. McNally described as "of the nature of fermentation and analogous to the conversion of sugar into alcohol by the action of microphytes in the presence of oxygen," results in the production of offensive and poisonous substances of the nature of ammonia. When such results are produced, the inconvenience and nuisance to those who live in, or may come to the vicinity of, the Cooum is very great. Several of the most prominent of the Madras buildings, such as the "Senate House," "Government House," the Penitentiary, the "General Hospital," the "Women and Children's Hospital" and a large number of buildings on the Mount road are adjacent to the Cooum; it is evident, therefore, that the existing state of matters is a question of no small importance.

10. The state of the Cooum has for many years been a source of constant complaint, and during these years as many suggestions have been made for its remedy.

11. In the year 1882, owing to the Cooum being in the state which has been previously described, the then Senior Medical officer of the General Hospital proposed the admission of sea-water at high tides. Dr. Cornish, who was then Surgeon-General, in his order on that suggestion said: "The remedy suggested was tried on one occasion within the Surgeon-General's recollection, but instead of abating the nuisance only increased it. On this occasion (1870) the sea-water was let in at a time when the sea was full of a species of oscillatoria producing the phenomenon of phosphorescence. These minute creatures died by myriads under the changed conditions of their existence, and produced so fearful a stench that many persons having to pass near the river on any portion of its tidal length were attacked by sickness. Fortunately, heavy rain fell early in June of that year sufficient to force open the bar and remove the offensive matter."

12. It will have been noticed that the cause for the ordinary recurring offensive smells described by Dr. McNally and on the special occasion noticed by Dr. Cornish is the want of circulation in the river. In the ordinary case the animalculæ breed undisturbed until some rainfall or other cause brings them into contact with the atmosphere and oxygenation occurs; in the special case the oxillatoria were unable to live because their condition of life was changed by their being thrown into water comparatively fresh. There is therefore but one remedy and one alone which can prevent this recurring nuisance, and that remedy is circulation; if the water in the river is in constant circulation, the animalculæ if they die will die in average numbers throughout the year unnoticed and at the same time their productiveness will be exceedingly decreased and the nuisance will in fact disappear. The cause of the increased nuisance in the case referred by Dr. Cornish was not the letting in the sea-water alone, but the want of more water and a constant influx of sea-water so that the conditions of life in the Cooum and the sea would not have been very materially different; the remedy therefore recommended is the constant admission of sea-water to the Cooum and a corresponding daily rise and fall of the tide. How I propose to effect this I reserve until I come to discuss the engineering details of my scheme.

To change the water in the Cooum daily is the object to be effected and it is necessary to attain this as quickly as possible and to limit the flow to as small an area as possible. For this purpose it will be necessary to place a lock across the Buckingham canal near St. Mary's bridge and a

weir must also be placed somewhere in the river, because it is impracticable to keep the whole river within municipal limits as a tidal river; the upper portion of the river therefore must be treated in a different method from the lower. In the upper I propose to retain the water in tanks gradually ascending one above the other, the lower portion will be continually tidal.

13. The point where the dividing line should be has been of course a matter for much consideration, and my reason for fixing the site for the dividing line a short distance above Harris bridge, where a weir will be constructed, is that the ordinary tides when freely admitted will flow up to this point, and this weir will be above any of the points of entrance of sewage drains into the river.

14. In para. No. 8 I have already stated that 21 drains enter on the right bank and 13 on the left bank of the river. All these drains enter the river below the site I propose for the permanent weir.

15. That these drains are the most predominant cause of the production of organisms and animalculæ of all sorts need hardly be stated, and until these drains are wholly diverted from the river, the river will never be in the condition it ought to be. These drains in floods bring down large quantities of silt into the river; at other times they bring down sewage much of which is deposited at or near their mouths. It will be many years before the municipality are able to divert all the sewage from the river, but as the villages of Triplicane and Chintadrepet are most flagrant in respect to their steady discharge of sewage into the river, it seems to me that these villages might well first, before any other parts of the city, receive attention at municipal hands; pending such measures, it is my duty to suggest certain arrangements which will, without diverting the drainage from the river, tend to filter it before entering the river and also allow of the removal by the municipality from time to time of the solid sludge which I propose to arrest. These measures I shall refer to later on in this report.

16. When the measures I have suggested are carried out, they will prevent the pollution of the river in the future, but the deposits of many past years and the consequent present state of the river have yet to be dealt with.

17. To a certain extent no doubt the river gets cleared by annual floods; but it is just as certain that large deposits in the river never get cleared at all and also that a large amount of silt deposit is merely annually moved from its original site and re-deposited on the convex curves of the river, where large banks are formed which go on increasing, thus narrowing the river and causing an increased scour and encroachment in the concave banks at the bends and also cause the flooding of the lands adjacent to its banks.

18. Further radical improvements necessary therefore are these:—

(1) The removal of the banks referred to.
(2) The restoration of the banks where eroded.
(3) Deepening and re-sectioning of the river.
(4) The proper training of the river so that at ordinary seasons it will be confined to the centre of its bed and during floods will cease to deposit the silt it carries down on the convex side and scour away the concave side, and for this purpose the erection of groynes, &c., is necessary.
(5) The formation at certain places of wharves which would, to some extent, serve as groynes or training walls and afford facilities for the landing of goods at present effected in the muddy foreshore.
(6) The restoration, improvement and re-sectioning and turfing of existing banks and their future protection.

19. The acceptance of proposal No. (3) will allow of cargo boats proceeding up the river much further than at present and of No. (5) will ensure an income to Government probably in excess of the expenditure on the construction of wharves which would, I believe, be productive works. An instance in the point is the wharf erected by the municipality at Trevelyan basin, Black Town, where the cost of the wharf was covered by the profits from two or three years' income.

20. These recommendations do not, at first glance, seem to demand any great expenditure, but it will be seen, when engineering details are discussed, that they absorb a large proportion of the total amount of the estimate.

21. The Cooum when in floods at times rises higher at certain points than its banks; this, as regards that part of Madras called Lang's Garden, in the village of Chintadrepet, and on the left bank of the Cooum, is due to the very small waterway afforded by St. Andrew's bridge; a reference to paragraph No. 71, where the waterways of the various bridges are compared, will at one show how limited the waterway is at that bridge.

22. Below St. Andrew's bridge and still on the left, the bank, the roadways, &c., are also flooded; the floods affect the site of the Women and Children's Hospital; this, it is believed, will shortly be removed, but the roadway along the river between St. Andrew's bridge and Law's bridge is very often submerged much to the inconvenience of, and danger to, the public and on this account and for the proper training of the river the road ought to be raised.

23. Above the point where I propose to place the weir the river assumes a different aspect to that which it has in the lower reaches. It is very broad with a sandy bottom, and practically no sewage enters it. It is extremely shallow, and in the hot season is, in fact, a series of shallow pools. Its appearance is decidedly ugly; its banks are very ragged, and large expanses of sand encourage the growth of noxious vegetation and the commission of nuisance. Dhobies wash in these pools containing only small bodies of water, and as they are seldom replenished, the state of water in which the clothes are washed is not uncertain. The iron weir sluices which have been erected at the Commander-in-Chief's and Andrew's bridges are much too low to dam up the water for any distance back so as to completely cover the bed, and it has been remarked that these sluices probably let out more water than they retain. However that may be the principle on which their erection was based, viz., the retention of bodies of water so as to keep the bed of the river covered throughout the hot season is a good one and it is the principle I still propose to adopt, but as to the means of attaining that end my proposals will be slightly different. A greater depth of water is necessary to be of any use, and the manner in which I propose to secure their object will be found among engineering details.

24. When the river has been dealt with according to my scheme it will be found that—

(1) There will be a gradually increasing depth below the proposed Harris bridge weir with a constant circulation of the waters and the river will become a tidal one.

(2) The river will be trained and flow in the centre of its bed whether in flood or otherwise.

(3) The banks will be improved and will have proper slopes, and the present exposure of silted sewage banks will disappear.

(4) The river will be navigable to traffic from its mouth to Harris bridge and greater facilities will be placed at the disposal of the public for the import of firewood and other commodities.

(5) The periodical smells which arise from the river will, I believe, disappear.

(6) The upper reaches will be a series of lakes suitable for boating, and bathing might be allowed at certain places. The washing of cattle should, however, be prohibited.

25. I have now to consider what steps should be taken in regard to the north arm of the Cooum.

The points for consideration are these—

(1) What is the necessity for this branch of the Cooum at all?

(2) If there is no necessity, is there any advantage?

(3) Whether there would be greater advantages where this branch closed?

(4) If the branch cannot be closed, can any steps be taken to improve it?

26. What is the necessity? It serves at present to discharge or to partially discharge the flood waters brought down by the Buckingham canal. In para. 3 I stated that the figures I gave were not strictly accurate, because I based them on the supposition that all the drainage of the canal passed down the main branch of the Cooum. If the drainage can so pass, then one necessity for the north arm or branch of the Cooum disappears. While this may be so, there are circumstances which may call for the retention of the north branch, viz., that it may receive the storm drainage from certain portions of Madras. It in fact at present does do so for the "Scoop-drain" which drains the esplanades and which is also a storm overflow for part of the Black Town drainage scheme, discharges into the Cooum (north branch) between the Wallajah bridge and the Medical College. This branch of the Cooum also during floods brings down a supply to the Fort ditches.

27. As to the Scoop-drain, if the north arm of the Cooum were filled up the drain can be carried to the other branch at St. Mary's bridge, but I have no plan to suggest for the filling* the Fort ditches with water unless from the sea if the north arm ceases to fill them; perhaps as a sanitary measure it might be suggested that they would be better filled up altogether with earth. Whether military exigencies will allow of that I cannot determine; this, however, is a small matter, and I think it may be taken for granted that no necessity exists for the north arm if the main branch of the Cooum is sufficient to carry off all flood waters, and that is so because—

* They can be filled from the proposed canal if scheme No. (2) is adopted.

(1) Both branches discharge through the Napier bridge.

(2) Because the proposed improved section at Government House bridge will allow of a similar discharge.

(3) Because the improved sectional area of the river above Government bridges will be also sufficient.

28. What then is the advantage of the north branch? The only advantage that I can see is that it affords a course for boating, but if it be done away with, the improvement of the main branch will compensate for the loss of the north. It will perhaps be necessary to supply a small open channel to carry off to the sea the drainage from the slope of the south glacis and a portion of the island and this is provided for in the estimate.

29. What would be the advantages if the north arm were filled up? They are, namely:—

(1) There would be a more direct connection between Black Town and Mount road.

(2) A much-wanted communication from Body-guard road would be afforded.

(3) A large piece of land would be added to the island, making it much more valuable for military purposes and for public amusements.

(4) A much-wanted addition to the grounds of the General Hospital and College would be obtained, though by the present position of the South Indian Railway the access would require to be across that line.

(5) The summer odours, now thrown out by this branch of the Cooum, which in proportion to its length has a considerable area, would cease to pollute the air to the inconvenience of the Fort, the Medical College, the General Hospital and the general public.

(6) The flow of the tide up the main branch of the Cooum would be at a much greater speed and the circulation obtained much greater. This object might also be effected by a weir where the north and main branches of the Cooum join.

30. The filling of the branch would be effected by depositing, by means of a light railway, the excavated earth from the northern branch; to cover this, sufficient soil could be dug from the banks before filling up the river.

31. If the closing of the branch is objected to, this branch can, of course, be dealt by measures similar to those proposed for the main branch, but I strongly advocate its complete closure. The full benefits to be attained by the adoption of that measure will be more readily appreciated by a study of the plan of the present island with the branch closed.

32. The Buckingham canal extends from the north branch of the Cooum for a distance of 7 miles before the Shadayankuppam lock is reached. If the tide is to be allowed to flow up the canal, the Cooum will never obtain the full effects of the tide, and as this, I venture to think, is a necessity, as I have already indicated, I am strongly of opinion that lock gates ought to be erected near St. Mary's bridge. A design has been prepared for the site at St. Mary's bridge, which bridge requires renewal and widening. The design effects both these objects.

33. This is not the first proposal to place a lock near the Central station. His Grace the Duke of Buckingham, when Governor of Madras, had a temporary bund erected at the Central station. The main objection to this lock, which would be most useful as regards the Cooum and probably also in keeping the canal at a high level during a part of the year, is that the canal for half a mile above this point is much polluted with sewage. No doubt a large number of drains flow into the canal, but these shortly will be diverted from it, and as there is practically at present (except in flood times during which time the gates would be open) no circulation, it does not appear that the erection of a lock at the point indicated will, from a sanitary point of view, tend to aggravate the present condition of the canal.

34. For reasons similar to those already stated, a lock should also be placed at the north end of the Junction canal. The lock at the Adyar is no doubt a double lock and, while flood-waters of the Adyar can be sent to the Cooum, at the same time the Cooum can be prevented from flowing to the Adyar; but the question is how best to obtain the full benefit of the tide in the Cooum, and there can be no doubt that in proportion to the less area to be filled, will depend our success in keeping up more or less perfect circulation by the in and out flow of the tide.

35. With these remarks I may conclude what I may call the preliminary portion of my report, which embodies generally my proposals; the latter portion details with the engineering features of the scheme and details regarding the manner in which it is proposed to carry out the work.

Engineering Details, &c.

36. This report has been prefaced by a small scale plan of the Cooum within Municipal limits.

37. It is accompanied by—

Particulars.	Number of sheets.
1. Large scale-plan showing the river at present and as proposed ..	1
2. Longitudinal section of river showing present and proposed levels of bed, &c.	1
3. Cross sections of the river showing the proposed new sections of the river	7
4. Plan and sections of the proposed arrangement at the mouth of river	1
5. Sketch-plan and elevation of the lifting bridge at the Napier's bridge	1
6. Plan and sections of the weir at Harris bridge and cross section of wharf wall	1
	12

Particulars.	Number of sheets.
7. Plan and sections of lock gates at and improvement at St. Mary's bridge	1
8. Plan showing the extension of St. Andrew's bridge	1
9. Plan of the place now called island as proposed to be improved ..	1
10. Sections across the island showing relative levels, high and low water mark, and the flood level as proposed	

38. The first question to be considered is the method of opening and keeping open the Cooum bar and this is a question which must be considered at some length.

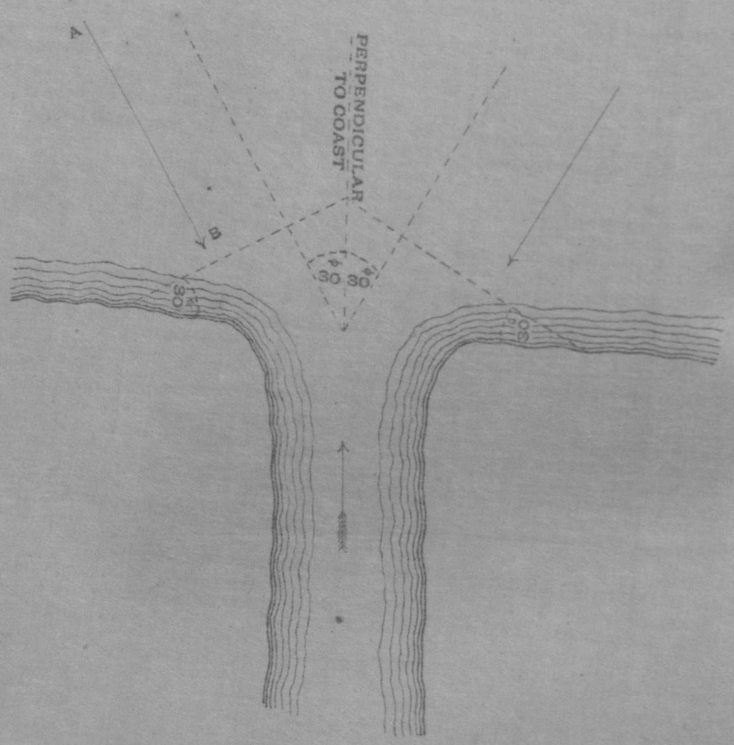
39. The experience gained in the construction of the Madras Harbour has shown that, as a rule, a groyne projecting from the coast will have the effect of accumulating sand to the south of it, while causing a scour to the north of it, because we may consider that the two groynes of the harbour as one groyne of great breadth.

