

Local & Munl. (1896) Department.

MISCELLANEOUS.

G.O., No. 71 M

DATED 15th January 1896

[Despatch Abstract.]

Canal.

Communicating to the Municipal Commissioners Madras, G.O.,
Public Works Department, sanctioning the estimate for a --- from
the Madras Harbour to the Buckingham Canal.

BACK PAPERS.

G.O.	No.	Department.	Date.	G.O.	No.	Department.	Date.

FURTHER PAPERS.

G.O.	No.	Department.	Date.	G.O.	No.	Department.	Date.
Cm. 738h/96							

Local & Municipal Dept.

CURRENT No. 28m

IRRIGATION.
ACCOUNT.

Govt. of {1895} Madras.
PUBLIC WORKS.

Dated December, 14th.

Recd.

Encl.

6 spare copies

G.O. No. 1084 A I., 14th Dec. 1895.

CHIEF SECRETARY
-3. JAN. 1896
DECEMBER
DEPARTMENT OF MADRAS

Canal

Orders sanctioning the estimate, as revised by the Chief Engineer, of Rs. 9,50,000 for a — from the Madras Harbour to the Buckingham canal.

2/11/96
Order No. 71 Min. D/154-96
Communicated to the Municipal Commissioners
Madras

V.R.
11/1/96
15.1.96

To The Pres. M.C. Madras
17/1/96

11/1 2/11/96

GOVERNMENT OF MADRAS.
PUBLIC WORKS DEPARTMENT.

Irrigation.
Account.

READ—the following papers :—

From A. S. RUSSELL, Esq., Superintending Engineer, II Circle, to the Chief Engineer, Public Works Department, dated Madras, 13th November 1895, No. 61 C.

In continuation of this office letters, Nos. 212 B.C., and 39 C., dated 20th September 1895 and 1st November 1895, respectively, I have the honour to submit the plans and estimates for the Cooum improvement scheme as noted in the margin.

- 1 Comparative statement of original and modified estimates.
- 1 Note by Superintending Engineer suggesting modifications of Mr. Smyth's plans and estimates.
- 1 Report to estimate.
- 1 Letter and tracing from Agent, Madras Railway.
- 25 Estimates.
- 31 Plans with a list.
- 1 Classified abstract.
- 1 List of plans and estimates.
- 1 General abstract.

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2. The estimate was originally submitted by Mr. Smyth in August last. Revision was found necessary in certain particulars, and at the same time Government ordered the cost of protective arm in the harbour to be included in the estimate, which was consequently returned to Mr. Smyth. As already reported, no information can be obtained from the Harbour Board or Harbour

Engineer, and the estimate is, in accordance with your oral instructions, now forwarded without the inclusion in it of the works in or adjoining the harbour.

3. Detailed proposals for the preparation of the estimate were made and orders passed upon them in the papers noted in the margin. These papers comprise the only written record regarding details of the estimate and plans, and in paragraph 2 of his report to the estimate

Mr. Smyth states that these proposals have been "amended under the personal orders of the Chief Engineer." On receiving, on 4th instant, the plans and estimates from Mr. Smyth, I considered important modifications necessary, and, in accordance with your personal instructions given on 6th instant, I submit them accompanied by a note showing what modifications are necessary or advisable, as also by comparative statement giving differences in cost between original and modified estimates. The amounts entered in the comparative statement, for all modifications proposed, have been calculated, though time has not allowed for preparation of new detailed designs and estimates.

4 The original and modified estimates, inclusive of the Railway bridge over new canal between Beach road and Harbour (*vide* comparative statement), compare as follows :—

	Rs.
Original	13,75,722
Modified	14,91,100

resulting, notwithstanding that every economy possible has been effected, in a total increase of Rs. 1,15,378 of the modified over the original estimate.

This is mainly due to inherent defects, as is explained in the accompanying note in the designs made by Mr. Smyth.

5. *Coom river.*—The main deviation made by Mr. Smyth from the scheme approved in Chief Engineer's Memo. No. 573 C., dated 13th February 1895, is the proposal, in paragraph 16 of his report, for dredging out and keeping open by dredging a deep channel in the Coom. Not only would the maintenance of such a channel involve unceasing outlay, since it would fill up with every river fresh and would be blocked with sewage, which would most certainly not be carried out to sea by tidal circulation, but the proposals for raising the rest of the river-bed by the excavated, and highly contaminated soil, are open to great objection, while the proposal, in paragraph 17 of the report, to systematically shoot out pure sewage in large quantities "beyond canal banks," is wholly inadvisable. I have therefore cut out of the estimate the cost of dredging the Coom.

