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MEMORANDUM.

HAVING completed a tour of inspection in the Kistna Delta I beg to submit, for the information of Government, the result of my observations and of the discussions which I have had with the Superintending Engineer of the 2nd Division and the several Range Officers. Colonel Moberly accompanied me throughout my tour, and I have had the advantage of his intimate knowledge of the delta in considering what measures are required for its improvement and in ascertaining its present condition.

2. *Main Canal*.—The Western Delta was first gone over. The main canal has its head at Sectanagram, and is intended to have a bottom width of 96 feet when completed to the full width provided for in the estimate, amounting to Rupees 2,76,400, forming Budget item No. 87 of the current year. This estimate is made up of the following items, some of which hardly belonged properly to the main canal ; but, at the time the estimate was prepared, it was probably not considered that funds would be available for completing the whole system of irrigation and navigation consecutively and as rapidly as the demand for the extension of irrigation and the labour obtainable would allow :—

RS.

Earthworks		2,09,800
		RS.
1. Alteration of Dugirala Weir		7,870
2. Improving Jagarlamudi Escape		3,640
3. Do. Commamur Channel		19,590
4. Kolimerla Aqueduct over the Nukkavagu drainage		19,300
5. Outfall Channel from do.		8,430
Balance of an old estimate		1,144
Iron Punts		6,630
		66,604
Total...		2,76,404

Items 2, 3, 4, and 5 do not belong to the main canal, but are really a part of the Commamur Canal project.

The earthwork estimate was apparently a somewhat rough one : against 1,598,665 cubic yards provided for, 1,652,806 cubic yards have been excavated, and about 10,000 Rupees worth of work remain to be done ; but the actual rates have been considerably below those allowed in the estimate, and the balance of the latter is more than 60,000 Rupees, so that there will be a saving of 50,000 Rupees. On the other hand, it is almost certain that at some future date this main canal will

Area irrigated and to be irrigated. require additional widening, for the ultimate area has been estimated, by taking 400 acres to the square mile, at 230,000 acres, and a main canal, with a bottom width of 96 feet, will not suffice to irrigate this extent of land. The present area of irri-

gation in this part of the delta is, according to the latest returns, only 64,395 acres, or less than one-third of the contemplated area. It is certainly of importance that the necessary works for the extension of irrigation should be pushed forward as rapidly as circumstances will admit, for at present the supply admitted to the delta is very greatly in excess of the wants of the area irrigated, and it is owing to the incompleteness of the subsidiary works that a considerable proportion of this water cannot be utilized, added to which the expense of clearances is disproportionate to the extent of the cultivation. It is expected that this canal will be completed during the working season now about to commence.

3. *Western Bank Canal.*—The first branch canal is the Western Bank Channel, which takes off at about $7\frac{1}{2}$ miles from Seetanagram. In the current year's Budget, Item No. 86, there is an estimate, Rupees 1,46,480, for this work,* and up to the close of last year the expenditure incurred amounted to about 7,000 Rupees in excess of the sanction. A large supplemental sanction will be required, not because the provision in the estimate, which was prepared in 1855, was insufficient for the work then contemplated, but because that estimate contained no items for drainage, branch channels, etc., but allowed only—

- 1st.—For cutting a canal with a bottom width of 10 yards.
- 2nd.—For constructing weirs across it at intervals.
- 3rd.—For head-sluiques to branch channels.

I find that the bottom width was subsequently, in accordance with the general scheme for the delta, sketched out by the late Colonel Anderson when Superintendent of the Division, altered to 75 feet or 25 yards; also, it having been found that any considerable extent of irrigation under the upper part of the canal was improbable, owing to the unwillingness of the people to convert their lands from dry to wet cultivation, the pushing on of works below Kullur, including the Iskapully Channel, was approved by Government. The following expenditure on works not included in the sanctioned estimate has I find been incurred:—

Iskapully Channel	Rs. 13,562
Side Channel, Kullur to Nellatur, with Head-sluique	3,601
Do. Vellatur to Repalli	4,308
Total	21,971

On the other hand, certain small head-sluiques, which were provided for, were not built from the estimate, but on separate sanction, as Minor New Works.