40. Undoubtedly a groyne at the mouth of the Cooum would have had a similar effect before the construction of the harbour; the first question to be considered is, will it have it now? tively due.

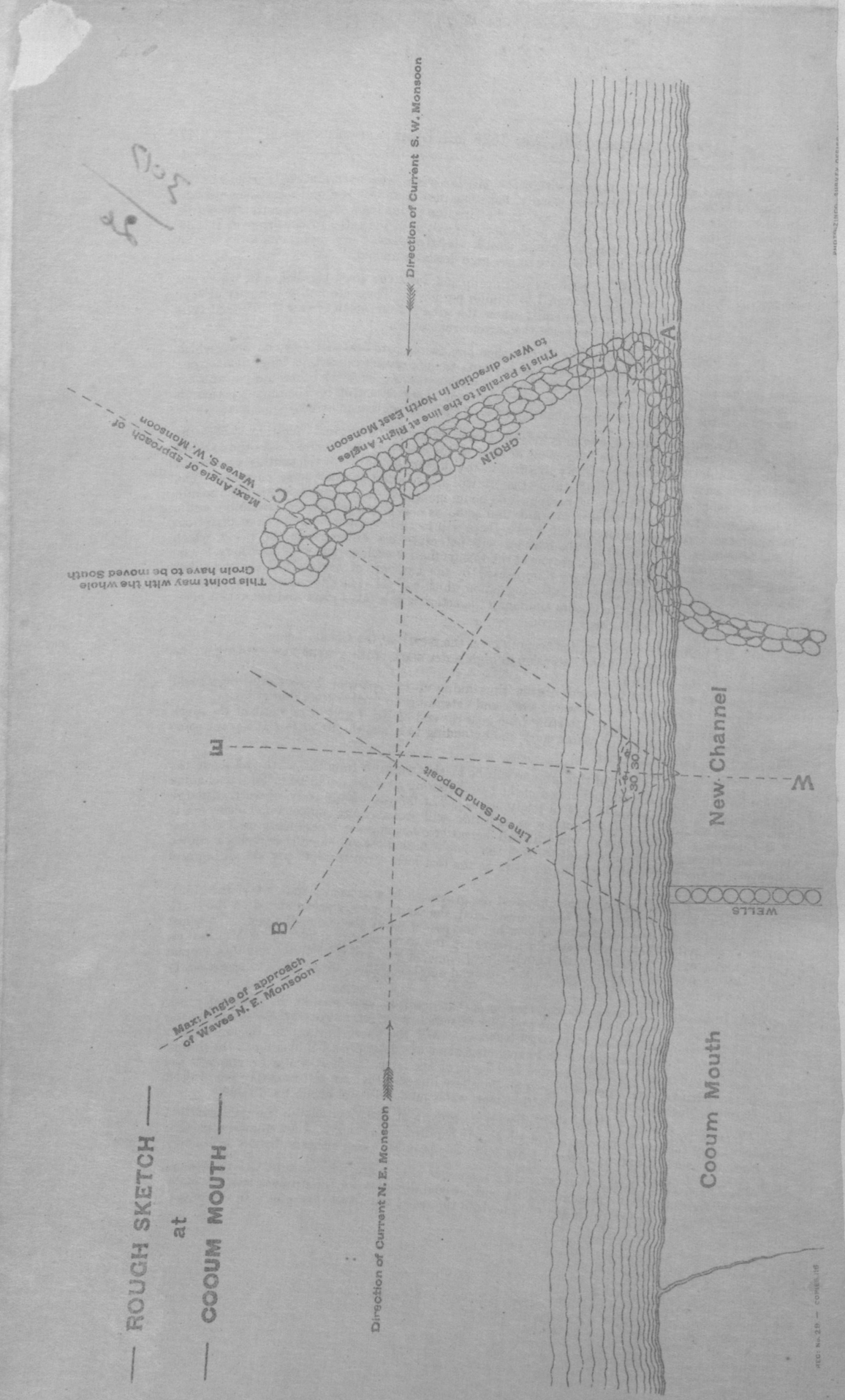
41. We have first to consider to what, at the accumulation of sand and scour, are respec-

42. In evidence (55—p. 4) before the committee appointed to inquire into the question of the position of the entrance to the Madras Harbour, the late Mr. Parkes said, in reply to a question as to the general direction of the sea: "It seems to be quite independent of the wind so far as I can see" and (56—p. 4) "It varies a little to the north of a line perpendicular to the coast and a little south of that line;" but if paragraph 104 (p. 6) is referred to, we find the Chairman, with reference to a letter by Captain Taylor, saying: "This all rather seems to me to point to the sea accompanying the wind and not to the independent swell that is always setting on the entrance." Mr. Parkes: "There is no doubt that the seas do come from the south of east during the south-west monsoons and from north of east during the north-east monsoon" and in paragraph 108 (p. 6) we have the Chairman saying: "In no case," he says here, "is it believed that the angle exceeds 30° to the general line of the coast.?"

43. This is an important point The Cooum, when its mouth is open and when discharging into the sea with any great velocity, discharges at right-angles, or almost at right-angles, to the coast, and in the following sketch is shown the maximum limits of the direction of the sea and accordingly the line of the waves breaking on the coast



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44. Now the bar of the Cooum within the last ten years was open during portions of the months of November and December usually, but sometimes from October and sometimes as late as 21st of January. During these periods the direction of the sea and, accordingly, the waves breaking on the coast, has been that from the north of east or as indicated by the arrow A B, and it has been observed that, before the bar is closed, the river flows more and more away to the south side of the channel which the river in the high floods scours out.

45. There is also a series of currents passing up and down the coast parallel to it, which are calculated to run at a velocity of from 1 to 3 miles per hour. These are not necessarily always in the direction of the wind, but generally when the wind is from north of east the current runs south and when the wind is south of east the current runs north.

46. We have at the mouth of the Cooum, therefore, two facts to deal with—the currents which convey the sand up and down the coast which, owing to their reversed direction, lodge at one time sand on one side of any projection from the coast while removing it on the other, and, at another time, reversing the operation. The southerly current, however, acting for the longer period, is the cause of the deposit of a larger quantity of sand than the northern current.

47. Having seen how the sand is lodged, I now return to the original questions—Will the harbour have any effect on the lodgement of sand at the mouth of the Cooum? As the harbour is north of the Cooum it is not likely to affect in any degree the action of the southerly currents, and, from what follows, I do not think that it will much affect the northerly currents. The outermost point of the harbour bears from the Cooum mouth 33° east of north, so that the mouth is unprotected from the north-eastern winds and as 33° is only 3° more than the maximum angle at which the waves may approach the shore, there will be little or no change in their direction. I am of opinion, therefore, that the harbour will not cause any difference in the result which would occur from the placing of a groyne at the Cooum than if such groyne were elsewhere. The small increase to the general shore line, caused by the harbour, of course, will continue, but harbour groynes will not prevent the scouring action which will take place to the north of a groyne erected near the mouth of the Cooum similar to the action which takes place and has taken place to the north of the north harbour groyne.

48. My proposals, therefore, for keeping open the mouth of the Cooum are—

(1) The improvement and extension to high water mark of the groyne now existing on the south bank at the Cooum mouth.

(2) A groyne 100 feet north of this (thus taking up two spans of the existing bridge) and widening out to 200 feet at high water mark and extending no further than that point.

(3) A breakwater groyne starting from near the end of No. 1 groyne on south of the south bank of the Cooum from high water mark and extending to a length of 650 feet at a point some 530 feet from high water mark.

49. The general result of this groyne will be to shut off sand from the south and scour the Cooum mouth and the combined action of the two diverging groynes would be to form a channel through which the sea would have a ready access. The flow of a large body of water through this channel and its subsequent outflow at each tide will probably keep the channel clear, but if it did not do so the dredger to which I shall hereafter refer, may be occasionally used for that purpose. Diverging groynes, so as to give the river a funnel-shaped mouth, have been shown lately at the Institution of Civil Engineers to be the best form of entrance to prevent silting and the formation of a bar.

50. Coming back again to the proposed sea groyne, it is well known that, when the south groyne of the harbour works was being constructed, the sand not only accumulated on the south of the south pier in the south-west monsoon but also passed round the end of the pier. To arrest the sand altogether, and to prevent its passing up the coast would, according to Mr. Parkes, require a groyne 700 feet long with 33,000 tons of stone, at a cost of Rs. 66,000, and that groyne would only arrest the accumulation of one year and another groyne would have to be similarly added the following year.

51. It is evident from these facts, therefore, that it will be well to make the proposed south groyne as short as we conveniently can and only of sufficient length to give sufficient scour to the north of it and afford sufficient passage between it and the shore line at the Cooum mouth. What that length will finally be actual experience alone can determine, but looking to the design proposed hereafter and to the intended bed level of the river, the breakwater groyne will not require to extend more than 530 feet from the shore line and the cost will probably not exceed Rs. 69,000. The other two groynes within high water mark will cost about Rs. 70,000.

52. The proper direction of the outer or sea groyne at the river mouth is a question that involves many considerations and is one which has required some study. I am unaware whether the question which I shall now consider has up to this been answered either in theory or practice.

53. The harbour works, as is well known, consists of two groynes (consider the two as one groyne) at right-angles to the shore. That position and direction for the groynes was, of course, fixed from considerations which do not come into the case I am about to argue. In the present

case the real question is—What direction should the breakwater groyne take with reference to the shore line? Now it is well known that a groyne at right-angles to the shore, arrests the sand on one side and scours it away in the other, the action being reversed from time to time according to the season of the year. We may, however, leave the north-east monsoon out of the question and consider it in relation only to the south-west monsoon. Then the current is from the south and the waves strike the shore from the south-east more or less. Will a groyne at right-angles to the shore give the greatest scour to the north of it? The greatest scour can only be achieved if there is no lodgement of sand to the north of the groyne. Now the sand which would be lodged to the north of the groyne must come from the south and it would be sand washed round the end of the groyne.

54. The groyne then ought to be in such a position and have such a direction that the sand from the south will be arrested as slightly as possible and in such a position that the current carrying the sand will be diverted from the shore as much as possible and be also in a direction which would secure the mouth of the river from sand which has passed north of the groyne being carried towards it by the waves. Now these objects, during the south-west monsoon, would be secured to the greatest extent by placing the groyne at angle not less than the angle at which the line of the waves meet the shore during the south-west monsoon or in sketch accompanying the line A B.

55. There are, however, objections to the groyne in that position: firstly, it would have to be a long groyne; secondly, during the north-east monsoon its position is likely to cause a larger deposit of sand than if the groyne were inclined at a less angle to the shore. The north-east monsoon, it must, however, be remembered, is not so important a consideration as that of the south-west, because during a long period of the former, the river is ordinarily in flood and keeps its mouth open by its own action.

56. Taking all these considerations into account, I believe that the best position for the groyne is that shown as A C. The line of it is such that the southerly current will be diverted without being arrested or causing the sand to deposit at the back of groyne to the same extent as it would do if the groyne were at right-angles to the course of the current. The scour inside the groyne, owing to the greater area of slack water which will exist, will probably be greater. The position of the end of the groyne has been fixed with reference to the new level of the Cooum bed, the depth at the end being slightly greater than the depth at the mouth of the Cooum. The point is also fixed with regard to the necessity for ensuring that a scour will take place at the mouth and not only north as might be the case were the end of the groyne too far north, for, as is known, the scour at the north arm of the harbour works has not so much affected the line of shore close into the breakwater.

57. The funnel mouth of the groyne in shore will produce the greatest possible scouring effect through the channel and keep the channel clear, the bottom of it being laid with boulders. The effect of the outgoing tide can, if necessary, be improved by the use of scouring shutters which would be shut at high, and opened only at low, tide and the aid of the dredger still to be referred to can also be called in when necessary. I am therefore of opinion that the bar can be kept open and, such being so, circulation in the lower reaches of the Cooum will be secured.

58. The two in-shore groynes, as I have already stated, will be 100 feet apart at the Napier bridge and widen out to 200 feet at the sea margin. The south groyne may be formed by large boulders cemented with cement concrete but the north groyne must be of different construction. When the mouth of the river, except the narrow entrance to be maintained, is shut, that is, except when the river is in high flood, the north groyne must form a retaining wall to keep back the sand. When the river is in flood and the full breadth of the mouth is required for the discharge, that groyne will be in the centre of the flood waterway and must be such as not to take up more or little more than the breadth of the bridge piers, and, for this reason, I propose to form it of cement concrete cylinders sunk well down below a depth affected by scour. Between these two groynes at ordinary times the tide would run in at the rate of about two feet per second, calculated thus:—Under the new condition of the river yet to be described the area to be affected by the tide will be about 4¼ millions square feet. This would be filled in six hours, and, taking the average rise of the tide as 3 feet, and the sectional area of the channel as $100 \times 3 = 300$ feet, the rate of flow would average—

$$\frac{4,250,000 \times 3}{300 \times 6 \times 60 \times 60} = \frac{12,750,000}{648,000} = 2 \text{ feet per second.}$$

59. The rate would be less than this at the beginning of the flow and the ebb, but much greater during a large portion of the 6 hours, and the velocity will be quite sufficient, I believe, to keep the channel clear. If not, it will be easy to put up gates at the Napier bridge and dam up the tide in the river until low tide when the gates would be opened and a very high scouring action would occur.

60. The scour from the sea groyne proposed is not likely to affect the coast line to the north very much, but there is plenty of land to come and go on, and it is not likely that there will be more removed by the Cooum groyne than will be filled up again beyond the area of action of that groyne by the action of harbour South pier, probably indeed not so much.

3017/28

61. That portions of the proposals just detailed are not new will probably not discount but increase their value and I would refer Government to a similar proposal by the late Mr. Clark—*vide* Memorandum on the Cooum (Drainage of Madras. 1872) and to the evidence of late Mr. Parkes and Captain Taylor before the Madras Harbour Committee.

Mr. Clark says: "As the quantity (of flood water in the Cooum) diminishes at the cessation of the rains, the water of the flood tide gradually finds its way in, and it becomes a contest between the loose sand thrown up by the surf at the mouth of the river, and the entering and issuing tidal water; as this process goes on during the north-eastern monsoon current, the river is forced towards the southern end of the bridge, where there is a short groyne, and the drift sand occupies four-fifths of the waterway of the bridge, leaving a narrow channel only; this channel is kept open for several months by the scouring action of the tidal water in passing to and from the *reservoir* of the Cooum.

"As the river succeeds in forcing for itself a channel through the enormous quantity of loose shifting sand for several months, it may, I think, be expected that, if some comparatively small means of assistance were afforded, it would remain permanently open.

"Those who have known the river before the rough groyne of granite boulders, above alluded to, was placed on the sea side of the bridge at its southern end, will be able to say how far, or for what period, the closing of the 'bar' has been protracted.

"My observations during the past two months have shown that the outlet of the channel into the sea shifts towards the north. A quantity of sand accumulates on the 'bar' side at the head of the groyne, and gradually increases in extent, causing the opposite or north side of the channel to scour away the sand by the action of the waves which break on its face during flood tide, and carrying the sand nearer to the bridge, where a very considerable eddy is formed, and a quantity of sand is piled up at the back of the shoal first formed as above; as this action proceeds, the northern side of the channel becomes more and more exposed to the action of the waves, and the silting up of the channel is more and more rapid, until the time when the projecting shoal on the south side will overlap the northern side of the channel completely (it now extends to a point opposite the seventh arch from the southern end of the bridge) and will soon completely everlap the channel; in this condition of things the waves (which break nearly parallel to the shore) will commence to cut the point of the shoal itself and drive it bodily in towards the bridge, and the 'bar' will then at once be closed.