6. *Bed level of Buckingham canal from Basin to Coom.*—Mr. Smyth has not had sections taken at any of the bridges on the canal or Coom, or he would have discovered the fact that several of them have floors at level of about—4.00 M.S.L.

This consideration makes it advisable not to incur any outlay than can be avoided in lowering bridge floors and strengthening piers. A bed level of—5.50 M.S.L., or 3 feet below L.K.T., will both give a fair depth of channel for the free propagation of the tidal wave, and will not obstruct navigation, which is very heavy and continuous at all the wharves from the Basin to the Coom. The modified estimate provides for such a bed level, i.e., for saving of one foot in depth.

7. *Bed level of new Harbour canal.*—A similar bed level is proposed for the new Harbour canal. The reduction in depth can be made up, if considered necessary, by increasing the bottom width, but I do not think it worth the expense, since depth is far more important than width, and as the dimensions of the new canal are proportionate to those of the Buckingham canal, into which it discharges. If the Harbour canal is made larger, the effect will not be to get a better tidal flow into the Coom, which is the main object of the scheme, as the extra momentum of the tidal wave will be throttled on entering the Buckingham canal.

8. *Economy effected by adoption of proposals in paragraphs 5, 6 and 7.*—The proposals in the three above paragraphs will, if adopted, effect a saving of about Rs. 70,000—vide items (15), (18) and (19) of comparative statement which amount to a total of Rs. 54,530, while about Rs. 15,000 must be allowed for extra work on items (12a) and (19a), (which Mr. Smyth altogether omitted to take into consideration) involved by dredging to so low a bed level as—6.50 M.S.L.

9. *Principal excess shown in comparative statement.*—Three heavy items of excess on Mr. Smyth's estimates are (2), (17a) and (20) of comparative statement. These excesses cannot be avoided, and the necessity is demonstrated in the note accompanying and in paragraph 13 *infra* of this letter.

10. *Tramway for disposal of spoil from new canal.*—This tramway is necessary, and the reasons for it, and manner in which spoil is to be deposited, are discussed in paragraph 13 of Mr. Smyth's report. The Agent, Madras Railway, has been requested to state at an early date whether he accepts the debit of Rs. 70,000 for earth-work to be done for railway.

11. *Dredger.*—A dredger and plant will be required for excavating the last foot in depth of the new Harbour canal, and for deepening the canal from Basin to Coom. On completion of the work, it can be transferred at a valuation to the Buckingham canal division.

12. I do not recommend the adoption of the proposal, in paragraph 19 of Mr. Smyth's report, to fit up only one or two experimental shutters to the regulator at the mouth of the Coom, until it is seen whether the bar keeps open. I have personally no doubt whatever that the bar will have to be aided, at times, by manual labour to keep its mouth open, but the whole success of the scheme depends upon impounding tidal water, and letting it out, after half ebb, with a rush at the particular point where it is required to play upon the mouth of the bar—the latter moving under the influence of the prevailing winds and strike of the waves.

13. With regard to paragraph 20 of Mr. Smyth's report, I would merely remark that, while navigation will be stopped in junction canal by the adoption of such proposals, sanitary conditions of the canal will be little, if at all, improved, since no clearance whatever is provided in the very worst portion from 3 miles at Mylapore to 5½ miles at Adyar; heaps of sewage will frequently be exposed to the air; and the tidal flow will be of a comparatively feeble character. If the junction canal is to be frequently scoured, it *must* be deepened throughout its whole length, unless it is to fall into disuse as a line of navigation, since the bridges are too low to permit of traffic plying at high tides. The original proposals made in letter No. 2475, dated 18th January 1895, from the Executive Engineer, Buckingham Canal, and approved by the Chief Engineer, contemplated deepening the whole 4 miles to—5.50 M.S.L., and the construction of a powerful scouring and regulating work with a low level sill. I have cut out altogether Mr. Smyth's proposals from the estimate, and recommend that, in consideration of the Coom scheme doing entirely away with the utility of the junction canal lock (the sole object of which is to hold up the water level) and entirely altering for the worse the navigable conditions of the canal, a contribution of half a lakh be made by the Coom scheme, and the balance of the cost for improving the sanitary conditions of the canal, while at the same time preserving its utility as a line of navigation, be met from the funds of the Buckingham Canal division, the Executive Engineer of that division working out a scheme to effect both objects. The result of this alteration will be a net increase of Rs. 40,450 (vide items (20), (22), (23) and (24) of comparative statement) to Mr. Smyth's estimate.

14. For the execution of the whole project, I recommend that a special sub-division be formed in charge of Mr. Smyth, and be attached to the Buckingham Canal division, with the following executive and office establishment.

