

Gobt. of {1891} Madras.  
LOCAL AND MUNICIPAL.

Issued.

Recd.

Encl.

Reference, 23rd April 1891, No. 327.

APRIL.

The River Cooum.

Referring to the Sanitary Engineer, for remarks, Chief Engineer's note on the scheme for the improvement of—, and requesting him to specify, in detail, how far the amendments suggested by the Chief Engineer will affect the estimates already submitted.

6/4/12

11 papers

No. 1349 W-1/15 May 1891

Recorded.

(H) A.C.S.

W

GOVERNMENT OF MADRAS.

LOCAL AND MUNICIPAL DEPARTMENT.

READ—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.

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.

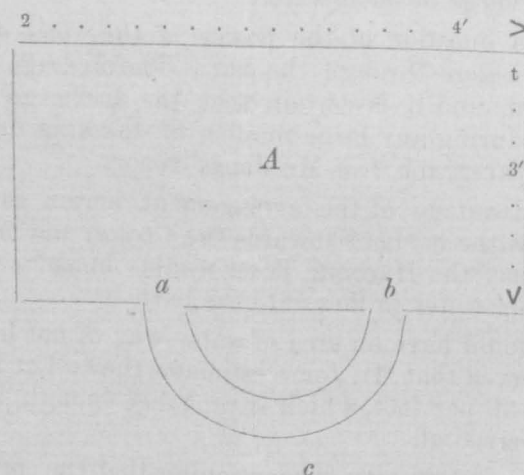
9. In the first place, it is by no means certain that the groyne proposed would keep the river mouth open at all; that it would remove the bar from its present position is certain, but it is not equally so that the latter would not reform further inland; my own belief is that it would do so, though the 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  $abc$  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  $abc$ , 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  $abc$ .

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; 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 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  $\frac{12,750,000}{6 \times 10,800} = 197$  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.

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  $4\frac{1}{2}$  feet. As, however, the wing wall is  $5\frac{1}{2}$  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,  
16th 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 Ramrajapuram 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  $7\frac{1}{2}$  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  $7\frac{1}{2}$  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  $7\frac{1}{2}$  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. ~~40,000~~ <sup>82,000 less</sup> more than the cost of the four dams proposed by Mr. Jones and Rs. 27,750 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,  
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(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.

O. V. BODDY, Major, R.E.,  
Under Secretary, P.W.D.,  
for Chief Secretary.

To the Sanitary Engineer.  
" Public Works Department.

Er. P. L. Pereira.

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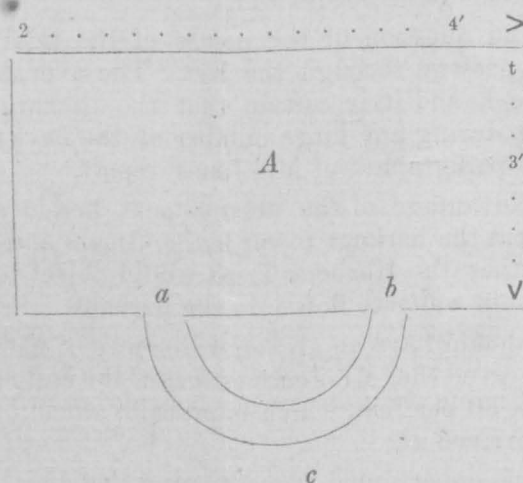
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33. At the best this scheme merely provides for covering the bed with a series of pools of stagnant water, which would be only in a very small degree (if at all) preferable to the dry bed.

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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,

16th 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 Ramrajparam tank in connection with the Periyar 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-foot 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  $7\frac{1}{2}$  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  $7\frac{1}{2}$  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-foot span—sill of sluice 16.00, top of shutters when down 23.50; lift  $7\frac{1}{2}$  feet. Springing of arches 24.00, crown 27.00, roadway 29.50. Shutters to be worked with double screws as in the Cauvery and Vennar regulators.

12. The cost of this sluice would be about Rs. 40,000 or about Rs. 82,000 more than the cost of the four dams proposed by Mr. Jones and Rs. 27,950 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, (Signed) J. PENNYCUICK, Colonel, R.E.,  
2nd April 1891. 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.

O. V. BODDY, Major, R.E.,  
Under Secretary, P.W.D.,  
for Chief Secretary.

To the Sanitary Engineer.  
„ Public Works Department.

Exd. P. L. Pereira.

Gobt. of {1891} Madras.  
LOCAL AND MUNICIPAL.

Issued

Recd.

Encl.

Reference, 23rd April 1891, No. 327.

APRIL.

The River Coom.

Referring to the Sanitary Engineer, for remarks, Chief Engineer's note on the scheme for the improvement of—, and requesting him to specify, in detail, how far the amendments suggested by the Chief Engineer will affect the estimates already submitted.

13494 of 15-5-91

Revised

(Sd) OUB

9-5-91

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GOVERNMENT OF MADRAS.

LOCAL AND MUNICIPAL DEPARTMENT.

READ—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.

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.

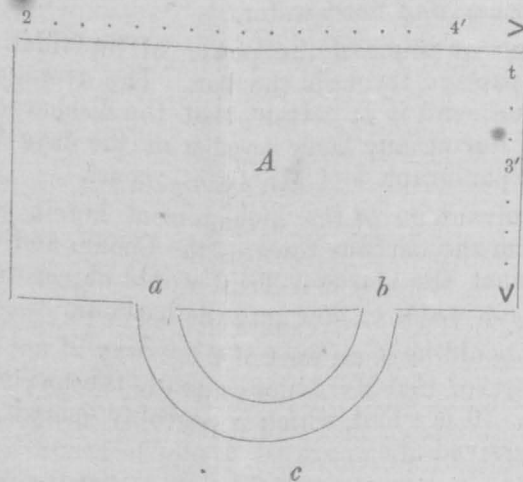
9. In the first place, it is by no means certain that the groyne proposed would keep the river mouth open at all; that it would remove the bar from its present position is certain, but it is not equally so that the latter would not reform further inland; my own belief is that it would do so, though the 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  $abc$  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  $abc$ , 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  $ab$  be kept open or one closed and the water admitted through the other; showing that there is nothing like real circulation in the trough  $abc$ .

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  $\frac{12,750,000}{6 \times 10,800} = 197$  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.

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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,  
16th 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 Ramrajparam 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-foot 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  $7\frac{1}{2}$  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  $7\frac{1}{2}$  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-foot span—sill of sluice 16.00, top of shutters when down 23.50; lift  $7\frac{1}{2}$  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. 82,000 <sup>less</sup> more than the cost of the four dams proposed by Mr. Jones and Rs. 27,950 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.

O. V. BODDY, Major, R.E.,  
Under Secretary, P.W.D.,  
for Chief Secretary.

To the Sanitary Engineer.  
„ Public Works Department.

Exd. P. L. Pereira.