"I am of opinion that, if a channel of suitable width be formed by the construction of groynes on both sides, and the entering and issuing water be confined to this channel during the dry season, a quantity of water, moving at sufficient velocity, will be obtained to keep the channel open throughout the year, by the scouring action of the tidal water alone.

"I have roughly estimated the quantity of water which the river Cooum will contain between the South beach and Harris bridge.

"The ordinary rise of the tide, I learn, is about 3 feet; for purposes of calculation I have taken 2 feet 6 inches as spread over the area of the Cooum between the above points, and I find the quantity to be about 16¼ millions of cubic feet which must enter through the channel at the 'bar' in 6 hours; this quantity in a channel having a sectional area of 300 square feet would give an average velocity of 2½ feet per second. Of course this velocity is not uniform; it is greatest about half tide of both flood and ebb; and at extreme high or low water the velocity for a brief period is *nil*, but for a very considerable portion of the 6 hours the velocity will be much higher—from 4 to 5 feet per second—and I consider quite sufficient to keep the channel with a capacity such as I have mentioned open, if the loose sand at the mouth be so far confined and controlled as to admit of the scouring action of the water being concentrated on its sectional area only, and in a direction at right-angles to the general shore line.

"I have repeatedly observed the water entering with a velocity at the surface of 4 feet per second (and the channel I take to be about the size I have indicated) under the present condition of things, but the mass of sand it has to contend with, on both sides, along its whole length, is too great to be overcome by the small stream opposed to it."

Mr. Parkes said, in reply to Sir George Nare's question No. 2923 *—"What groynes are being constructed south of the harbour now?"—"I saw that Captain Taylor mentioned that one groyne had been made at the mouth of the Cooum. I do not think that he quite explained the state of affairs at the Cooum, but the Cooum is a river which comes round at the back of Madras and discharges itself some little distance to the south of Fort St. George, and, during the south-west monsoon, the mouth of the Cooum is completely closed by the drift of sand across it. Generally with the rains of the north-east monsoon, and the consequent floods in the Cooum, that bank is burst open; sometimes the floods are not sufficient to do that. The first time I was at Madras in 1873 it never opened; sometimes it is nearly open, and then they help it by casting out the sand. But lately, since I have been at Madras, I imagine, from what Captain Taylor said, they have attempted to keep this opening permanent by a groyne on the south side of it, which he seemed to say was 150 feet long. If so, I feel pretty certain that it is insufficient. He seems to think that it is on the wrong side, but I do not know what are his grounds for thinking so."

* Minutes of evidence taken before the Harbour Committee.

Captain Taylor said, in reply to Sir George Nare's No. 3090—"The southerly current passing the east face of the harbour must strike the land somewhere to the north to scour out the sand on the north side and carry it northward, do you think that it would strike anywhere south of the railway works?"—"It comes right into the corner."

No. 3091.—"It runs at present along the north pier, and curls right round there?"—"Yes, it curls round on to the revetment and the Railway Company's beach."

No. 3092.—"But with strength sufficient to carry the sand along?"—"With strength enough in stormy weather to displace the stone of the revetment. It is almost impossible to give you a clear idea of the thing without seeing it. On this particular occasion the revetment was washed away in many places; in the case of the Sailors' Home all the wall was gone, and the sea came up within a few feet of the house itself."

No. 3093.—"There is no doubt whatever of the movement of the shore; but what I cannot understand is, how that small amount of sand that is lodged in the corner between the north side of the north pier and the railway jetty can possibly be carried northward by the southerly monsoon current striking round there."—"This is matter of experience; I am certain it is so; I do not know how I can convey my opinion in any other language than that I am certain it is so. The tendency of the groynes on this coast is that, after the sand is deposited on the one side of the groyne, the waves cut close round, *so much so that you could keep the mouth of the Cooum open there*, and you could keep the canal open, thereby choosing a proper position for the groynes."

62. The proposal, therefore, is one which has the approval of no mean authorities, but I think it advisable to recommend that the construction of the sea groynes should be undertaken only after some experience has been gained of the results of the two in-shore groynes, the sea groyne it is just possible may not be found necessary.

63. Many years ago I made a proposal, I think at the time of the famine, to construct a canal *via* Ráyapuram from the Harbour works to the Canal basin; that certainly would have been a better means of communication with the harbour than *via* the Cooum bar and the sea. The Collector of Madras lately called for a copy of that plan showing the line of the canal proposed. Many buildings have sprung up in the intervening 13 years and the line then proposed would now involve the destruction of much property.

64. Seeing, however, that circulation in the canal and Cooum would have been secured by that proposal and looking to the fact that the proposed method of keeping open the Cooum bar may be the cause of controversy, and that, however, much discussion may take place, it is not likely that the matter can ever be decidedly settled until the experiment (if it be so called notwithstanding the strong arguments I have used and the proofs of its probable success which I have put forward) is ventured upon. I have, therefore, an alternative to suggest to Government which, perhaps, from the fewer undetermined factors in probable results, will more favorably commend itself to Government. An alternative estimate has been worked for this scheme now about to be detailed, taking the cost of the canal as proportionate to the cost of the Junction canal (I do not think that the cost will be more) and it will be seen that the total cost of this scheme is less than that for opening the bar.

65. The alternative scheme is this, also a canal from the harbour, but in a different direction. I propose to start this canal 50 to 60 feet wide (perhaps 100 feet would be better) from the south arm of the harbour and continue it along the coast through the newly-formed foreshore as far as the north-east angle of the Fort. The canal would then pass along the Fort and to the west thereof *vid* the Fort ditches until it joined the north arm of the Cooum near the Medical College, thence it would pass on at the back of the General Hospital taking up only 100 feet breadth of the north arm until it joined first the Buckingham canal and then the Cooum near St. Mary's bridge and the Penitentiary. The route taken is an economical one. No property, except Government property, would be interfered with and by passing through the Fort ditch a great deal of excavation is avoided. The following special works would have to be executed:—

(1) The harbour would require dredging on its eastern side.
(2) An intercepting sewer for storm water should be constructed or arrangements made to pass storm water under the canal by means of syphons.
(3) The Fort engine, which lifts the sewage from the main drain, would require to be moved to a new site.
(4) The line of the intercepting sewer at or near this point might have to be slightly altered.
(5) A syphon to carry the storm waters of the main drain would be required.
(6) Bridges to carry the Beach and Benfield roads over the canal would be necessary.
(7) A lock near St. Mary's bridge would be required to shut off the Cooum when in floods from the sea canal.

66. While the elements of uncertainty are less in this scheme than in the one of opening the Cooum bar, the benefits to be derived from it will probably not be so great as it brings some compensating evils in its train. It may silt up to some extent and its mouth in the harbour may silt up. When the boats are passing to and fro, some of the draw-bridges in the Fort would have to be opened. The substitution of the canal for the river near the hospital would not be so advantageous as the complete abandonment of the whole north arm, &c.

3017/29

67. The plan has, however, much to commend it.

68. I have in paragraph 49 spoken of having the assistance of a dredger to keep open the mouth of the Cooum, and for the improvement, and for the maintenance of that improvement in the lowest parts of the river, I consider a dredger will be the most economical method.

69. Before dealing with the mode of dredging, sectioning the river, &c., it is convenient to consider first what sectional area is required in the river, for on that area depends the amount of material which has to be removed.

70. As the river is bridged at many points, it is evident that the dimensions of the sectional area to be adopted must be, to a great extent, dependent on the waterway now existing at the various bridges.

71. Taking the bridges in order (I do not propose to deal with the river above Munro's bridge), we find them as follows with the lineal feet of waterways as noted:—

	Lineal feet.
Munro's bridge	170
Anderson's bridge	160
Commander-in-Chief's bridge	200
Harris bridge	192
St. Andrew's bridge	144
Law's bridge	220
Government House bridge	318
Napier bridge	450

72. To pass the same quantity of water in the same time through each of these bridges, requires a varying depth and a varying velocity, and the quantity of water to be dealt with naturally increases as the mouth is approached, but unfortunately the waterways of the bridges are not so arranged.

73. As before stated, St. Andrew's bridge is the most flagrant example of this anomaly; for, while it has fully four more square miles of drainage area to serve than Munro bridge, it has 26 feet less waterway, while the river banks are not so high; it has 56 less lineal feet of waterway than Commander-in-Chief's bridge which has 2 to 3 square miles less area to drain; and Law's bridge just below St. Andrew's bridge has 78 more lineal feet of waterway.

74. That St. Andrew's bridge has quite insufficient waterway is further proved by the cross section of the river immediately below it which has been scoured out so deep as to be a danger to the bridge, and we have also the fact of the extreme flooding of Lang's Garden village above the bridge on the left bank.

75. In considering, then, what ought to be the proposed sectional area of the Cooum, this bridge, as it at present stands, may be omitted from consideration, for its extension is evidently a matter of great necessity and this has been provided for in the rough estimate.

76. Accepting the figures given in paragraph No. 1 of this report, we have at Coratoor anicut 200 square miles drainage and a maximum discharge of 10,614 cubic feet per second. Deducing the co-efficient for the formulæ $D = C M^{\frac{2}{3}}$, we find that it comes to 310·35, and applying this co-efficient for the other areas, we have to provide for the discharge as follows:—

Names of bridges.	Drainage area.	Discharge = 310·35 $M^{\frac{2}{3}}$.
Munro bridge	207 sq. miles.	10,831 c. ft. per second.
Commander-in Chief's bridge	211 ,,	10,986 ,, ,,
Law's bridge	215 ,,	11,161 ,, ,,
Government House bridge	223 ,,	11,420 ,, ,, if canal drainage is included.
Napier bridge	223 ,,	11,420 ,, per second if canal drainage is included.

77. From the cross sectional maximum flood level areas and fall of the river, the velocity of the discharge in the river is found to vary from 5 to 6½ feet per second. It is advisable to keep the velocity at the lower figure, if possible; and in the calculations which follow, a velocity of 5 feet per second has been adopted. Taking the discharge at the bridges as above, the sectional area required at these points will be:—

Munro bridge	$\frac{10,831}{5}$	= 2,166 sq. ft.
Commander-in-Chief's bridge	$\frac{10,986}{5}$	= 2,197 ,,
Law's bridge	$\frac{11,161}{5}$	= 2,232 ,,
Government House and Napier bridges	$\frac{11,420}{5}$	= 2,284 ,,

and dividing these latter amounts by the waterways, we get the depths during floods as follows:—

		Flood depth.	Hydraulic mean depths.
Munro bridge	$\frac{2,166}{176}$ =	12·7 ft.	11·0 ft.
Commander-in-Chief's bridge	$\frac{2,197}{200}$ =	10·9 „	9·9 „
Law's bridge	$\frac{2,232}{220}$ =	10·1 „	9·2 „
Government House bridge	$\frac{2,284}{318}$ =	7·1 „	6·8 „
Napier bridge	$\frac{2,284}{450}$ =	5·1 „	4·9 „

78. The next point to be considered is the level at which the bed of the river ought to be fixed and the gradient of the various portions of that bed.

79. The depths and hydraulic mean depths and velocity at certain of the bridges having been fixed from the formulæ—

$$F = \frac{\left(\frac{V}{\cdot 9}\right)^2}{2\,H.M.D.}$$

when F is the fall in feet per mile and V the velocity in feet per second, it is found that the fall of the river above the bridges, as undernoted, must be as detailed; the total falls are calculated and noted in the last column:—

Names of bridges.	Distance from sea.	Intermediate distance.	Fall required above bridges feet per mile.	Total fall between each bridge.	Increasing total.
Napier	650	..	..	..	..
	..	3,570	3·1	2·08	2·08
Government House	4,220	..	..	..	..
	..	3,210	2·3	1·38	3·46
Law's	7,430	..	..	..	..
	..	9,320	4·7	3·00	6·46
Commander-in-Chief	16,750	..	..	..	..
	..	8,870	1·6	2·67	9·13
Munro	25,620	..	..	..	..
	..	..	1·4	..	..

80. It is curious to observe that the Cooum has a less slope in the upper reaches than in the lower, the reverse of what is usually the case; but this is to be accounted for by the fact that, in the upper reaches, the Cooum flows more in the direction of a line parallel to the coast, while below Law's bridge it is flowing almost eastwards in the line of natural slope of the country.

81. In the above table it will be observed that the waterways of the bridges between Munro's and Commander-in-Chief's bridges and between the latter bridge and Law's bridge have been omitted from consideration and they have been so because, while the discharge must naturally be an increasing quantity, some of the waterways of these bridges are less than those higher up, while the river banks are lower, and to introduce them for the purpose of calculation would only tend to vitiate, or at least complex, the calculations above made, while no satisfactory result would be obtained by their inclusion.

82. Indeed, the figures obtained in the above cases can only be approximated to as there are many additional considerations which, to a great extent, determine the depth and breadth especially through the city, other than those just referred to.

83. It is not intended (except in regard to St. Andrew's and St. Mary's bridges, which require consideration by themselves) to make any proposal for the increase of the waterways of the bridges.

84. It is desirable that the gradients, as above calculated, should be fixed with reference to the levels of the bed of the river at the bridges, omitting the scour depths; that is to say, to fix the new bed level as nearly as possible at the level at which the top of the floors would have been placed in the bridges when originally designed and it is found that to do so it will be necessary to start from the Napier bridge with the bed of the river at a level of 10·50, which is 6 feet above the lowest point of scour at present.

85. It should be here observed that all the levels in this report have reference to DeHavilland's datum, and not to the Trigonometrical Survey datum, and, for this reason, that some of the survey work was done so long ago as 1883-84 and the bench marks in Madras City are on the DeHavilland datum; and it was therefore more convenient to work out the scheme on that datum

86. The mean sea level as fixed by De Haviland would be at a level of 20·00; it has, however, been shewn by the erection of a tide guage at Madras that the correct level of mean sea according to De Haviland's datum is 18·97 or 1·03 feet lower than De Haviland calculated it. The proposed level of 10·50 for the bed of the river at Napier bridge is therefore 8·47 feet below mean sea level, and taking the range of tides as 3 feet, the lowest spring tide would fall to a level of 18·97—1·50 = 17·47, so that a level of 10·50 gives the bed at the Napier bridge about 7 feet below the lowest spring tide.