- 1 Sub-Division officer, Mr. Smyth, Executive Engineer.
- 1 Sub-Engineer.
- 2 Supervisors or Overseers experienced on masonry works.
- 1 Accountant.
- 1 Clerk on Rs. 40.
- 1 do. " 30.
- 1 Draftsman on Rs. 50.

The works are in a ring fence, and can with ease be inspected daily, and experienced contractors can be got in any number in Madras.

The working of the tramway will, it should be noticed, require almost the undivided attention of a smart upper subordinate. I deprecate the work being taken from under the control of the Executive Engineer, Buckingham Canal. It is so intimately connected with the canal that it cannot be separated from the same general executive control without confusion and delay arising in the settlement of the various questions that must inevitably crop up during the execution of the works.

15. I have already brought to notice in the marginally-noted documents the necessity for special arrangements being made for acquiring land expeditiously, and making payments, so as to utilise grants. It seems advisable that the Military Department be now moved to Paragraph 7 of Superintending Engineer's No. 15 C. of 16th October 1895, to Chief Engineer for Irrigation, and paragraph 5 of enclosure to same letter.

take steps to hand over the lands in their possession. 16. I have signed Mr. Smyth's plans with remarks, but his estimates require material alterations if my modifications are accepted, and the comparative statement forwarded shows the lump sums required. If these modifications are approved by you, detailed estimates can be prepared by Mr. Smyth.

17. It is necessary to point out, in conclusion, that the earth-work of the project is the *first thing* to be put in hand, and must be pushed on energetically, since it should precede the construction of the line joining the East Coast Railway with the Madras Railway—a work, I understand, shortly to be begun. After the line has been constructed, it will be difficult to carry out the land reclamation proposed in paragraph 13 of Mr. Smyth's report to estimate.

ENCLOSURES.

Note by Officiating Superintending Engineer, II Circle, on Plans and Estimates submitted by Mr. Smyth, Executive Engineer, for Coom Improvement Scheme.

Wing and retaining walls.—General remarks.

Throughout Mr. Smyth's designs the wing and the retaining walls are generally of insufficient thickness. The proper mean thickness has been, calculated, and an extra allowance made on this account and entered in the comparative statement.

Use of cement or surki concrete for well foundations.—On the Buckingham Canal, all wells for lock foundations, going down to the level of -15.25 M.S.L., and 6 feet in depth, have been filled in entirely with surki concrete, which has been found to set quite well. A similar economy might be practised in the Coom estimates for wells not exceeding such depths or not going to a lower level, and the well foundations allowed by Mr. Smyth, in his designs for bridges on the new Harbour canal, have been modified accordingly. Where cement concrete has been provided for well foundations, it is specially mentioned.

Remarks on plans, estimates and report to estimates.—To facilitate reference, I have entered brief marginal remarks on plans, estimates, and report submitted by Mr. Smyth.

Plan No. 1 and Plan No. 2, sheet No. 1.—The estimate provides for no works east of Beach road, except for railway bridge, the design for which is shown in Plan No. 14.

Plan No. 2, sheet Nos. 2 and 3.—Bed level proposed by me to be fixed at -5.50 M.S.L.—*vide* paragraph 7 of accompanying letter.

Plan No. 2, sheet No. 4.—From Beach road bridge to some little distance on the other side of Royapuram lock (*vide* plan No. 2, sheet No. 1) the revetment of laterite blocks, laid at the steep slope of $1\frac{1}{2}$ to 1, and unsupported by any toe wall at foot, is not safe and would not stand the earth pressure, to say nothing of the risk of slipping and being undermined by tidal score.

The reasons for adopting such a revetment are given by Mr. Smyth, in paragraph 8 of his report, but are not satisfactory. Land in this portion of canal is so hard to get, and the rush of the tide will be so great, that it is necessary to run the canal in this portion between retaining walls, which will conveniently allow of giving loading and unloading facilities on side *opposite* railway, adding steps so as to make a regular wharf wall, as shown on sketch A.

On the opposite or northern side, it will be left to the railway to provide wharf steps, if they wish to, and a retaining only is provided from canal estimate, with its top at level of $+4.50$ M.S.L.

The retaining wall will be of concrete with granite coping and the steps of laterite, which is suitable, above water, but wears badly in salt water.

Plan No. 3.—The laterite revetment, shown at toe path level, is unnecessary, and the ground will be cut and turfed at its natural slope.

The wells, 8 feet in depth, under the storm gate, go down to the very low level of -19.50 M.S.L.; the percolation will be excessive; and the difficulty in lowering the concrete will be considerable. Cement concrete will therefore be used for these wells, but all other wells will be filled in with surki concrete, as their bottom level does not exceed -13.50 M.S.L. and their depth is only 5 feet.