4. *Distribution works completed for lands which are not irrigated.*—It seems necessary that I should bring prominently to notice here the circumstance that a great deal of unprofitable expenditure has been incurred on distribution works. The ryots of certain villages expressed their desire to be supplied with water, and signed, I am informed, agreements to take water for considerable areas; thereupon channels, sluices, etc., were constructed for the purpose of affording the desired supply, but either no water has been taken, or but for a very small area compared with that promised. I am told that the Collector was spoken to on the subject during last year's jumabundy; but that he said that the orders of the Board of Revenue did not admit of any action being taken, and that the ryots could take water or not as they pleased, provided they did not use canal water three years in

succession. It seems to me that it is perfectly right to allow ryots to cultivate what sort of crops they please; but that, where expenditure is incurred to meet their wishes and they refuse afterwards to make use of the works provided, other people should not suffer, which the general tax-paying community manifestly does, if the interest on the outlay be not paid by those for whose special advantage it has been incurred. I would suggest, therefore, that, in lieu of the rule allowing ryots to relinquish or to refuse to take water for their lands, this rule be so far modified as to allow them the option of taking water and paying the water-rate, or of cultivating their lands under dry crops and paying such an additional cess as will represent $7\frac{1}{2}$ per cent. interest on the outlay incurred for the works constructed to supply water to such lands, added to a share of the cost of the canals above. This interest would, I think, be about fair, as, what with preliminary investigations, supervision, and direction, works may be taken to cost about 50 per cent. more than the actual outlay upon them, so that they would really pay five per cent. on the expenditure properly debitable to their villages. It may be necessary to base the capacity and laying out of canals on the expressed wishes of the villages interested; but that would seem to be all that is necessary to prevent even an appearance of making them pay for works the construction of which they have not desired.

5. The three regulating weirs* across the Bank Canal have been completed with the exception of a little of the superstructure, and their general design is suitable; their shutters should, however,

* Kullur.
Vellatur.
Penamudi.

be fitted with screw gearing. Above Kullur the canal has not been completed to the full width of 75 feet, but some parts approximate to that width. Below Kullur the intended width of 60 feet has been finished. The length of this canal is about 45 miles. A fourth regulating weir will be required near Mortola and a tail regulator near Gungadipalem.

6. *Navigaton, West Bank Canal.*—This canal is at present navigable as far as Kullur, or for 20 miles from the head and 27 miles from Seetanagram. I think it will be advisable to include in the completion estimates a second class lock to be built at Kullur, which will make the canal navigable for 12 miles down to Penamudi, which point is only two miles from Repalli, the cusbah town of the talook. At some future time, if the area intended to be irrigated by this canal be taken up, it would be proper to provide locks at the lower weirs so as to afford means of transport for produce, for the southern part of this tract of country is particularly unfavourable for wheeled traffic, and, on the other hand, it is probable that the greater portion of the irrigation will be under the southern reaches of the canal.

7. *Ultimate area of irrigation.*—The ultimate area of irrigation under this canal is entered in the general scheme at 75,000 acres.

8. *Drainage requirements.*—The main drainage of the country north of Repalli will pass down the Meninghy Drain which is reported to act fairly, and by the Gudivally Drain which has been completed on an estimate amounting to Rupees 10,460. For the country south of the Iskapully Channel, which has its head at the Penamudi weir, it is proposed to make a main drain running nearly due west from Adavaladur to the east end of the Nizampatam backwater, and the drainage in detail will be conducted into this by the side channels formed in obtaining soil

for the branches of the Iskapully Channel, which will for the most part be in embankment. This arrangement is simple, and is likely to prove efficient. The eastern part of this southern tract will be irrigated direct from the Bank Canal, and the drainage, as it exists, is expected to suffice.

9. Mr. Norris, the Range Officer, hopes to have the estimates for the completion of the Bank Canal, including water distribution and drainage, ready by next April.

10. *Branches of the Main Canal at Dugirala.*—The main canal is considered to terminate at Dugirala, 12 miles from Seetanagram. Here it is divided into two branches—the one running nearly due south to Nizampatam, and the other south-west to Chinna Ganjam: this latter is called the Commamur Canal.

11. *Nizampatam Canal.*—The Nizampatam Canal is, as far as the main line is concerned, fairly complete. What slight improvements are required can be carried out from Repair Funds or as Minor New Works. Some time since, it having been found that the slight fall of the canal led to such a great deposit of silt yearly as seriously to interfere with its efficiency both for irrigation and navigation, estimates were prepared for constructing side channels, which, having a much greater fall and velocity, should carry the silt in suspension and deposit it on the fields, where it would be valuable for manure, instead of leaving it in the canal, whence its removal would be expensive. An estimate, Rupees 56,740, for constructing side channels with a fall of $10\frac{1}{2}$ inches a mile, was prepared and sanctioned, and the outlay has amounted to Rupees 53,217. The work provided for in the estimates has been completed. Some modification, however, will be required, for it has been found that the fall given places the channels in the first five miles on too low a level to admit of the efficient irrigation of the lands, and it will be necessary, therefore, to construct small dams to raise the water. These should be so arranged as to reduce the fall as little as may be consistent with the proper irrigation of the lands under the branch channels. The regulating sluice at the head of the eastern side channel should have its vents blocked at a level which will admit of the maximum supply required being passed with the rest of the vents fully open, and it should then be fitted with screw gearing to the shutters. Similar gearing should be given to the shutters of the sluice at the head of the west side channel. The Pedda Ravur branch from the eastern side channel obstructs the drainage, and it will be advisable to take off a branch for this village at Tenali. No other irrigation works are required.