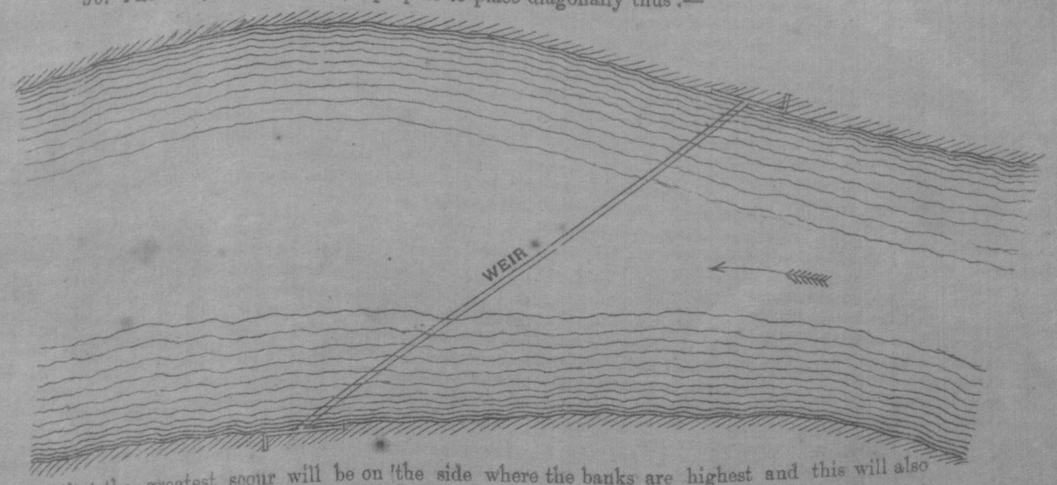
87. From the table in paragraph 79 it will be seen that the total proposed rise in the river is 9·13 up to Munro bridge, so that the spring tides starting with a level of 18·97 + 1·50 = 20·47 would reach that bridge; the bed there having a level of 19·63, this would cover it by about 20·47—19·63 = 0·84 feet, that is if the necessary minimum gradients are not exceeded. The calculated gradients and levels proposed to be adopted are shown below: —

—	Calculated rise.	Mean level of sea.	Calculated level of bed.	Depth below H. S. tide 20·47.	Depth below L. S. tide 17·47.
Tidal.					
Napier	0	18·97	10·50	9·97	6·97
Government House	2·08	18·97	12·58	7·89	4·89
Law's	1·38	18·97	13·96	6·51	3·51
St. Andrew's	·79	18·97	14·75	5·72	2·72
Harris'	1·01	18·97	15·76	4·71	1·71
Not Tidal.					
Commander-in-Chief's	1·20	18·97	16·96	3·51	0·51
Anderson's	1·21	18·97	18·17	2·30	— 0·70
Munro Bridge	1·46	18·97	19·63	0·84	— 2·16

88. In paragraph 13 I have given certain reasons for selecting a point above Harris' bridge for a dividing weir, and that the point selected is the proper one is shown by the fact that, in addition to the reasons given in the paragraph referred to, there is the fact that the river bed at this point will have a level of 16·00, so that with a L. S. T. (17·47) we will have about 1·5 feet of water in depth at the foot of the weir. The exact point is 700 feet above Harris' bridge, cross section No. 16. The plans of this weir will be found in sheet No. 6 and training walls will have to be built below the weir as far as Harris' bridge, one of these training walls will be the front wall of the wharf which it is proposed to form at this point.

89. The floods will not cause a rise over this weir of more than 2 feet in depth, but in case the rise in the river over this weir is greater than this, I propose to have self-acting sluice doors in the weir, as in all other weirs, so that the area of obstruction will be reduced and the maximum overflow limited. The river, at the place where I propose to place the weir, has a cross sectional flood area of 2,935 square feet against 2,163 square feet at Harris' bridge just below and 2,163 square feet higher up.

90. The weir, as other weirs, I propose to place diagonally thus :—



so that the greatest scour will be on the side where the banks are highest and this will also cause less scour on the concave side of the river at the bridge.

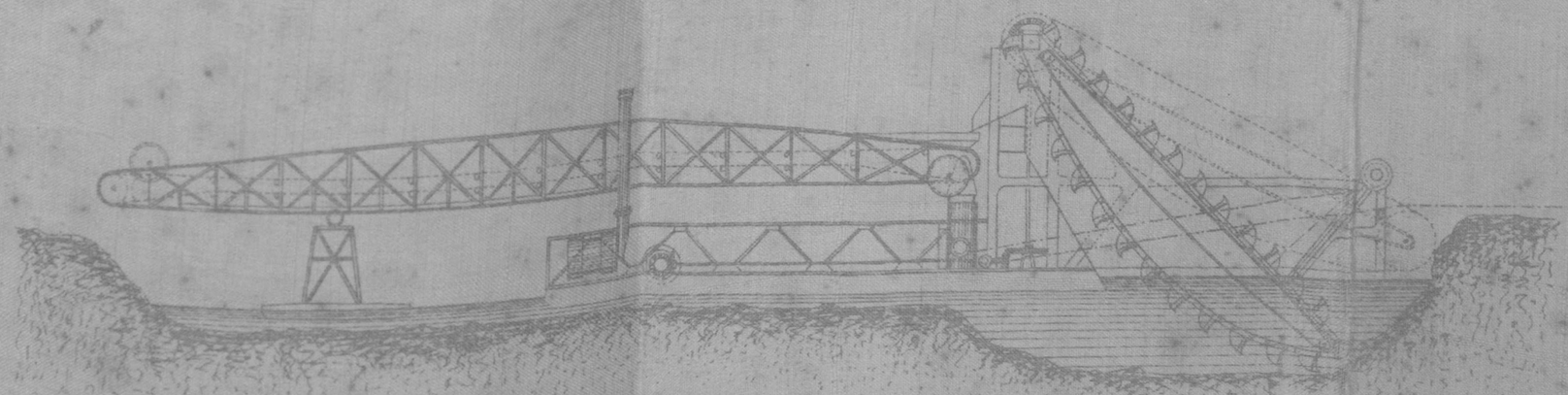
IMPROVEMENT OF RIVER COOUM

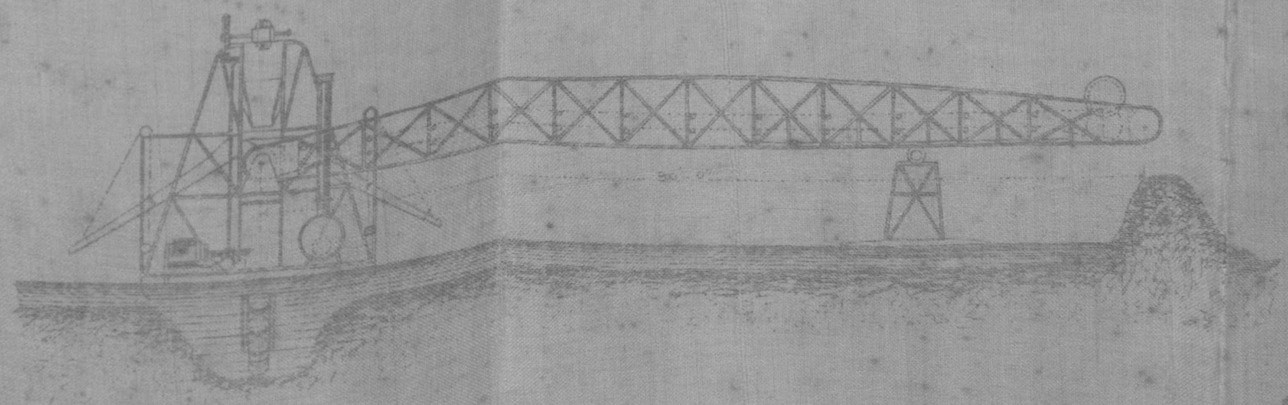
SKETCH PLAN

SHEWING CLASS OF

DREDGER

PROPOSED TO BE USED





OFFICE OF THE SANITARY ENGINEER TO GOVT:
FORT ST GEORGE DECR 1890

J. MEM: INST: CE
SANITARY ENGINEER TO GOVT

Note - To face Para 100

Reg: No. 26 :-Copies 86.

Photo Zinco. Survey Office. Madras. 1891.

3017/30

91 The determination of the gradients allow of the proposed cross section of the river being fixed and these will be found in sheets No. 3 to No. 3/3, where the area of earth to be removed from the river bed and to be embanked is shown. The amount of earth to be excavated between the proposed weir and the sea is estimated at 808,770 yards and above that point at 333,000 yards. This is a very large quantity and the question which naturally presents itself is — What is to be done with it ?

92. It must be remembered that all the foregoing calculations are based on the idea of the acceptance of the proposals for closing the north arm, for, if the north arm be not closed, there will be less water coming down the main branch below Law's bridge and less provision for it will be required to be made.

93. Assuming, however, that the north arm is to be closed, we have to fill into that arm 723,040 cubic yards of earth, and for banking the sides of the Cooum we require 47,319 cubic yards, a total of 770,359, which is less than what will be removed from the main branch below Harris' bridge, viz., 808,770. But there is one improvement that I think very desirable, and that is the improvement of the Island itself. Sections sheet No. 10 show that it lies extremely low and it is very liable to floods; by stripping the low portions 12" deep and burying the stuff to be removed from the Cooum, a great improvement will be effected, and that improvement will be for the benefit of the Military and the general public.

94. There may be some fear that the stuff to be removed from the Cooum will be deleterious when exposed and may cause an outbreak of disease. I do not anticipate any such result, and I feel certain that the stuff when removed and exposed to the influence of a tropical sun will have much less effect on the people than lying where it is as a breeding ground for all these organisms which are now produced in the Cooum waters. This, however, is a matter on which some persons may hold one opinion and some another; it may be, however, noted that during the famine the bed of the Cooum was greatly exposed, that a large number of famine coolies were set to work to clear it; the exposure of such emaciated creatures to the imminent risk of disease was not an act which would have been sanctioned, and I do not think that there is any recorded outbreak because of the famine coolies being placed on such work, hence we may conclude that the proposals now made will not affect the health of the town.

95. The manner of removing and locating the removed material now claims attention.

96. I have given the matter serious consideration and I have come to the conclusion that the only satisfactory way of removing the Cooum deposits and of forming the bed into proper section is by means of a specially designed dredger and by a light tramway of about 1 mile in length which will be laid along the banks of the Cooum where required, and moved and relaid from time to time.

97. The railway would be used for the following works :—

(1) To carry the earth for filling in the north arm.
(2) To convey the stone for the sea groin from the South Indian Railway across the Island.
(3) To carry earth along the bank of the Cooum from the place of excavation to the place of deposit.
(4) And finally the railway might be handed over to the Municipality who require some such appliance for the removal of rubbish from the heart of the town to some distance from it. One mile would perhaps not be enough and 1½ to 2 miles might be required.

98. The dredger may also require to be used for clearing the channel which is to be kept open to the sea, and for this purpose it will be necessary that the dredger pass the Napier bridge. It cannot pass under it as the bridge is too low at present. This bridge, however, is in such a decayed state that I have for some years been endeavouring to effect its removal, and only a few years ago its bracings were almost entirely renewed, but the top and bottom booms are now almost entirely gone. The bridge, in fact, is in a dangerous state, and will immediately require at least new girders for its whole length, if not new piers.

99. My present reason for referring to it, however, is in regard to the dredger; should the proposal to open the bar be accepted, arrangements should be made to allow of its passing under the bridge, and my proposition is that, whatever way the bridge is renewed or restored, the spans over the new outlet channel be made in the form of a lifting girder bridge. In this class of bridge by means of balance weights, the spans are bodily raised to any required height above the ordinary floor level so that vessels can pass underneath. The cost of my proposal as regards two spans of 50 feet each would be about Rs. 20,000. By the adoption of this proposal the dredger would be able to pass in and out, and so also, I believe, could other boats and vessels, and I do not see any reason why a constant communication may not by this means be maintained between the harbour, the Cooum and the canals.

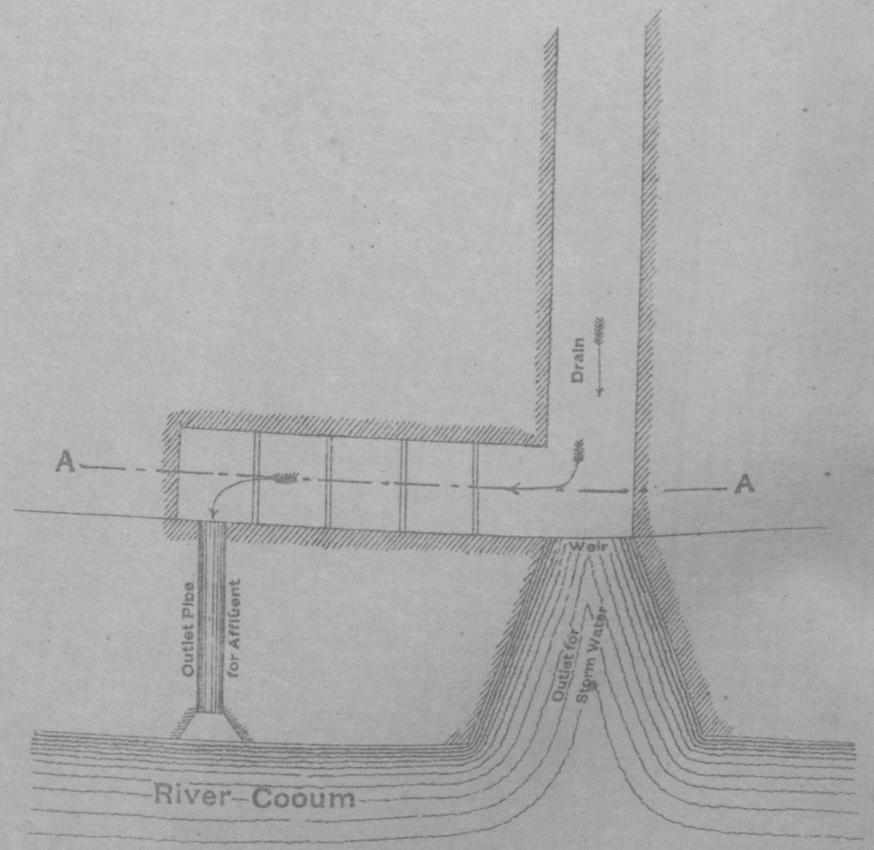
100. Whichever plan of keeping the lower portion of the river tidal is adopted, it will have to be dredged, and the proposed method of dredging would be somewhat similar to what is to be seen on the Suez Canal and also to what is adopted in Holland, viz., the stuff raised by

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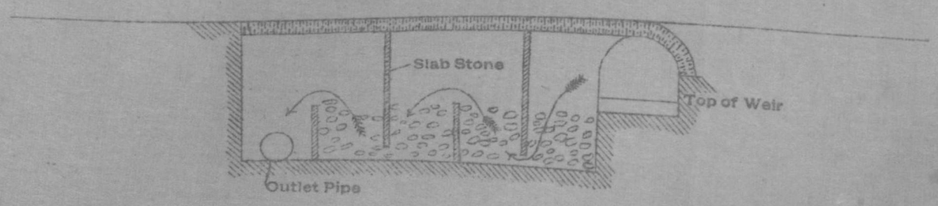
SCHEME FOR IMPROVEMENT OF RIVER COOUM

Sketch of Proposed Alternative Sewage Drain

AT THE MOUTH OF DRAIN



SECTION ON A. A.



REG: No. 27— COPIES 116

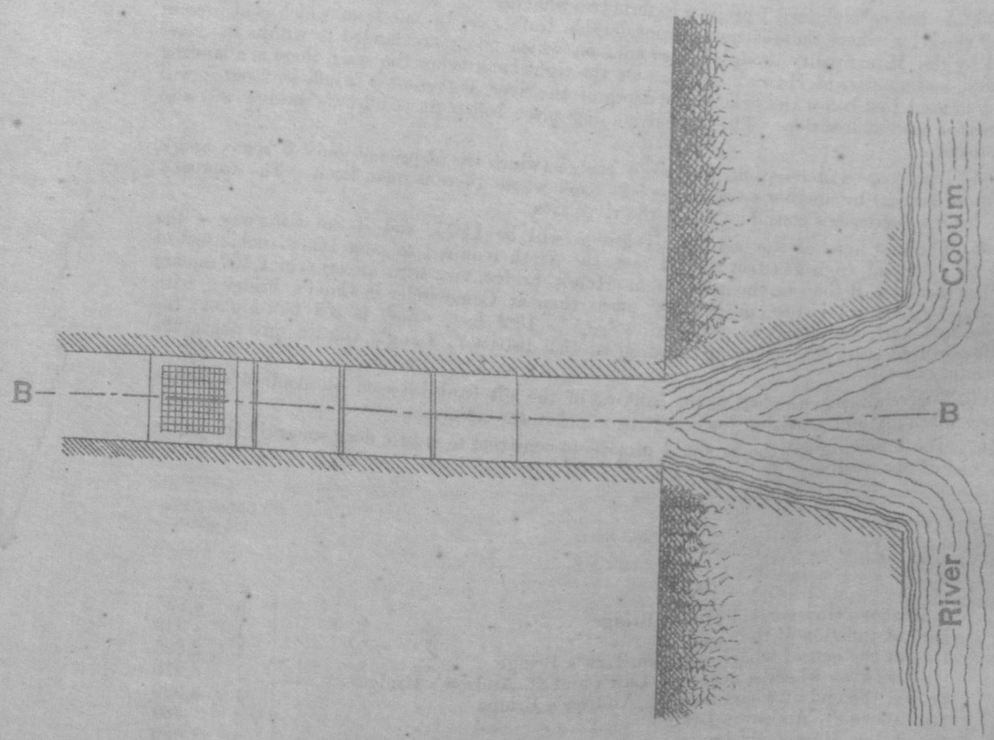
PHOTO-ZINCO., SURVEY OFFICE, MADRAS, 1901.