Plan No. 3, sheet No. 4.—The storm gate will probably be rarely used, but a heavy swell will roll up the leading channel to the lock in rough weather, and it is convenient to have the means of closing the canal to the sea, when necessary or advisable for protection of traffic.

Plan No. 4, Inverted Syphon.—A concrete retaining wall, with its top at $+4.50$ M.S.L., is allowed in place of the steep laterite revetment.

Plan No. 5 and Plan No. 6, sheet No. 1.—Wings strengthened, calculations made for velocity, and flooring found not necessary, particularly as bed level of canal is now proposed to be only -5.50 M.S.L., instead of -6.50 M.S.L.

Plan No. 7.—Design very defective. There is no necessity to go to the expense of building wing walls 75 feet long. The site of the lock has been moved near wharf wall, and a wing of normal length, viz., $1\frac{1}{2}$ times height, is proposed to be built into wharf wall. On the other side, a wing of the same length is provided, and will be joined on to high ground by an embankment. The soil is slush and not sand, and the Madras wharf wall adjoining had to be built on fascines, and gave a great deal of trouble in construction. Below level of -10.00 M.S.L. wells of 5 feet, filled with surki concrete, are necessary and are provided.

Plan No. 8.—A saving of 1 foot depth of excavation can be made, as recommended in paragraph 6 of letter accompanying, but items (12 a) and (19 a) of comparative statement (*vide* paragraph 8 of letter accompanying) are necessary and must be carried out.

Plan No. 9.—If the Coom is not to be dredged, this weir is quite unnecessary, as the run of the tide practically ceases immediately beyond its site.

Plan No. 10, Sheet No. 1.—The abutments of the existing Napier bridge are founded on 16-feet wells, and other bridges on the Coom have the same depth of foundations. The site of regulator is very exposed, while heavy scour is probable, and has already been observed in former years at the Napier bridge. Wells, 15 feet in depth, the bottom 7 feet, of which will be filled with cement concrete from 23.50 to 16.50 , and the upper 8 feet with surki concrete, are necessary, and are provided in the modified estimate. I am not at all sure that it would not be prudent to add an apron and retaining wall on the sea side of regulator sill, but the modified estimate has already so greatly exceeded the original estimate that I have not estimated for this.

Plan No. 10, Sheet No. 2.—Design made by Mr. Smyth is defective. The shutters will be subject to water pressure on each side alternately, the pressure on the sea side, however, never amounting to more than that due to a maximum head of $1\frac{1}{2}$ feet, owing to full rise of tide being experienced on that side long before it is felt on the other, the distance from harbour to Coom mouth by river and canal being five miles. This somewhat complicates matters. The modified estimate allows for horizontal girders at the level of H.S.T. on each side of the uprights, and for double screw-gearing, and Mr. Smyth has been requested to submit a fresh design and detailed estimate.

Plan No. 10, Sheet No. 4.—The possibility of heading up of floods above the regulator, owing to heading up of water at high tide above mouths of Coom outfall, has been pointed out in paragraph 27 of letter No. 2475 of 18th January 1895 from Executive Engineer, Buckingham Canal. I understand from Mr. Smyth that the Chief Engineer considers the water-way now allowed to be sufficient.

Plan No. 11, Sheets Nos. 1, 2 and 3.—Proposed work all cut out of modified estimate—*vide* paragraph 5 of letter accompanying.

Plan No. 12, Sheet Nos. 1 and 2.

Plan No. 13.—Altogether omitted from modified estimate—*vide* paragraph 13 of letter accompanying.

Plan No. 14.—Exact site of railway bridge not shown. Site plan has been asked for. It is believed the bridge crosses the canal at a curve, and that the piers present the least possible obstruction to traffic, an essential point, as a very rapid tide will set in down the canal from the harbour.

(Signed) A. S. RUSSELL,
Offg. Superintending Engineer, II Circle.

13th November 1895.

REPORT to accompany estimate for a canal from the Madras Harbour to the Buckingham Canal and for improvements to the River Coom.

General.—The estimate is prepared in accordance with the general lines laid down in the papers recorded with G.O. No. 1528 M. of 19th September 1891, and with the note by the Chief Engineer, Public Works Department, dated 14th August 1894.

2. Detailed proposals were submitted by the Executive Engineer, Buckingham canal, in his No. 2475, dated 18th January 1895, and criticised in a memorandum by the Chief Engineer, No. 573 C., dated 12th February 1895, and these proposals have been still further amended under the personal orders of the Chief Engineer and among other things made to fit in with a scheme for certain improvements to the Madras Harbour.

3. These proposals may be briefly summed up as follows:—

The excavation of a canal from the harbour to the Buckingham canal north of the Salt Cotaurs, the admission of sea water during the rise of the tide through this canal into the Buckingham canal and thence into the Coom river and its exit at or about half ebb at the mouth of the river Coom with the necessary regulating works.