12. *Locks, etc.*—There are five locks on this canal, namely, at Dugirala, Kuchipudi, Jatur, Nullavada, and Nizampatam, the last being a tidal lock. The head lock gets much silted, but this is unavoidable. The Kuchipudi Lock is said to require repair, and the walls are only 1 foot above present water-level; they should be 18 inches above full supply-level. There is a great deal of Lunka grass in the canal below this lock, and this should all be taken out. The sluice gate of the side culvert leaks greatly. Proper levers should be provided for lifting the gates, and the lever should have a fixed fulcrum, the pins through the shutter needle being placed on the line of the shutters instead of at right angles thereto. At present the masonry is much damaged by the rude appliances in use. A small waste weir should be built in the right bank of the canal just above the Nullavada Lock, and it should be bridged for the tow-path. It can be constructed out of funds for Minor New

Works. The lock has no side culverts. The lower gate leaks enormously; sill-stones said to be displaced. It has been out of repair for three or four years, which should not be allowed. Wooden sill bars should be inserted. Gearing out of order. One of the upper gates has lost its gangway plank. This lock was filled in 8 minutes and emptied in $2\frac{1}{2}$ minutes. A new bridge has been built over the east side channel, but there is no bridge over the tailbay of the lock. As there is not room there for a bridge, one may be thrown across the chamber, leaving, however, the top of the side walls of the chamber clear so that there may be a passage along these. The banks between this lock and the tidal lock are not in good order, and they are obstructed by bushes and prickly-pear, which should be cleared away. A good deal of drainage enters the canal below the Nullavada Lock. A sweet-water channel for Nizampatam has its head a few yards above the tidal lock. This channel has been of great benefit to the town, and it is highly appreciated by the inhabitants. A reservoir has been constructed, and the bank of this is kept nicely turfed. Caste people only are allowed to take water from this; but singularly enough the Pariahs are allowed to take water from the supply channel at a short distance above, and so, after all, they are not badly treated. The wings of the surplus weir in the left bank above the lock are too low, and the banks adjoining the wings were not more than 6 inches above water-level. The canal establishments ought to be required to look after such matters, and to see that there is always a safe margin. The wing walls should be raised 18 inches, and the earthworks $2\frac{1}{2}$ feet. There is some leakage through the joints of the quoin stones of the upper gates of the tidal lock, and some of the copper sheeting of the lower gates wants fastening. The lower sill appears to be 6 feet below high-water level, but the water sometimes reaches to $7\frac{1}{2}$ feet on the sill. I think it would have been better had the canal been carried into the backwater close to Nizampatam, instead of tailing into the Toongabuddra at a point which is some five miles distant as regards navigation, though only $1\frac{1}{2}$ miles by land.

13. *Drainage.*—South of Kuchipudi and as far down as the Sandole and Vellatur road the country requires draining partly into the Meninghy Drain, partly into the Gudivally outfall, and partly into the Pamocalwa, which drains into the same outfall through the sand ridge near Kavur: the exact arrangements have not yet been determined. All the water not going into the Meninghy will find its way into the Nullavada, which has at present five outfalls, the natural one into the Toongabuddra having been completely closed by the Nizampatam Canal—one into this canal; 2nd, into the Soollavagu irrigation channel; 3rd, into the Komarevole irrigation channel; 4th, Idupully drainage channel; 5th, Pedapully drainage. The most feasible plan appears to be to enlarge the Idupully Drain; to straighten and enlarge the salt creek into which it falls; and to enlarge the Pedapully Drain from its present width of about 7 feet to 40 or 50 feet, or perhaps more: this latter will discharge into the Toongabuddra below the tidal lock. West of the Nizampatam Canal, east of the Toongabuddra, and north of Sandole, the country is very much in need of drainage. South of the line from Aramanda on the Toongabuddra to the Nizampatam Canal at Turumella the drainage has been stopped by the Aramanda Channel, and it must be conducted to the aqueduct near the Sandole Tank; probably some cross drains also will be required. Between the Toonga-

buddra, the Aramanda Channel, and the Jutur and Ponnur road the drainage may perhaps be carried into the Toongabuddra; south of this it will have to be taken partly into the Sandole surplus channel and partly into the river direct.