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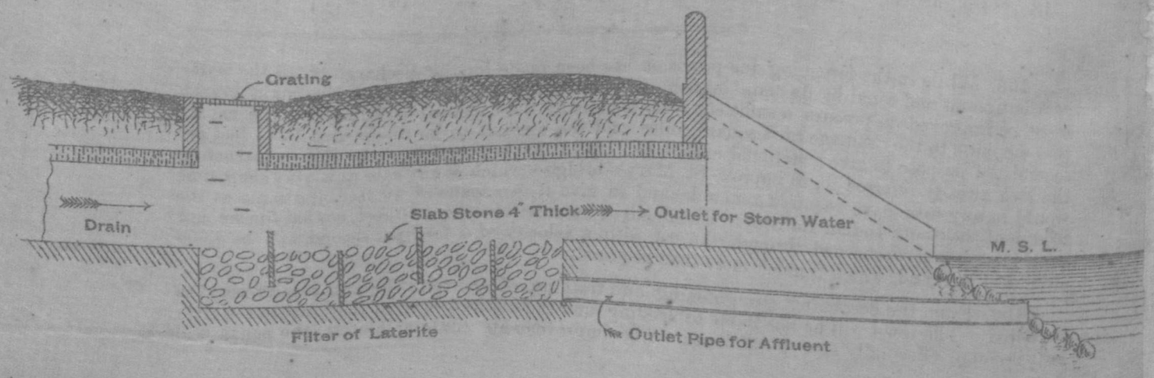
SCHEME FOR IMPROVEMENT OF RIVER COOUM

Sketch of Proposed Sewage Filters

at the Mouth of Drain



SECTION ON B. B.



REG. No. 28 — COPIES 116

PHOTO-ZINCO., SURVEY OFFICE, MADRAS.

3017/34

the dredger, in some cases mixed with water, will be sent on to the bank through pipes or by means of an endless belt. The earth will when dry be loaded into wagons in the light railway and deposited where required; in cases where the river is to be narrowed, the earth will be deposited by similar means on to the slopes and allowed to fall on the face thereof until the proper section of the river has been obtained.

101. The plan of the improved course of the river shows where such narrowing is proposed. The dredger would be used only in the tidal portion of the river; the upper portion would be excavated by ordinary manual labor.

102. A sketch of the class, but not the size, of dredger proposed will be found attached. The gearing must be capable of being lowered to pass the low bridges on the river.

103. As before explained I propose to form two wharves—one above Law's bridge on the left bank of the river where there is now a considerable traffic, the income from which is at present derived by the Municipality though the ground on which goods are landed is within the river boundary, and another at Harris' bridge. On the right bank below the weir, there is a landing place at present just below the bridge, the depth of the river at present is insufficient but it will be increased even at low tide. The present landing place below St. Andrew's bridge will also be improved.

104. I propose to increase St. Andrew's bridge (which has at present only 3 spans and 2 extra small arches) by another span on the left bank where there is room for it. The approach of this bridge encroaches considerably on the river area.

105. The new level of the bed at this bridge will be 14·75, and if the waterway of the bridge be extended from 144 feet to 192 feet, the depth required to pass 10,986 cubic feet of water per second will then be the same as at Harris' bridge, viz., with an area of 2,197 square feet, say, $\frac{2197}{192}$ = 11·4 feet or slightly more than at Commander-in-Chief's bridge; with its present length of waterway it requires $\frac{2197}{144}$ = 15·2 feet, which is 3·8 feet higher; the reduction will decrease the recurring flooding of the district of Lang's Garden just above the bridge.

106. I have already alluded to the banking of the left bank between St. Andrew's bridge and Law's bridge, and provision for it will be found in the estimates.

107. The following are the groins I propose to construct to ensure deep water in the centre of the bed of the river:—

Number.	Particulars.	Distance from the mouth. M.	FUR.
1	Groin above Government House Bridge	0	4,825
2	Do at junction of the canal	1	915
3	Do. at the end of wharf near Col. Law's Bridge	1	2,820
4	Do. between wharves near Col. Law's and St. Andrew's Bridges	1	3,270
5	Do at the end of wharf near St. Andrew's Bridge	1	3,920
6	Do. above St. Andrew's Bridge	2	460
7	Do. below Harris' Bridge	2	1,980
8	Do. below Weir No. 2	2	4,380
9	Do. between Commander-in-Chief's Bridge and Weir No. 3	3	1,150
10	Do. between do. do. do.	3	1,710
11	Do. below Anderson's Bridge	3	4,490
12	Do. above Weir No. 4	4	2,110
13	Do. above do.	4	2,740

108. While in the foregoing due provision has been made for the discharge of all the water of the Cooum and canal by its main branch, the cut between the canal and the main branch must be improved to procure a sufficient area for all the discharge which comes *viâ* the canal; this amounts to the drainage of 8 square miles and the amount to be discharged 1,241 feet per second. I propose to give a sectional area to this cut of 800 square feet, and, while constructing the lock already referred to, to improve St. Mary's bridge—which at any rate in a very short time would in any case have required renewal—and to give it two spans of 40 feet, the same as the bridge of the South Indian Railway. The depth of water will be about 10 feet, so that the amount capable of being discharged through the cut with a velocity of 5 feet per second will be 4,000 cubic feet a second, which is much more than required.

109. From the deepening, straightening and training of the river the best results may be expected. The town will be less liable to flooding, and the discharges from the town to the river will be more effectually carried off to sea. The improvements contemplated to the banks will

make a marked improvement to the city. In very few cases has it been found necessary to encroach on adjoining lands, the most prominent instance of encroachment is in Napier Park, but I have less hesitation in recommending this knowing that a large portion of the river was taken and added to the Park some years ago and Government will only be resuming or taking little more than what belonged to it, and that for the public good. There is no doubt that more sectional area is required at this point. Deficient sectional area can result only in flooding the portions above the point of reduction of area.

110 One important proposed measure yet remains to be described, viz., the manner of preventing the deposit of the solid portion of the sewage in the river and the purifying of the effluent.

111. As the purification of the sewage does not require to be so efficient as if it were to pass into a stream the waters of which may afterwards be used for dietetic purposes, it will not be necessary to adopt the ordinary slow rate of filtration of 6″ in depth per hour. What is chiefly required is the arrestment of solid matters, actual contact of every particle of the water with the filtration medium is therefore not necessary. I propose that at the outlet of each drain a set of settling tanks or filter such as are used in the Gorbals water-works system of filtration be placed at or above the mouth of each drain, where the level will permit, and that when these are constructed the Municipal Commissioners be required to keep a proper staff to regularly attend to them and remove the solid matter; the design of these filters or tanks is shown in the sketch accompanying.

112. The best material for use in the filters will be ordinary laterite, small and large, as used for metalling roads. The iron in it will have considerable effect in the way of purifying the sewage as well as arresting the solid matter.

113. These filters may be placed either in the river at the mouth of the drain or as high as possible. Flood water will pass over them; at such times it will be impracticable, as it will also be unnecessary, to filter the contents of the drains.

114. The three drains marked as follow require special treatment. No. 3-R.B. is the main drain of Triplicane, it has a discharge of 525,000 gallons daily, an average of 22,500 gallons per hour or a maximum of 45,000 gallons or 7,200 cubic feet per hour. The sewage during the day is pumped up on to a portion of Napier Park in which there has been formed a sewage farm, but during the night and a portion of the day and on Sundays and Holidays the sewage flows into the Cooum. Arrangements should be made by the Municipality to pump night and day; there is not available sufficient land to use up all the sewage coming down this drain and therefore filters must be used as at other drains, but as this drain enters the Cooum at the low level of 18·98, filters cannot be placed below the level of the floor of the drain. I propose therefore that, on the line of the drain and above it, a set of filters be erected — there is plenty of space for this away from the Park — and that, when the sewage cannot be pumped on to the sewage farm, pumping be continued by running all the sewage through the filters, which may be somewhat differently arranged to those at most of the other drains. No alteration would be necessary to the present pumping station in the Park; an additional pipe would have to be laid or channel made from the pumps to the filters. This drain, probably more than any other, causes the filthy state of the Cooum near or below Government House bridge, and some special measures are therefore very necessary in regard to it.

115. On the left bank of the Cooum are two other large drains which must be similarly treated. One is the drain which receives all the sewage of New Town, Vepery No. 1-L.B., and which discharges just below Law's bridge close to the Penitentiary; who knows but that this drain may not be responsible for the outbreaks of disease among the prisoners, for they do garden work in close proximity to the outfall of the drain? A portion of the contents of the drain during the day is raised from a well in, and distributed over a portion of, the People's Park. The lifting is done by picottahs, and the raising and stirring up of the sewage is a nuisance to those who live in proximity to the well and is also a nuisance to those who frequent the Park. His Excellency the Governor has once or twice publicly remarked on this nuisance, and I propose to deal with this drain very similarly as regards filtration to the Triplicane drain outlet at the Napier Park. Here, instead of the picottahs, should be placed a small steam or hydraulic motor. Such motors run for hours without attention, the latter motor can sometimes be arranged to run for days. The well should be covered in and properly ventilated high above adjacent buildings. A system of covered filters would be placed over this drain also. There would then be no nuisance. The discharge of the sewage on to the grass would not be noticed, and during damp weather and at nights, instead of the sewage finding its way into the Cooum as it does now, it would be sent through the filters. A very great sanitary improvement would result by this method.

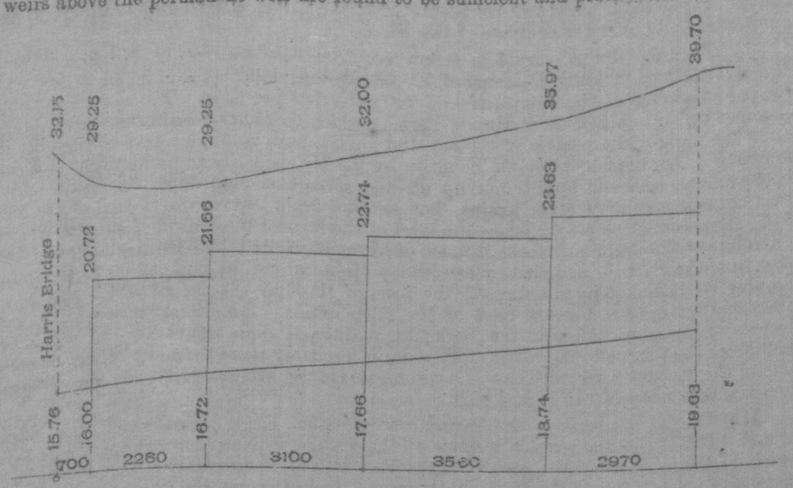
116. At Lang's Garden Road near the Egmore Police Court is another drain No. 8 L.B. of similar character. There is a sewage farm and a well, but the area of land is insufficient to take all the sewage, none of which is lifted after sunset. A large proportion, therefore, goes into the Cooum. Similar arrangements to what are proposed for the People's Park drain are necessary.

117. Should the drainage of Triplicane be early taken in hand, as it ought to be, all the sewage on the right bank will be diverted, and it will be very easy by the Shone system to join to it those sewers which run in on the left bank. This, no doubt, is the proper and most perfect way of diverting sewage from the Cooum. The proposals I have advocated are proposals which, in event of improved drainage not being carried out, may be accepted as tentative improvements. It will take some years to effect the drainage of Triplicane and Vepery, and until then the improvements suggested would be of benefit. The motors, which cost from £100 to £200, could then be moved elsewhere.

118. I now pass to consider the manner in which the upper reaches of the river should be dealt with

119. What is desirable is to secure a depth of water in the river which will at all times under ordinary circumstances cover the bed.

120. The months during which there is ordinarily no rainfall which would to any extent affect the river are January to June, or, say, six months. The evaporation and percolation during these months may be taken as amounting to 4 feet, and this is the least depth that ought to be retained in that portion of the river not in connection with the sea, that is to say, we must have a series of tanks at least 4 feet deep at the upper end and varying at the other according to the fall of the river bed; the rise of the river from the permanent weir already proposed to Munro bridge is from 16·00 to 19 63, in all 3·63 feet, so that to cover the bed 4 feet deep at Munro bridge, if no other weirs were used, the permanent weir proposed would have to be 7 63 feet high. The permanent weir near Harris' bridge, however, from engineering consideration, viz, the necessity for keeping it as low as possible to pass floods, &c., cannot rise to a greater height above the bed than 4 or 5 feet, so that it will be necessary to place another weir a comparatively short distance above it. It is desirable to keep the weirs as low as possible, in order not to back up the subsoil water to too great a height under the adjoining lands; the banks of the river, however, are very much higher along its upper than its lower reaches and three weirs above the permanent weir are found to be sufficient and practicable.



121. The banks are fairly high at all the places where these weirs are proposed to be erected, and a calculation shows that if permanent weirs be put in, they would not raise the flood waters to an extent greater than the banks will allow, that is, they will not raise the river so as to cause flooding of adjacent lands. They will probably be much less expensive in the end than earthen weirs, which must be protected in some way or other and which would require restoration from year to year.

122. The design of the weirs will be similar to that of the permanent weir already described, and each weir will have self-opening sluices of considerable capacity for discharge.

123. The river would, of course, be first sectioned in the upper reaches before the weirs are built.

124. I propose to turf the banks and protect the same with fascines; sea turf should be used and a staff must be kept on to protect the turf until it is in a growing state. At some portions of the river retaining walls and stone pitching are required to avoid encroaching on roadways, &c., and to permit of the river retaining its necessary width.

124A. Such generally are my proposals for the improvement of the River Cooum.

125. In the present state of matters it was, I thought, not desirable to go very deeply into estimate details; the figures I have given are, therefore, to be accepted only as approximate but sufficiently close probably to allow Government to consider whether the benefits to be obtained are sufficiently commensurate with the expenditure to be incurred.

126. I desire, however, to call attention to certain portions of the estimate which seem to require explanation.

127. *Item No.* 3 *in Estimate No.* 1 is not an essential one to the scheme unless it be found that the funnel-shaped mouth gets unduly silted and cannot be kept open even with the plan of tidal gates maintaining high tidal level in the river until low tide. If the dredger must be used, then the alteration in the bridge must be effected, but the bridge will have to be soon renewed at any rate, and the whole cost of the alteration of the two spans is not fairly debitable to this estimate.

128. *Item No.* 5 *in Estimate No.* 1 does not appear in Estimate No. 2, as the scoop-drain is a storm drain and may enter the proposed canal at the same place that it now does the river.

129. *Item No.* 7 *in Estimate No.* 1 *or Item No.* 4 *in Estimate No.* 2.—Provision is made in the former estimate for a double lock to suit its position near bridges of double 40 feet spans. The sea canal enters the river *viâ* St. Mary's bridge, it may be better to put the lock up near Elephant Gate bridge, where probably a single lock will be sufficient.

130. *Item No.* 9 *in Estimate No.* 1 *and Item No.* 6 *in Estimate No.* 2.—This item will not be required if the drainage of Madras is carried out as proposed. The proposals are of a tentative nature.

131. *Item No.* 10 *in Estimate No.* 1 *and Item No.* 7 *in Estimate No.* 2.—A portion of this item is for three wharves to accommodate traffic up the river, and they are much required. The wharves themselves will cost about Rs. 35,000, and an income of not less than Rs. 1,500 per annum may be expected from the three.