Subsidiary to this is a second smaller channel and regulator from the junction canal to the sea a little north of St. Thomé to work in a similar way, i.e., the water will flow from the Coom river through the junction canal and out to sea by the new channel.

There will thus be a continual current flowing down the Buckingham canal through that portion of the Coom river surrounding the island and through the junction canal as far as St. Thomé, and there will be an oscillating current in the Coom river above the island up to a weir proposed to be built above Harris' bridge. The water in this portion will be also continually changing owing to the varying heights of the tides.

It is hoped that the purification thus effected of these at present foul waters will cause considerable improvement in the health of Madras.

4. *Harbour Canal.*—The canal will pass through the Harbour works yard, north of the Municipal Pumping station at Rayapuram and thence straight to the old Bastion and Bullet factory near the Rayapuram lines. Thence it turns northwards passing through the Sepoy lines

and from the Tiruvattur road it runs along side the proposed connecting link between the Ráyapuram and main lines of the Madras Railway entering the Buckingham canal at Cochrane's basin.

The reason of the bend to the north is to give the canal a fair entry into the Buckingham canal; this is essential to prevent loss of head and dissipation of the tidal wave through eddies which would otherwise occur.

Another advantage of this bend is that a part of the spoil will be used in forming the railway embankment alongside.

5. *Land and Buildings compensation.*—The only buildings of importance passed through one Messrs. Best and Company's workshop, the Municipal slaughter-house, the old Bullet factory now used in part as a school, the quarters of the Assistant Surgeon attached to the Ramaswamy Lying-in Hospital and the Sepoy lines. The estimate for land and buildings compensation amounts to Rs. 1,37,200 and includes the value of all land in the occupation of the Military Works Department and the Municipality excluding roads.

6. *Harbour Works.*—East of the beach road all works will be executed by the Harbour Works Board and are therefore omitted from the estimate with the exception of a wrought iron girder bridge to carry the Madras Railway over the canal.

7. *Beach Road Bridge.*—The beach road will be carried over the canal on wrought iron skew girders at an angle of 70°; a roadway of 22 feet is allowed for this and other bridges.

8. *Canal, Beach Road to Ráyapuram Road.*—From the beach road to the Ráyapuram road the canal will be walled in by a cut laterite revetment with a slope* of $\frac{1}{2}$ to 1 which will allow of boats being loaded and unloaded without

reach, the bottom width of which will be 100 feet. The cost of a masonry retaining wall is considered prohibitive,† being three and-a-half times that of the revetment.

9. *Ráyapuram Lock and Overbridge.*—At the Ráyapuram pumping station a lock 150 feet × 30 feet with cill level 8.50 will be built and the Ráyapuram road will be carried over its centre by a wrought iron girder bridge of 40 feet span. Storm gates, the design of which is modified from a design supplied by the Kidderpore Dock Superintendent, are provided at this lock.

10. *Storm Overflow Drain.*—The storm overflow drain will be slightly diverted and syphoned under the lock and the discharge pipe from the pumping station will also be syphoned under the canal.

11. *Section of Canal—Bridges over Canal.*—From this point the canal will be of one uniform section 75 feet bottom width and side slopes 2 to 1. The Monegar Choultry road will be carried over the canal by a skew bridge similar in all respects to that of the beach road. Bridges have also to be built for the Tiruvattur road and basin road; the road between them, called the Ennore road, which is only used by Municipal carts being diverted along the north bank of the canal to join the former.

Consent of Municipality necessary.

All bridges have three spans of 35 feet on the square with a tow path on either side and a clear headway of 14 feet at H.S.T.

12. *Road Diversions.*—A new road is also provided to give access to the Christian cemetery from cross section No. 21 to cross section No. 24. This will also accommodate the new division office which it is proposed to locate here.

13. *Disposal of Spoil.*—The value of the land along the line being high, it is proposed not to form any spoil banks but to carry the spoil across the Buckingham canal and raise a large area of low ground to above flood level. A letter and plan received from the Acting Agent, Madras Railway, is enclosed ‡ in which it is proposed to fill in low ground and form sidings, ¶ &c., for a new station at Salt Cotaurs. The figures given in the letter have been adopted, not those in the plan.

† This is put up with the estimates.

to deal with 4,900,000 cubic feet of spoil, 866,000 cubic feet being thrown up to form the proposed railway bank alongside the canal, and 4,034,000 cubic feet being carried § across the Buckingham canal and used to fill in low ground and form sidings, ¶ &c., for a new station at Salt Cotaurs. The figures given in the letter have been adopted, not those in the plan.

§ Across temporary bridges.

¶ See blocks marked in general Plan No. 1.

The spoil excavated east of Ráyapuram pumping station will be deposited in the sea north of the harbour.

The balance amounting to 7,675,000 cubic feet will be carried across the Buckingham canal and used to raise the low ground ¶ (about 28 acres in extent) west of the basin, on the average 7½ feet, i.e., 1½ feet above M.F.L. The value

¶ See block marked in general Plan No. 1.

of this land, when raised, is estimated at Rs. 85,200, the rate for valuation being that allowed in the estimate for land compensation, namely, Rs. 200 per ground. This land is very favourably situated both with regard to the canal and railway.

For executing this work it is proposed to purchase from Hajee Sujjan Laljee, contractors at Secunderabad, a tramway plant consisting of two locomotives, 19 small and 8 bogey trucks and nearly four miles of truck, the price of which is stated to be Rs. 30,000; but it is probable that less would be taken. This is a very light tramway of about 2 feet gauge which was made use of by Messrs. Molesworth and Company in widening the head of the main canal, Kistna Western Delta. It was found very useful under difficult circumstances and with an increased number of trucks and an extra engine in case of breakdowns will, it is believed, be found capable of completing the earthwork in twenty months, i.e., by October 1897.

A lump sum of Rs. 40,000 is provided under tools and plant to include also the cost of a new engine and 30 trucks, sleepers, and for overhauling and repairing the existing plant. The earthwork is estimated to cost Rs. 10 for 1,000 cubic feet as follows:—

	Per 1,000 cubit feet.		
	RS.	A.	P.
Getting and loading trucks ...	4	10	0
Unloading ...	2	5	0
Coal ...	1	0	0
Two temporary bridges and laying truck	0	9	0
Staff employed in upkeep of truck	0	8	0
Drivers and firemen, pointsmen, &c.	0	8	0
Repairs to locomotives and trucks	0	4	0
Oil and other stores, &c.	0	4	0
Total ...	10	0	0

* No terms have yet been made with the railway.

The value of work to be done for the Madras Railway estimated at Rs. 70,000* should be taken into account in estimating the actual net cost of the work.

14. *Basin Lock.*—The first work after the canal is a lock with end walls† continued right across Cochrane's basin, the object of which is to hold up water in the Buckingham canal between Madras and Ennore and prevent it running out at low tide which would stop navigation.

15. *Buckingham Canal.*—The Buckingham canal between the basin and the Cooum river will be dredged to the same section as the harbour canal.

16. *River Cooum.*—The bed of the Cooum river being for the most part only 1 foot to 2 feet below M.S.L., it was evident that water rising and falling to any great extent would (especially in the hot-weather months when both sides are low) expose large areas of mud‡ banks which would be likely to cause an epidemic of fever.

† Not only mud but sewage.

It was proposed not to allow water to fall below M.S.L., § but this would lose half the available flow and it is therefore intended to dredge out a deep channel from the weir above Harris' bridge to the regulator to be built at the mouth of the Cooum. This channel will be 100 feet bottom width with bed level 8.50 at the mouth and a rise inland of 2 feet per mile. The excavated material will be used for raising the rest of the bed of the river to 1½ feet above M.S.L. and water will not, except in times of flood, be allowed to rise up to this level.

§ No such proposal was ever made.

All sewers discharging into the river will be led into the central channel and it is considered that the concentrated current will prevent, to a large extent, the deposition of sewage which will, at all events as regards fluids, be carried out to sea on each side.

17. *Dredging.*—There is no doubt that this channel will require a certain ¶ amount of dredging at intervals as also with the canal; and the following plant is provided for in the estimate. A Cockburn's dredger and Steam Guab discharging plant on self-propelling vessels and four steel punts. The discharging vessel will tow the punts (two at a time) outside Municipal limits and then empty ¶ them, depositing the sludge beyond the canal banks.

¶ I should say constant dredging would be wanted to keep it open.

¶ Where?

The rate allowed for dredging the channel in the Cooum river is based on the rates at which work has been done with these dredgers in other places. The cost of dredging the Buckingham and Junction canals will be double that at the Cooum river, as the spoil has to be carried away in punts and discharged at a distance.

18. *Weir in River Cooum.*—The weir above Harris' bridge is provided to prevent the tide washing up sewage, and leaving it deposited on the river bed.

19. *Combined bridge and Regulator at mouth of River Cooum.*—The regulator at the mouth of the Cooum river will consist of a masonry bridge of eight spans of 40 feet, each span will be divided into four bays of 10 feet by wrought iron standards fixed in the floor and at top in which wooden shutters will work.