132. It is proposed to turf the banks and protect the toes of the slopes by piling filled in with wattle; if this is considered unnecessary, the amount of this item can be reduced.

133. Certain suggestions in regard to the execution of the scheme and other matters in reference to it will be found in my letter to which this is an enclosure.

Order—dated 11th March 1891, No. 349 M., Local and Municipal.

Referred to the Chief Engineer with Government for very early remarks.

2. Paragraph 98 of the report will be considered in the Public Works Department with a view to the repair of the Napier Bridge, if found necessary, being carried out at the earliest possible date.

(True Extract.)

(Signed) J. F. PRICE,
Chief Secretary.

To the Chief Engineer to Government, Public Works Department,
" Public Works Department. with plans and estimates.

READ—also the following papers :—

No. 1482-C.

NOTE by the Chief Engineer, Public Works Department, on G.O., dated 11th March 1891, No. 349 M.

Mr. Jones' scheme for the improvement of the Cooum consists of two parts, which may conveniently be considered separately.

2. The first part, dealing with the lower portion of the river, provides for closing the northern of the two branches into which it divides near its mouth, for improving, deepening and resectioning the remainder of the bed, and for obtaining a constant communication between the river-bed and the sea.

3017
36

3. For the upper portion of the river above the Harris' Bridge, he proposes the construction of three weirs, in addition to that between the tidal and non-tidal portions of the river, for the purpose of maintaining a maximum depth of four feet of water in the bed.

4. In both portions, the banks are to be improved and strengthened, training walls and groynes to be constructed where necessary and sewage to be diverted from the river, while wharves for the convenience of boat traffic are to be constructed in the tidal portion.

5. For the first or tidal portion of the river, two alternative schemes are submitted—one in which it is proposed to admit the tide through the present mouth of the river, the bar being removed by the action of a groyne which it is proposed to construct to the south of the Napier Bridge, the other scheme being for the excavation of a canal from the harbour to join the river near the St. Mary's Bridge.

6. The first scheme is estimated to cost Rs. 12,25,000, the second to cost Rs. 10,90,000; about Rs. 2,50,000 in each case being due to the non-tidal portion of the river, and the remainder to the lower or tidal portion.

7. Mr. Jones expresses a strong opinion in favor of the first of the two schemes for dealing with the lower portion, and in paragraphs 38 to 62 of his report, he discusses the measures to be adopted for keeping the bar open and gives his reasons for considering that the groynes proposed by him will be effective.

8. I regret that I am not convinced by the arguments brought forward, and cannot concur in the proposal to keep the bar open by means of groynes.

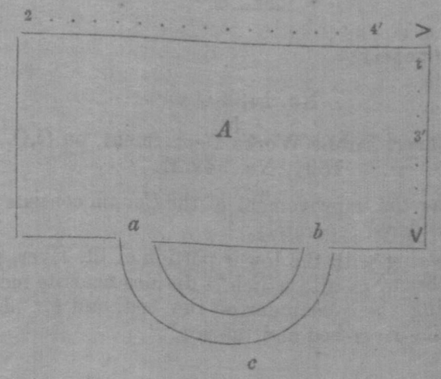
9. In the first place, it is by no means certain that the groyne proposed would keep the river mouth open at all; that it would remove the bar from its present position is certain, but it is not equally so that the latter would not reform further inland; my own belief is that it would do so, though the question is so beset with uncertainties that it is impossible to give a positive answer to it.

10. Whether the bar would be removed or not, it is almost certain that the construction of the groynes would cause erosion of the shore to the north of the river mouth, and with the result of the construction of the harbour (which in its effect upon the coast is nothing but a big groyne) before our eyes, I cannot but think it would be highly unwise to construct any more sea groynes in the neighbourhood of Madras.

11. Their construction is the less desirable, in that the object aimed at can be attained much more certainly and efficiently by a slight modification of Mr. Jones' second scheme.

12. Paragraph 12 of the report shows that he sees clearly that the prime object to be arrived at is not the mere admission of water into the river bed, but the circulation of that water, and this is only very partially provided for by either of the schemes proposed.

13. Admission of tidal water, and its emission by the same outlet, will produce oscillation, but not, or only to a very trifling extent, circulation. A very simple experiment will show this :—



A is a good-sized tank 12 inches deep and *a b c* a curved trough of the same depth connected with the tank at both ends. If the tank be filled to within about six inches of the top and some light material such as sawdust sprinkled over the surface of the water in *a b c*, and the tank then alternately filled to the brim and emptied to six inches from it, it will be found that there is next to no movement of the sawdust, and this will be the case whether both ends *a b* be kept open or one closed and the water admitted through the other; showing that there is nothing like real circulation in the trough *a b c*.

14. The condition is strictly analogous to that of the Cooum and proposed new canal connected with the harbour at one end and the sea at the Napier Bridge at the other.

15. If instead of keeping one or both ends of the trough permanently open, we now close the end *b* while the tank is being filled, and while it is being emptied close both ends until the water has fallen three inches and then open *b*, it will be found that a decided current is produced from *a* towards *b* and that after a few "tides," the whole of the floating sawdust will have been carried out through *b* into the tank.

16. It may be objected to this reasoning that, as a matter of fact, tidal rivers having only a single communication with the sea do maintain a constant circulation; but in all such cases the real circulation is maintained, and the transport of foreign matter effected, by the land drainage, which is, as it were, pounded up by the flood tide and allowed to flow down during the ebb, the velocity in all cases being considerably greater during the ebb tide than during the flood. The peculiar feature of the Cooum is that during a great part of the year there is no land drainage at all, and the velocity during the ebb and flood will be the same.

17. We can apply the principle of the experiment described above to the Cooum, by the construction of the canal provided in Mr. Jones' second scheme, and of a lock or flood-gate at or near the entrance of this canal into the harbour, such gate to be opened during flood tide and closed during the ebb. In the mouth of the river (at the Napier Bridge) construct sluices to be closed during the flood tide and during half the ebb, and opened from half ebb to low tide; there would then be a constant circulation from the harbour towards the river mouth, and the water issuing at the latter would, as will be shown below, certainly have sufficient scouring capacity to keep a channel through the bar permanently open.

18. According to paragraph 58 of Mr. Jones' report, the area to be affected by the tide would be 4,250,000 cubic feet, and the rise of the tide being 3 feet, the total current of tidal water impounded would be 12,750,000 cubic feet, and as the gates would not be opened till the tide had fallen $1\frac{1}{2}$ feet, the mean velocity through them would be about 6 feet per second; to discharge 12,750,000 cubic feet in three hours with this velocity would require an area of $\frac{12,753,000}{6 \times 10,800} = 197$ square feet. It will, however, be probably more convenient to put shutters throughout the length of the Napier Bridge, though only a few of them would be lifted at each tide, the remainder being reserved for the discharge of flood-water.

19. There need be no question of the power of the tidal water, controlled as proposed, to keep open a passage through the bar. The average discharge is about 1,200 cubic feet per second, and it is certain that the discharge of the Cooum did not approach this amount during any large number of the days during which it kept the bar open, as stated in paragraph 7 of Mr. Jones' report.

20. An incidental advantage of the arrangement herein suggested is that the flow would always be from the harbour towards the Cooum and not *vice versa*; it is by no means improbable that the Harbour Trust would object to the construction of works which allowed Cooum water to flow into the harbour.

21. The new canal should have an area of water-way of not less than 300 square feet at low tide. It is observed that Mr. Jones estimates the cost at Rs. 1,50,000, which is at the rate of about Rs. 30 per foot, which is probably enough, but there is nothing to show how the rate is arrived at.

22. I should take this opportunity of mentioning that the proposal to allow sea-water to enter from the harbour and return by the river mouth under the control of the sluice gates was embodied in the scheme submitted by Mr. Chatterton, Professor of Engineering at the Madras College of Engineering, to the Committee appointed by G.O., No. 643, of 16th September 1890; all the schemes submitted to that Committee provided for a canal from the harbour or the sea to the north of it to the Cooum, but none of their authors except Mr. Chatterton realised the essential necessity of circulation and of a constant scour at the river mouth.

3017/37

23. Mr. Jones in paragraph 59 of his report proposes sluice-gates in connection with the groyne at the river mouth, but apparently does not see the necessity for them in connection with the alternative scheme of a canal from the harbour.

24. It has been suggested that the necessary circulation might be obtained by pumping water from the sea into the river and so providing a current in the latter. On this point it is enough to say that the efficiency of such circulation will be directly proportional to the quantity of water pumped and the height to which it is lifted; the cost will be directly proportional to the same elements. By the canal and sluice gates we can circulate daily $25\frac{1}{2}$ millions of cubic feet; the cost of plant for circulating this quantity of water would enormously exceed that of the canal and gates, and the working expenses would be dead loss.

24 (*a*). The proper course for the canal is a question for consideration; it has been suggested that it should run from near the mouth of the river along the foreshore to the east of the Fort, and it is possible that, so far as the actual excavation is concerned, this would be slightly cheaper than the route chosen by Mr. Jones, but the latter is the most convenient in many ways and has the great advantage of bringing the sea-water into the river at a point as far as possible from the mouth, thereby greatly improving the circulation. On the whole I concur in Mr. Jones' selection of a route.

25. As the dredger will not, with the arrangements herein proposed, have to pass under the Napier Bridge, there is no occasion for making provision for lifting any portion of the latter, nor, so far as I can see, need the new bridge (if a new one has to be constructed) be as long as the present one.

26. The maximum amount of flood water to be discharged may be taken at 12,000 cubic feet per second, and as the M. F. L. of the river is fully five feet above tidal H. W. L., a velocity of 10 feet per second may be allowed through the bridge, requiring an area of 1,200 square feet of waterway. It will not be convenient to give the sluice gates a lift of more than 6 feet, so that a length of 200 feet exclusive of the piers of the sluices will be required; a total length of 300 feet instead of the 450 feet of the present bridge would be enough.

27. The details of the design of the sluice at the river mouth and of its combination with the bridge will have to be separately considered if the general principle of the scheme under discussion is accepted.

28. There seems no occasion to put the sills of these sluices so low as 10·50 on DeHaviland's datum; $6\frac{1}{2}$ feet below high-water level, or say 14·00, is quite as low as is necessary, nor does there appear any object in artificially excavating the bed below this level. A considerable reduction may therefore be made in the excavation below Law's bridge.

29. I entirely agree with Mr. Jones as to the desirability of filling up the northern arm of the river, and as to the necessity for lengthening St. Andrew's Bridge, the insufficiency of the waterway of which is a very serious evil, though I am inclined to think he has under-estimated the cost of this work. His proposals for the improvement of outlets of drains, and for the construction of wharves and training walls, appear judicious, but I am not satisfied of the necessity for the construction of the locks proposed to be built in the Buckingham canal and the Junction canal; provided the canal from the harbour is of ample section, the increase of area available for the storage of tidal water is a positive advantage. Nor am I satisfied of the necessity for the groynes proposed to be erected in the bed of the river. These, if constructed at, all should be constructed tentatively and bit by bit.

30. I consider his selection of a point near the Harris' Bridge as the point of division between the tidal and non-tidal portions of the river to be judicious; but the design of the weir requires some modification. In paragraph 89 of the report it is stated that the floods will not cause a rise on the weir of more than 2 feet. It is not clear how this figure is arrived at; the length of the weir crest is 400 feet, and as it is oblique to the river, the effective length is probably not more than about 320 feet. To pass 11,000 cubic feet per second, even allowing for a considerable velocity of approach over this length, would require a depth of at least 4½ feet. As, however, the wing wall is 5½ feet above the crest, there would be no fear of the latter being turned.

31. I am afraid the self-acting sluices proposed for this weir would be useless; they would be certain to be choked up by sand. No dependence can be placed on constructions of this sort in a river, though they may work in a canal or an artificial reservoir.

32. The above remarks have reference only to the tidal portion of the river; with regard to the non-tidal part, I regret that I am unable to support Mr. Jones' proposals. The idea is to divide the river into a series of reservoirs by means of dams of sufficient height to give a depth of 4 feet at the top of each reach, this 4 feet being the depth that will in ordinary years be evaporated during the period in which no fresh supply is received by the river.

33. At the best this scheme merely provides for covering the bed with a series of pools of stagnant water, which would be only in a very small degree (if at all) preferable to the dry bed.

34. As a matter of fact, however, the proposed weirs would not answer this purpose. In two or three years, the reaches would be silted up to the level of the crests of the weirs bounding them, and the bed would be exposed just as it now is in dry weather, above the influence of the tide, except that it would be in a series of steps instead of in a single slope.

35. It may be contended that the undersluices left in each weir would remove the silt, but I am of opinion that they would not do so; sluices of the particular design proposed would probably not work at all, and although more efficient ones, such as those used in connection with irrigation works, might be provided, they would not serve the purpose required, but would merely produce irregular channels in the river bed, and would in fact reproduce the irregularities in depth, causing the formation of isolated pools, which it is the chief object of the scheme to avoid. The effect of undersluices is exceedingly local; they will keep open a channel for a short distance in front of themselves, but if it be required to keep down the bed level throughout the whole breadth of a river, the sluices must be distributed over the whole length of the weir and pretty closely spaced together. No automatic arrangement is of the smallest use for such a purpose, and any other known arrangement is costly to construct and requires labor to work it out of all proportion to the advantages to be gained in such a case as the present. It would certainly not be justifiable to construct three such weirs in a distance of little over a mile merely to keep the bed of the river covered with a few inches of stagnant water.

36. I cannot recommend that anything should be done to this portion of the river beyond a little straightening and improving the banks; and for this the sum of Rs. 1,02,387 proposed by Mr. Jones to be expended appears out of all proportion to the object to be attained.

37. The weir above the Harris' Bridge (No. 1) must be retained to divide the tidal from the non-tidal portion of the river, and prevent the bed of the former from assuming a slope part of which would be dry at low water; it should in my opinion be built at right angles to the river; the undersluices may be omitted, as even if they act they are not wanted. The retaining wall of the apron should not project above the level of the latter, but the surface of the apron itself may with advantage be depressed a foot in the middle; looking to the small fall over the weir, 12 feet would be ample breadth for the apron, but a second apron 18 feet wide of dry stone should be added in rear of the retaining wall; it is not clear what is gained by the rather peculiar section given to the body wall with a tongue of concrete between

two layers of masonry; the latter should extend the whole thickness of the wall. It seems doubtful whether the foundations are quite deep enough, but Mr. Jones has better information as to the soil than I have and has probably satisfied himself on this point.

38. It must be remembered that the construction of this weir will of itself tend to raise the level of the river bed above and to terminate the existence of the unsightly pools of stagnant water which now form the worst feature of the upper portion of the bed.

39. The estimates submitted give no details of quantities, but there is no reason to suppose that the amounts allowed are otherwise than accurate; the rates allowed for earthwork appear ample, as plant is provided for separately. The omission of the locks in the Buckingham and Junction canals will cause a saving of Rs. 84,000 on Mr. Jones' estimates, while the provision of sluices at the Napier Bridge and of a single tidal lock on the new canal will add about Rs. 60,000.

40. To sum up, I would recommend the adoption of Mr. Jones' scheme, No. 2, including the weir at the Harris' Bridge, with the modifications in detail explained in this note, and with the addition of sluice gates at the Napier Bridge. For the non-tidal portion I would recommend that nothing be done beyond slight improvements to the bed and banks.

41. Although I have not found myself able to concur in all Mr. Jones' views, I consider that the care and completeness with which he has worked out this scheme are remarkable, and deserve acknowledgment.

MADRAS, 16*th March* 1891. (Signed) J. PENNYCUICK, Colonel, R.E., *Chief Engineer, P.W.D.*

To the Local and Municipal Department.

Note by the Chief Engineer, Public Works Department, dated 2nd April 1891.