The floor of the bridge will be at 8.50 and to facilitate construction, the second pier from each end will be an abutment-pier. The parapet will be of cut-stone in harmony with the Marina wall.

The shutters will be pointed with copper point which has been experimented on and found to resist the action of shell fish and borers perfectly. If considered desirable, only one or two vents need be fitted at first with standards and shutters until it is seen whether the regulator is fairly successful in keeping open the bar, the other vents being banded across temporarily. This would reduce what may be called experimental expenditure to a minimum, as the bridge itself is required independently of other considerations and most of the other works are in themselves useful as improving communications between the harbour and all parts of the city.

20. *Junction Canal.*—The remaining work is the improvement to the junction canal. There is a culvert near St. Thomé under the Marina, the floor of which will be lowered as much as possible to 2.9 feet below M.S.L. The canal from the Cooum to opposite this culvert will be dredged to the same level, i.e., practically all the sewage will be cleared out of it.

21. *Culvert at St. Thomé.*—The culvert is calculated to discharge about 500,000 cubic feet each average tide which will give sufficient circulation in this narrow canal.

22. *Rates.*—The rates are mostly taken from the rate-book of the Consulting Architect's division; use has also been made of the rate current in the Buckingham Canal Division. The lump sums allowed for baling, timbering, centring, &c., have been calculated as carefully as each case allows.

23. *Execution of works.*—As regards the execution of the works, it is probable that the regulator will take two seasons to build, as the foundations will give trouble. There is no other individual work except perhaps earthwork that cannot be carried out in one season, so that (provided funds are forthcoming), the whole work can be completed and in working order by November 1897 so as to come into use directly after the floods have opened the bar.

As regards dredging, it is considered inadvisable on sanitary grounds to commence work until the river has been scoured out by flood and a continuous current is flooding through the canal and river, carrying off the fouled water; so this work will take a few months more to complete.

Everything, however, should be finished before the end of the official year 1897-98.

3rd November 1895.

(Signed) T. W. SMYTH,
Exr. Engr., Cooum Improvement Scheme.

COMPARATIVE statement showing the differences between the original and modified estimates for Cooum Improvement Scheme.

Items.	As per original estimate.	As per modified estimate.	Increase.	Decrease.	Remarks.
1. Compensation for land and buildings ..	RS. 1,37,200	RS. 1,37,200	RS. ..	RS. ..	
2. Combined bridge and regulator at the mouth of river Cooum.	1,47,800	1,73,700	25,900	..	
3. Weir across river Cooum at 2,530' above Harris bridge.	9,300	..	..	..	Increase due to deeper foundations allowed and to improvements to shutters.
4. Under-tunnel at Rayapuram lock for storm overflow drain.	14,200	14,200	..	9,300	Not required.
5. Inverted syphon to carry discharge pipe from Rayapuram pumping station under Harbour canal.	780	780	..	..	
6. Bridge under Basin road at 0 mile 5 chains of Harbour canal.	47,600	47,740	140	..	
7. Bridge under Tiruvattore road at 0 mile 52.57 chains of Harbour canal.	46,820	46,960	140	..	
8. Skew bridge under Monegar Choultry road at 1 mile 11.50 chains of Harbour canal.	49,640	49,800	160	..	Alterations made are wells in foundations filled with soorki and strengthening of wings, resulting in a small increase.
9. Skew bridge under Beach road at 1 mile 57.50 chains of Harbour canal.	47,830	47,990	160	..	

Comparative statement showing the differences between the original, &c.—cont.

Items.	As per original estimate.	As per modified estimate.	Increase.	Decrease.	Remarks.
10. Tunnel under over bridge approach for Messrs. Best and Company.	RS. 1,290	RS. 1,290	..	..	
11. Diversion of road from Ennore road to Tiruvattore road.	2,300	2,300	..	..	
12. Road from Monegar Choultry road to eastern end of cemetery.	1,510	1,510	..	..	Omitted in Mr. Smyth's estimate, vide paragraph 8 of Superintending Engineer's letter.
12a. Lowering floors of existing bridges in Buckingham canal from Basin to Cooum.	..	5,000	5,000	..	Vide Superintending Engineer's note accompanying.
13. Rayapuram lock at 1 mile 35 chains of Harbour canal.	97,300	75,730	..	21,570	Vide paragraph 7 of Superintending Engineer's letter accompanying.
14. Lock at Basin in Buckingham canal ..	23,600	29,110	5,510	10,630	
15. Excavating Harbour canal ..	1,63,700	1,53,070	..	..	Vide Superintending Engineer's note accompanying.
16. Cutlatterite revetment to Harbour canal ..	53,400	..	..	53,400	
17. Retaining wall west of Beach road bridge..	9,930	1,30,600	1,30,600	..	Vide paragraph 5 of Superintending Engineer's letter accompanying.
17a. New retaining wall and wharf steps in place of above items 16 and 17.	27,700	..	..	27,700	
18. Excavating channel in river Cooum from Napier bridge to weir above Harris bridge.	28,840	20,940	..	7,900	Vide paragraph 6 of Superintending Engineer's letter.
19. Clearance in Buckingham canal to its junction with the river Cooum.	..	6,000	6,000	..	Vide paragraph 8 of Superintending Engineer's letter.
19a. Clearance of Elephant gate and Trevelyan wharves.	4,900	..	..	4,900	Vide paragraph 13 of Superintending Engineer's letter.
20. Clearance in Junction canal ..	210	210	..	1,700	
21. Demarcation stones to Harbour canal ..	1,700	..	..	2,825	Vide paragraph 13 of Superintending Engineer's letter.
22. Improvements to road culvert under Marina for drainage channel at 3rd mile of Junction canal.	2,825	..	..	25	
23. Excavating drainage channel from 3rd mile of Junction canal.	25	..	..	..	
24. Demarcation stones for Junction canal ..	9,20,400	9,44,130	1,73,610	1,49,380	
Total for works ..					