In paragraph 35 of my note of the 16th ultimo on Mr. Jones' scheme for the improvement of the Cooum, it is stated that any known arrangement of weir, suitable for the purpose therein under consideration, "would be costly to construct and require labor to work it out of all proportion to the advantages to be gained," and that "it would not be justifiable to construct three such weirs in a distance of little over a mile merely to keep the bed of the river covered with a few inches of stagnant water."

2. It has, however, since occurred to me that Mr. Jones' object might be attained by the construction of one weir of slightly-increased height, instead of three, and although this weir would be costly and the result not, in my opinion, worth the expenditure, the latter question is not an engineering one, and it would have been better to show more precisely how the end in view could be attained, and what its cost would be.

3. It may be said that there are practically only two ways of keeping the water in a river-bed at a level above its natural one without raising the bed level by silting, namely, falling shutters and lifting shutters worked by screw gearing.

4. The former have considerable advantages under certain conditions, but these conditions do not exist in the Cooum; for this river they have one fatal defect, namely, that they cannot be made water-tight. In a river which has a dry weather discharge sufficient to meet the loss by leakage this does not matter, but the Cooum, for months together, has absolutely no natural supply.

5. The loss by leakage in a falling weir three hundred feet long would certainly not be less than 20 cubic feet per second (and would probably be a good deal more), and this would empty a reach a mile long and 300 feet broad, at the rate of a foot of depth, in twenty-two hours.

6. The only practically useful arrangement for the Cooum would be a series of shutters lifted by screw gearing, similar to the surplus sluice at the Red Hills reservoir, and to the one now under construction for the Ramrajpuram tank in connection with the Periyár project.

7. The width of the Cooum, at Mr. Jones' lowest weir, is about three hundred feet, and could be closed by sixteen vents of 12-feet span with piers six feet thick.

8. The level of the bed of the river, according to the levels given in paragraph 120 of Mr. Jones' report, is 16·00, and the sill of the sluice might be placed at this level. Shutters 7½ feet high would retain the water up to 23·50, which is practically the same level as the crest of the uppermost of Mr. Jones' proposed weirs and would give a depth of 3·87 feet at the Munro bridge.

9. There is no objection to this level being retained at the lower weir, for the flood level on the original solid weir, with crest at 20·72, would certainly not be less than 25·00, and the level of the river bank is 29·25.

10. The lift of the shutters should be 7½ feet, giving an area of 1,440 square feet of waterway, and as the maximum discharge is 11,200 cubic feet per second, the velocity through the sluice would have to be 7·78 feet per second. As nearly as I can calculate, this velocity would be attained with a water level above the sluice of a little about 24·60, or rather less than that on the solid weir.

11. The leading dimensions of the sluice would be, sixteen vents of 12-feet span—sill of sluice 16·00, top of shutters when down 23·50; lift 7½ feet. Springing of arches 24·00, crown 27·00, roadway 29·50. Shutters to be worked with double screws as in the Cauvery and Vennár regulators.

12. The cost of this sluice would be about Rs. 40,000 or about Rs. more than the cost of the four dams proposed by Mr. Jones and Rs. more than that of the single dam necessary for dividing the tidal from the non-tidal portion of the river; whether this sum would be worth paying for the advantage of keeping the bed of the river constantly covered with water is, as remarked in the beginning of this note, not an engineering question.

13. It is perhaps hardly necessary to observe that for a sluice of this sort it is much cheaper to have one than two or more; if, instead of keeping the water at 23·50 by a single sluice, we increased it to 21·50 by one and to 23·50 by a second, each of the two sluices would be almost as costly as the single higher one, the only saving being in the reduction of height in the piers and shutters; the flooring, foundations, arches and superstructure, which form the most costly part of the work, are practically independent of the height. The increased depth of water at the lower end is of course an advantage.

(Signed) J. PENNYCUICK, Colonel, R.E.,
Chief Engineer, P.W.D.

To the Secretary to Government, Public Works Department.

No. 1822 C.

Transferred to the Local and Municipal Department in continuation of endorsement No. 1482 C., dated 16th March 1891.

MADRAS, *2nd April* 1891.

(Signed) J. PENNYCUICK, Colonel, R.E.,
Secy. to Govt., P.W.D.

To the Local and Municipal Department.

REFERENCE—dated 23rd April 1891, No. 327, Local and Municipal.

Referred to the Sanitary Engineer with Government for any observations which he may wish to offer, and with a request that he will specify, in detail, how far the amendments suggested by the Chief Engineer, and which in the main have the approval of Government, will affect the estimates already submitted.

(Signed) O. V. BODDY, Major, R.E.,
Under Secretary, P.W.D.,
for *Chief Secretary.*

To the Sanitary Engineer.
" Public Works Department.

3017/39

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, 9th June 1891, No. 590.

In reply to reference, No. 327, dated 23rd April 1891, Local and Municipal, I have the honour to forward herewith my remarks on the Chief Engineer's note on the Cooum Improvement scheme and I also send revised estimates; the basis on which these have been framed will be found fully set forth in my memorandum. At the end of the estimates will be found a comparative statement showing the differences between the present proposals and those of Scheme No. 1 revised in view of Colonel Pennycuick's remarks and of the memorandum accompanying this letter.

2. The item of Rs. 66,000 for the extension of the scoop drain may stand in abeyance meantime, as that expenditure will not be necessary if the canal be eventually constructed.

3. If the scheme is sanctioned at an early date, the following amounts would probably be expended within the periods named:—

		RS.
Up to April 1892	Plant	1,47,500
	Works	85,000
		2,32,500
April 1892 to 1893		4,00,000
After April 1893		3,00,200
	Total ..	9,32,700

ENCLOSURE.

Note by Sanitary Engineer to Government on reference, dated 23rd April 1891, No. 327.

Colonel Pennycuick's suggested alterations of the undersigned's scheme for the improvement of the River Cooum having in the main the approval of Government, it is with some amount of diffidence that he ventures in the following paragraphs to point out to Government why he is of opinion that some of the suggestions made cannot, while others he considers should not, be adopted.

2. The value of Colonel Pennycuick's criticism of the scheme cannot be overestimated, and after the issue of Colonel Pennycuick's first note, the undersigned had the advantage of discussing a few of the points which had occurred to him on first reading the note. He regrets, however, that a further study of the proposals made requires him to say that he is unable (at any rate, without further discussion) to accept the proposals hereafter referred to as improvements on his original design, and he desires to explain that it is with a due sense of the responsibility imposed on him on the one hand by his desire to see the scheme carried out in a manner likely to afford the best chance of success, and on the other hand of venturing to combat the conclusions and criticism of so experienced an officer as Colonel Pennycuick, to whose judgment in any case very great weight must be attached.

3. It is not proposed to discuss any of the minor alterations proposed. The points which seem to demand further discussion are these:—

(1) The proposal that the water shall enter by the canal and pass out by the mouth.

(2) The proposal that the intended level of the river bed at the mouth should be raised.

(3) The proposal to decrease in length the waterway of the Napier Bridge.

(4) The proposals made in respect of the weir at Harris' Bridge.

4. The other suggestions of Colonel Pennycuick, in framing the revised estimates (which will hereafter be referred to), have been accepted.

5. It will be observed that of the proposed canal Colonel Pennycuick intends to make a use different from that for which it was originally designed. The original proposal was on the basis that the river would thus have a new mouth, as it were, which would be always open and through which the water would pass in and out. Colonel Pennycuick's objection to this is that the Harbour authorities might object to the *exit* of polluted water from the Cooum (though possibly in a day or two after opening of the canal the water would be comparatively pure). He therefore proposes that the water should enter from the harbour (and by this means he hopes that better circulation would be secured), and that the tidal water should then find its exit by the existing mouth. But this latter part of this proposal *is in fact the main difficulty in the whole scheme.*

6. In paragraph 19 of his first note Colonel Pennycuick says: "There need be no question of the power of the tidal water, controlled as proposed, to keep open a passage through the bar. The average discharge is about 1,200 cubic feet per second, and it is certain that the discharge of the Cooum did not approach this amount during any large number of the days during which it kept the bar open, as stated in paragraph 7 of Mr. Jones' report."

7. This is the very point to which in the original scheme so much attention was devoted, viz., the means of keeping open the bar, and *if the bar can be kept open by the exit of the tidal water controlled by the proposed sluices, then what is the use of the canal at all?* for if the exit can be kept open *by the scour of the outgoing tide alone, then the tide will find no obstruction to its entry into the river, and the entrance between two short groynes would be a very much better entrance for the tide than through a canal 1½ miles long.* After discussing the question of the exit passage at the bar with Colonel Pennycuick, he seemed to be of opinion that in any case the inshore groynes which are placed there so as to form a built channel would be necessary; so that in fact should the canal scheme be adopted the bar scheme also to some extent would have to be so, omitting the sea groyne, about the advantage and result of which Colonel Pennycuick is so doubtful.

8. It will be noticed that the *manner of admission of the water to the river does not at all bear on the question of the keeping open of the bar.* Whether the water is pumped in or brought in by canal or otherwise, *it is to the effects of the quantity and head of water above low-tide level during the exit of the tidal waters from the river to which we must look for the result desired*, and putting aside consideration of the better circulation to be gained by the entrance of the water through the canal, the canal, as far as the undersigned can judge, if used in the manner Colonel Pennycuick proposes, will serve no good purpose.

9. Colonel Pennycuick says that the mouth of the river can be kept open by *backing up the water in the river and allowing it to flow out at low tide. If that is so, then the water will flow in at the mouth on the flood tide and nothing more is required.* This is practically the original No. 1 Scheme with the omission of the sea groyne, which the undersigned believes will still be required to keep the mouth open, whether the water is admitted by the mouth or by the canal.

10. It is, however, always advantageous to "hasten slowly" in such matters as this, and if Government, having followed the arguments adduced, is still of opinion that the canal may be unnecessary, the undersigned would ask that, without pledging itself to one scheme or other—that is, the sea-groyne scheme or the canal scheme—Government will in the meantime sanction the construction of the inshore groynes only with the other portions of the scheme as modified below. This is practically what was proposed in paragraph 62 of the original report. The canal or the sea-groyne can then be added if necessary after a further consideration of their respective merits, which it would appear is very desirable.

11. The next point is the question of raising the river-bed above the level originally proposed. The principles on which the proper level of the bed was determined were very fully gone into in the report, but Colonel Pennycuick proposes that the level of the bed should be raised from 10·50 above datum to 14·00.* It is hardly possible that this can, or should,

* High-water level, 21·47.

be effected, and on discussion Colonel Pennycuick did not consider it an essential point, especially as spoil has to be provided to fill the north arm, though it will cost less if taken from the shore than from the river-bed.

12. But in addition to the reasons given for the level proposed in the original report, there are strong reasons against the adoption of so high a level as that proposed by Colonel Pennycuick; one is this that the bed at Law's Bridge which cannot be raised (which bridge is 1½ miles up the river) has a level of only 13·96, and so that the river-bed would be practically level for 1½ miles, and this would certainly tend to cause flooding which should be avoided. Again, the proposed canal would enter below Law's Bridge. It is proposed to give this canal, if constructed, 300 feet area below low water, and as not more than 75 feet of width can be obtained through the Fort Ditches, the canal will have to be 4 feet deep and have its bed at junction with river at a level of 13·47. This is a lower level than Colonel Pennycuick proposes that the river should have at the mouth. Therefore, while desiring to meet Colonel Pennycuick's views in this respect, it does not appear desirable that the sill of the sluices at the mouth should be at a higher level than 13·47—1 = 12·47 (say, 12·50), and in the revised estimates for the inshore groynes and sluices, the excavation of the bed, &c., this figure has been adopted. Further, the depth of water in which a tide flows is an important factor in the time the tide will take to travel up the river, and the greater depth the more speedy will be the inflow of the tide; it is well, therefore, on this ground alone to keep the depth as great as it conveniently can be made, especially as the tidal flow, as proposed by Colonel Pennycuick, is not to be limited as originally proposed. The benefit to be derived by the greater depth did not, of course, enter into Colonel Pennycuick's calculations, as the tides he proposed should enter by the canal and only ebb at the mouth, though possibly the depth might also affect the speed of the ebb.

13. The next point to be noticed is the proposed decrease in the waterway of the Napier Bridge which Colonel Pennycuick proposes to reduce (and the sluices would have the same waterway) to 300 feet from its present length of 450. To secure the proposed velocity of 10 feet per second means a backing up of the river, and the backing up of the river means flooding the Island, the Napier Park, &c. One object kept in view during the preparation of the scheme was to endeavour to lower the flood level as much as possible, and the places mentioned, even with the existing amount of waterway, are occasionally very much flooded. It is true that the 300 feet of waterway proposed will discharge the river at a velocity of 10 feet per second, but the natural velocity of the river in flood is only 5 feet per second. It is thought that Colonel Pennycuick in making this proposal has omitted to consider how the waterways of the bridges above compared with his proposal. It will be found that Government House Bridge—4,220 feet from the mouth—has 380 feet of waterway (with piers), or 80 feet more than that proposed for Napier Bridge. If Napier Bridge is made 300 feet, the mouth of the river, which from calculations made requires (to keep the floods down below the banks) a breadth of about 450 feet, will be unduly throttled. Colonel Pennycuick, in recommending the extension of St. Andrew's Bridge, has admitted the principle that the waterways lower down the river should not be less than those above, but in this instance would apparently depart from the principle, it is presumed on the grounds of a small economy which would be effected, but the result would be much inconvenience by the extra flooding of adjacent lands, such as Napier Park, Government House grounds and the Island. The allowance in the estimate as revised is therefore Rs. 76,000 for sluices.

14. In regard to the weir at Harris' Bridge, the only remark necessary is that one reason for the proposal to have four weirs, and not one as proposed by Colonel Pennycuick, has been overlooked; from an engineering point of view Colonel Pennycuick's proposal has everything to recommend it, but a reference to paragraph 120 of the original report will discover the sentence: "It is desirable to keep the weirs as low as possible in order not to back up the subsoil water to too great a height under adjoining lands." The extra height of 3 feet proposed by Colonel Pennycuick in his second note would effect what the undersigned endeavoured to avoid. The Sanitary Engineer was, when he wrote his first report, under the impression that a high level

3017
48

of subsoil water brought about unhealthy conditions; such impression would appear not to be well founded: *vide* paragraph 19 *et seq*. With Colonel Pennycuick's weir as proposed, the water can be retained at any height, but if the water level is reduced at this weir it must be so for the whole length of the river above the weir, while with two or three weirs the height can be better regulated according to the level of the lands adjacent to the river.

15. It is understood that a question has arisen as to what will be the effect on the level of the subsoil water, due to the rise and fall of the tide, in the lower part of the river under the proposed scheme, and it may therefore, following up the last paragraph, be opportune to make reference to that question.

16. Referring to paragraph 7 of the original report, it will be observed that during 60 days in the year on an average we have a state of matters similar to what, under the scheme, will be introduced permanently. The remaining 10 months need therefore only be compared. When the bar is closed, it is usually so at high spring tides, and the water stands in the river about 3 feet above low-tide level. The bar has been closed as late as the 21st January, but we may take the 1st January as an average. From that date it would require $\frac{3 \text{ ft.} \times 12}{\frac{1}{3}}$ or 108 days (taking evaporation during these months at $\frac{1}{3}$ per day) to lower the water down to low-water level. This would occur about the middle of April. In most years rain occurs between this date and June, or it is possible to raise the level of the Cooum (and it is raised as in the present year) above low-water level, and it is believed that for the remaining portion of the year—say, from the end of May until the beginning of October—it stands about mean-tide level, if not higher, because each fall of rain or small fresh raises the river until eventually it bursts its bar or the bar is relieved to allow the water to flow out.

17. For the greater portion of the ten months, therefore, the Cooum is above mean-tide level, and as under the new proposals the Cooum will be only 6 hours per tide above mean-tide level, or 12 hours per day, it is probable that under one set of circumstances or the other the average level of the subsoil water will, so far as the Cooum is concerned, be very much the same, but by reason of the proposed rise and fall of the tide in the river, horizontal circulation will be attained and stagnation of subsoil water avoided to a larger extent than at present prevails, and this will be a distinct benefit. Had levels of the Cooum throughout past years been available, an accurate comparison could have been made, but this for want of information cannot be so.

18. But it has not been proved that the level of the subsoil water under Madras is entirely dependent on the level of the water in the Cooum, for the subsoil water as far as half-a-mile inland, *as is known for certain*, and possibly for a mile inland (within which distance the portion of the Cooum to be dealt with tidally lies), is affected by the daily rise and fall of the tide during the dry season and the subsoil water is raised above high-tide level during the wet season very considerably; therefore, whether the river is tidal or not, the level of the subsoil water along the lower reaches is not likely to be affected at all.

19. The foregoing arguments have been put forth directly in view of the supposed contention that an increased level of subsoil water is unhealthy; but the conclusions arrived at by the President of the Meteorological Society in a late address do not bear out that view, for he stated that investigations had proved that one set of diseases were rife during the period the ground is filling up with water and expelling the ground air, and another set of diseases when the reverse action took place; that enteric fever, cholera, diarrhœa and dysentery are more prevalent with a low level of subsoil water than with a high level—these diseases are very fatal in Madras; on the other hand, small-pox is said to take place after a long drying of the ground and when the subsoil water begins to rise.

20. It was further stated that in England, as a rule, typhoid fever occurs at periods of the year when the waters are unusually low and on the rise of the water. Coming nearer India, it has been found that a low "Nile" always marks an unhealthy period. The conclusions come to were, therefore, that disease is increased, not by the absolute height of the subsoil water—though a low level is always contemporaneous

with unhealthy years—but that it is the fluctuation of the level of the water which causes an increase in the various diseases, and a year will be proportionately unhealthy in regard to the number of fluctuations occurring.

21. If, therefore, the Cooum is kept open and varies only an amount exceedingly less than 3 feet per day, it will bring about a much improved set of conditions than those which exist when it is shut up for months and every fall of rain causes the subsoil to rise in a greater proportion than that fall, because the only means of escape of the rain *vid* by the Cooum is shut off and the rise in the Cooum under such circumstance gives a higher rise of subsoil water than that due to the actual amount of rainfall, because the river receives all the surplus from its drainage area, which is eventually redistributed through the subsoil.

3017/41

22. Referring to Colonel Pennycuick's remarks in paragraph 23, it is only necessary to point out that, under the original proposal for the manner in which the canal to the harbour was to be used, there did not appear to be any necessity for the sluice gates at the harbour. The gates proposed at the Napier Bridge were, under No. 1 Scheme, to bund up the water to ensure a scour and keep the bar open; in the harbour there would be no bar, and it is thought that it would have been under the original proposal advantageous to have allowed free circulation and the natural fall of the tide through the canal. Under Colonel Pennycuick's proposal the case is different, and of course the necessity for the sluice gates is apparent. The canal as originally proposed was to have flowed towards and also *from* the harbour, while the canal under Colonel Pennycuick's scheme was to have flowed from the harbour only, and hence the necessity for the gates.

23. In calculating approximately the cost of the canal, the cost of the Junction canal was taken to some extent as a guide, but no detailed estimates were prepared and it is now doubtful whether the cost will not be more than originally anticipated, because there is an omission of one item which will be of considerable cost, viz., a swing-bridge over the canal entrance at the harbour to allow of traffic along the breakwaters, and the syphon works will also be somewhat more expensive than at first presumed. As it is hoped, however, that the proposal made in paragraph 10 above will be accepted, it has not been thought necessary to work out the details of the canal scheme before submitting this reply to the notes under reference.

24. It is believed that the main points which can affect the efficiency of the scheme have now been fairly discussed, and with regard to the upper portions of the river, the improvement of which is not a necessity, it is left to Government to say what amount it can devote to that object, which is perhaps more a matter which ought to be viewed in a sanitary than an engineering sense. It would perhaps be advisable to remove some of the higher portions of the bed, which would be quickly uncovered by the fall of the water below weir top level and generally to protect the banks. This could probably be accomplished for a sum of about Rs. 12,000.

25. In paragraph 39 of Colonel Pennycuick's report, the amount of Rs. 84,000 considered as the probable saving on account of the omission of the two locks is underestimated; the cost of the two locks, including the rebuilding of St. Mary's Bridge, is entered as Rs. 42,000 + 90,000 or Rs. 1,32,000, but of this only Rs. 30,000 is due to the cost of the bridge, so that the saving will be Rs. 1,02,000.

26. The estimate for St. Andrew's Bridge has been checked, the calculations and measurements were found correct, but though Public Works Department rates have been used, they in some instances appear insufficient and the amount entered for baling (a class of work not easy to estimate) was not ample. A provision for centering had also been inadvertently omitted. The estimate as revised stands at Rs. 6,151.

27. Under the view that Government will be inclined to accept the proposals as now put forward, the estimates have been revised and now show a total of Rs. 9,32,700, but this includes Rs. 1,47,500 for plant which can afterwards be disposed of and credited to the work. The omission and additions are shown in a comparative statement. Neither the cost of the sea-groyne nor the cost of the canal is included, the adoption of either being left open for future settlement.

28. If the canal is ever made it should be, it is thought, constructed as a navigation canal, and there is reason to believe that a considerable traffic will take place between the canal basin and the harbour. Some return may therefore be expected against the expenses to be incurred in the construction of that work, and a large return undoubtedly will be received by the construction of the wharves in the river. Government itself is now paying Rs. 1,600 rent for a canal wharf erected by the Municipality in Black Town, and wharves in the vicinity of Triplicane, Vepery and Chintadrepett ought to pay in no less a degree.

FORT ST. GEORGE,
9th June 1891.

(Signed) J. A. JONES,
Sanitary Engineer to Government.

Reference, No. 544.

Referred to Colonel Pennycuick, for remarks.

OOTACAMUND,
13th July 1891.

(Signed) J. F. PRICE,
Chief Secretary.

Note by the Chief Engineer.

There is nothing in Mr. Jones' note of the 9th June 1891 to induce me to alter in any way the opinions expressed in my former notes on the subject of the improvement of the Cooum.

2. Paragraph 5 of the note under consideration shews that Mr. Jones has misunderstood the reasons which induced me to urge the necessity for allowing sea-water to enter the Cooum at one point and leave it at another.

3. These reasons were clearly and fully explained in paragraphs 12 to 19 of my note of the 11th March, and I see no occasion in any way to modify the opinions therein expressed.

4. Mr. Jones is entirely mistaken in stating that "Colonel Pennycuick's objection to this" (his original proposal) "is that the Harbour authorities might object to the exit of polluted water from the Cooum." My objection was, as stated in the plainest possible language in paragraph 13 of my first note, that the plan would produce oscillation only and not circulation, the latter being essentially necessary. The interest of the harbour was referred to in paragraph 20 as an *incidental* advantage of the modification suggested by me.

5. Since my return from leave I have had the advantage of discussing this question with Mr. Walch, which to my great regret I was unable (owing to his absence from Madras) to do before writing my first note, and he entirely agrees with the opinions expressed in paragraphs 9 and 10 regarding the probable effect of the sea groynes.

6. It is necessary to speak plainly upon this point, and it is my firm conviction that Mr. Jones' original "No. 1" Scheme (of keeping open the mouth of the Cooum by sea groynes) would be worse than useless; his "No. 2" Scheme by itself would be of but little practical value, but with the modifications suggested in paragraph 17 of my note it will be perfectly efficient.

7. The proposal in paragraph 10 of Mr. Jones' note under reply cannot be accepted; it is useless touching the river unless the canal from the harbour and sluice at the Napier Bridge are constructed.

8. With regard to the level of the river-bed referred to in paragraphs 11 and 12 of Mr. Jones' note, I am not aware that I said anything about "raising the level" of the river-bed; what I said, and now repeat, is that there is no necessity for placing the sill of the Napier Bridge sluice at a lower level than 14·00 above datum, and consequently no necessity *for excavating the river-bed to below that level*; of course, where it is now below that level, no one would dream of raising it.

9. For purposes of flood discharge, the level named (14·00) is quite low enough, but as it appears that the bed of the canal from the harbour must be at 13·47 or 4 feet below low-tide level—a depth which is also desirable in the interests of navigation—there is no objection to the sluice sill being put at 13·00.

10. My calculation of the length of waterway required at the Napier Bridge was not made without due consideration of the various data; the velocity of 10 feet per second would be obtained with the present M.F.L., but if it be desired to lower the latter, of course increased waterway would be necessary. As, however, it is now proposed to place the sluice sill at 13·00, instead of 14·00, the length of 300 feet would be ample. This should be the total length of sluice way provided; and if a new bridge has to be built, it need not be longer than this. Of course, it is not suggested that the existing bridge should be shortened.

11. Mr. Jones' argument from a comparison with the length of waterway of the inland bridges is not sound; depth and velocity have to be taken into consideration as well as length, and there is no connection between the velocity in the river channel proper and that through a sluice at its mouth, discharging into a sea whose maximum level is 4 feet below that of the river above the sluice.

12. With regard to the upper portion of the river, I do not know that I need add anything to the remarks in my former notes; I entirely agree with Mr. Jones that the matter is one which should be regarded from a sanitary (and financial) point of view rather than from an engineering one, but what I must repeat is that, if from a sanitary point of view it is considered desirable to keep the upper portion of the river-bed covered with water, this cannot be done by the small dams originally proposed by Mr. Jones, and some such arrangement as that indicated in my note of the 2nd April must be adopted.

13. I entirely agree with Mr. Jones that the canal from the harbour should be adapted for navigation; in point of fact, it is pretty certain that such a canal would have to be constructed sooner or later without any reference to the improvement of the Cooum.

OOTACAMUND,
21st July 1891.

(Signed) J. PENNYCUICK, Colonel, R.E.,
Chief Engineer, P.W.D.

No. 569 D.

Transferred to the Local and Municipal Department.

OOTACAMUND,
22nd July 1891.

(Signed) J. PENNYCUICK, Colonel, R.E.,
Secy. to Govt., P.W.D.

To the Local and Municipal Department,
with papers, &c., returned.

REFERENCE—dated 18th August 1891, No. 645.

With reference to his note, dated 21st July 1891, Colonel Pennycuick is requested to state his opinion as to the effect which will be produced, under his scheme for the improvement of the Cooum, on the portion of the river between the junction of the proposed canal and Harris' Bridge. From the facts before Government, it would appear that the sewage entering above the junction will be in a condition of mere oscillation to and fro, and that, unless means for dealing with this are suggested, the scheme will be incomplete.

(Signed) J. F. PRICE,
Chief Secretary.

To the Chief Engineer, Public Works Department.

No. 745 D.

Note by the Chief Engineer, Public Works Department.

The effect of the proposed improvements to the Cooum upon the portion of the river between the junction of the proposed canal and Harri's bridge will be quite sufficient to remove all sewage which enters the river between those points.

2. The space in question will be filled during each flood-tide, and the action of the sluices at the mouth of the river during the ebb will produce a current the velocity of which will depend upon the rise of the tide, but which will probably never be less than half a mile per hour, a velocity more than sufficient to carry any floating matter past the mouth of the canal (the distance being only just over a mile) in a single tide; once past the mouth of the canal, it must necessarily be carried out to sea during the next tide.

It may be taken as certain that sewage entering the portion of the river in question will be fully cleared out once in every twenty-four hours.

I observe that the memorandum under reply speaks of "my scheme for the improvement of the Cooum." The scheme is not mine, but Mr. Jones', with certain modifications in detail suggested by myself.

OOTACAMUND,
21*st August* 1891. (Signed) J. PENNYCUICK, Colonel, R.E.,
Chief Engineer, P.W.D.

To the Chief Secretary to Government.

G.O., dated 7th August 1891, Mis. No. 1227A M., Local and Municipal.

Read—the following papers:—

Telegram from Secretary of State, London, to Governor of Madras, Ootacamund, dated 9th July 1891.

Your private letter 16th June last. If you wish me to look for sanitary expert please telegraph wishes officially, with reasons.

Transferred to the Chief Secretary to Government for disposal.

(By Order.)

OOTACAMUND,
10*th July* 1891. (Signed) J. D. REES,
Private Secretary.

Telegram to Secretary of State, dated 11th July 1891.

Madras Government and Municipality, Madras City, contemplate treatment of water-supply; drainage; purification of Cooum. Government cannot sanction large expenditure till examination by ablest expert procurable. We request your Lordship will engage such expert for period six months on suitable terms. Reason for undertaking schemes is supreme necessity for improving sanitation of city and reducing death-rate.

Telegram from Secretary of State, London, to Governor of Madras, Ootacamund, dated 31st July 1891.

Your telegram in the Public Works Department, dated 11th July. Qualified expert ready to start in September next. Fee 3,500 guineas with travelling and all other expenses. Should this be acceptable, please send full papers regarding subject for his examination during voyage.

Transferred to the Secretary to Government, Public Works Department, with note by His Excellency the Governor.

(By Order.)

1*st August* 1891. (Signed) J. D. REES,
Private Secretary.

No. 614 D.

Transferred to the Local and Municipal Department from which Department the telegram to the Secretary of State issued.

1*st August* 1891. (Signed) J. PENNYCUICK, Colonel, R.E.,
Secretary to Government, P.W.D.

Order—dated 7th August 1891, Mis. No. 1227A M., Local and Municipal.

The following telegram will be despatched to the Secretary of State:—

"Terms accepted. Please wire name of expert and date of starting."

(True Extract.)

(Signed) J. F. PRICE,
Chief Secretary.

Telegram from the Private Secretary to His Excellency the Governor, Tiruvellore, to the Chief Secretary to Government, Ootacamund, dated 29th August 1891.

Secretary of State telegraphs; telegram begins—"Your telegram of 7th August last, water-supply project. Cousins leaves London 17th September next, expected to reach Madras 16th October next"—telegram ends. Please circulate and telegraph meaning to me.

Telegram to Secretary of State, dated 1st Sep er 1891.

Your telegram of 29th August last. Please telegraph name of steamer.

Telegram from Secretary of State, London, to Governor of Madras, Ootacamund, dated 5th September 1891.

Your telegram of 1st September. Cousins sails by *Bengal* as far as Aden and by *Assam* from Aden to Bombay. Will arrive about the 6th October Aden.

ORDER—dated 19th September 1891, No. 1528 M., Local and Municipal.

Recorded.

2. Copies of all the papers relating to the water-supply and drainage of Madras will be forwarded to Aden for delivery to Mr. Cousins.

(True Extract.)

for Chief Secretary.

Copy to the President, Municipal Commission, Madras.
" " Public Works Department.
" " Sanitary Engineer.
" " Sanitary Commissioner for Madras.
" " Accountant-General.
" " Public Department.
" " Editors' Table.
" "

Exd. P. L. Pereira.

P. W. CURRENT No. 1117

6/12/10 ✓

Govt. of {1891} Madras.

LOCAL AND MUNICIPAL.

Issued

Recd. 10-11-91 Encl.

G.O., 19th Sept. 1891, No. 1528 M.

SEPTEMBER.

Sanitation.

Recording papers regarding the various schemes proposed for the improvement of the water-supply and drainage of the City of Madras and the purification of the river Cooum and the selection of an expert to report on the subject, and forwarding copies of the same to Aden for delivery to the expert.

No. 3017 Wdy 11-Nov/9

Recorded.

C. A. & C. Genl. ✓ D 12/11.
C. E. for Genl. ✓
R. E. ✓
Supg. Engr. II Circle ✓

D 25/11/91

D.C. 16-11

D 13/11.
es to order 17-11-91

order