Note by the Chief Engineer, Public Works Department.

With his letter No. 61 C. of 13th November 1895, the Superintending Engineer, II Circle, submits the plans and estimates for the canal from the Madras Harbour to the Buckingham canal, and for the other works connected therewith, prepared in accordance with the instructions contained in G.O. No. 3164 W.* of 10th December 1894.

* G.O. No. 1651 M., Local and Municipal, dated 7th November 1894.

2. The estimates as prepared by Mr. Smyth, the officer entrusted with the investigations, amounted to Rs. 9,20,400 exclusive of charges for establishment and special plant, and the alterations made by the Superintending Engineer raise this amount to Rs. 10,14,130; to this must be added Rs. 1,49,422, being the cost of a railway bridge between the Beach road and the harbour, and that of the connection between the harbour itself and the new canal, no estimate for which has as yet been received, and which will be referred to later.

3. The plans have been prepared in accordance with general instructions given by myself to Mr. Smyth, in company with whom I have been over the line of the canal, and the modifications made by the Superintending Engineer are the result of subsequent personal discussion and for the most part have my approval; the nature of

23. With regard to paragraph 14 of the Superintending Engineer's letter, I was at first disposed to advocate the formation of a separate executive division for the construction of the canal, but on further consideration I think that Mr. Russell is right in proposing that it be attached to the Buckingham Canal Division; the question of the clerical establishment required will be separately dealt with.

24. His Excellency the Lieutenant-General Commanding the Madras Army has been addressed on the subject of the Ráyapuram lines.

25th November 1895.

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

From A. S. RUSSELL, Esq., Superintending Engineer, II Circle, to the Chief Engineer, Public Works Department, dated Madras, 1st December 1895, No. 98 C.

ORDER—No. $\frac{1084}{A}$ I., dated 14th December 1895.

His Excellency the Governor in Council accepts the recommendations of the Chief Engineer and sanctions the estimate as revised by him, for a canal from the Madras Harbour to the Buckingham canal, amounting to Rs. 9,50,000.

2. The question of the entrance of the canal to the harbour, and of the share, if any, of the cost of the works necessary for this connection, to be borne by Government will be considered in connection with the estimates for the improvements to the harbour which have been submitted by the Harbour Trust Board.

3. The question of the bridge for the proposed Beach railway will be deferred until the estimates for the railway itself are before Government.

4. The Government accepts the view of the Chief Engineer regarding the arrangements for the execution of the work, which will be attached to the Buckingham Canal Division. The Superintending Engineer, II Circle, will apply for such additional establishment as he may require, and will also report whether any funds in addition to those already allotted can be utilised during the current official year.

5. With a view to expediting the acquisition of the land required for the canal, orders will be issued in the Revenue Department placing Mr. A. Pinto, Deputy Collector, at the disposal of the Public Works Department for this duty.

6. The sanction accorded in paragraph 1 is registered as No. 159 I. of 1895-96 and classified under "Provincial 43. Minor Works and Navigation."

(True Extract.)

C. S. Russell
Under Secy. to Govt., P.W.D.,
Irrigation Branch.

To the Superintending Engineer, II Circle,
with plans and estimate returned (65).
,, the Chief Engineer for Irrigation.
,, the Consulting Engineer for Railways.
,, the Revenue Department.
,, the Chairman, Harbour Trust Board.
,, the Local and Municipal Department.
,, the Examiner, Public Works Accounts.
,, His Excellency the Lieutenant-General Commanding the Forces.

Exd. Shaik Karim.
Spare Copies