14. *When project should be completed.*—I think the completion estimates for this part of the delta should, with the aid of two Surveyors, be finished between this and the commencement of the next irrigation season, that is, by the middle of June.

15. *Aramanda Channel.*—I turned off from the Nizampatam Canal at Jutur and went down the Ponnur road to the Aramanda Channel, along which, however,

* Rupees 46,420.

I could not get owing to breaches. An estimate* for improving this under the name of the "Budam Project" has recently been sanctioned. I have already alluded to the drainage requirements of this part of the country, and certainly nothing could be more unsatisfactory than its present state in this respect. Both the Jutur and Ponnur and the Ponnur and Sandole roads have been breached in many places, and I was told that this has been going on for years. It is a waste of money to close breaches without providing proper passage for drainage, and no time should be lost in building masonry works on the roads in correspondence with the intended drainage arrangements. A short distance from Kodur is the aqueduct Tank. The aqueduct has no proper wings, and the side walls should be lengthened 15 feet and splayed to form proper wings and prevent breaches round them. It is a wretched work as it is. A few yards below is the surplus weir of the Sandole Tank. This is in bad order; but, if it be repaired properly, it will be an efficient work. It is intended to bridge it. The channels from the aqueduct and the weir unite lower down, and they will run down the south-western part of the Nullavada into the Toongabuddra, and, when the dam† across the latter has been removed, some improvement in the condition of this country may be expected. This year it has been better than usual, because the annual breach near the dam could not be closed, or had not been when I was at Sandole. There is plenty of fall available; but this fall must be utilized by proper channels, instead of cancelling it by constructing canals, channels, and roads across it in all directions.

† Called Dumbakodu Calingulah.

16. *Commamoor Canal to Jagarlamudi Lock.*—Returning to the head of the Commamoor Canal at Dugirala: this canal is locked down into the Toongabuddra. The lock is a new work, the masonry is good; it was filled in 4 minutes and emptied in a similar time. Culverts on one side only and their shutters are worked by a lever, which only required a fixed fulcrum to make it perfectly efficient. The valves in the upper gates do very well when only one or two boats are locked through at a time, but they make 15 to 20 feet at the upper end of the chamber useless. The chamber walls are rusticated masonry, which is not a proper arrangement, as they should be quite smooth. The sluices for the supply of this canal should have arches instead of a rather rotten platform bridge; proper shutters with screw gearing are likewise required.

The canal occupies the bed of the Toongabuddra for a distance of 8 miles, and, though winding and having a somewhat rapid current, I do not think it will, with some slight improvements, be otherwise than a convenient and efficient line of navigation. The deep drains on the banks should be bridged to allow of tracking, and a tow-path should be formed. At Jagarlamudi there is a weir built in 1859, and a lock constructed in 1858. These works are bridged. The masonry is all very good: the lock chamber is revetted, but it is a very efficient sort of work altogether; it has a drop of 3 feet. The weir is fitted with shutters which do not answer. Shutters with screw gearing should be given, and, if necessary, the bays can be divided into convenient widths by cast-iron standards of the pattern introduced by Mr. Rundall, with excellent results, at some of the weirs in the Western Delta of the Godavery. In the left bank a little above the weir are the surplus sluices into the old bed of the Toongabuddra, and the means of supplying the irrigation under that river. This work has six vents, and would be efficient were it not that the roadway is about 4 feet too low and the banks alongside are dangerously low. The banks below the sluices are much eroded, and should be revetted for 150 feet or so on concave curves. Between Dugirala and Jagarlamudi the Toongabuddra crosses the Guntoor and Masulipatam road at Kolakalur and a bridge is being built there, the estimate of which, amounting to Rupees 13,650, was sanctioned as part of the Delta improvement scheme, one-half of the cost being debitable to Local and the rest to Loan Funds. The piers and abutments are 10 feet high; the face stone is good, but all that is visible behind this consists of mere chips and small pieces. I was told that this was merely superficial; but it is, if so, somewhat singular that nothing else should be visible. I made inquiries about rates, and I cannot understand why Rupees 6-12-0 per cubic yard should be necessary; the data given to me on the spot would make about 5 Rupees the proper rate. The bridge has not been built on the present line of the channel but on what is considered to be an improved line, and a supplemental estimate will be necessary. There was a good deal of discussion about the design and requirements of this bridge before the estimate was submitted for sanction, and everything that was necessary should then have been provided for. The new cut has really nothing to do with the bridge estimate, and it should be executed from the sanction for the improvement of this canal, and be provided for in the completion estimate. The bridgework had been stopped; but, as the estimate is quite sufficient for its completion, I pointed out that it should be gone on with and finished, and sanction must be applied for for the debit of the cost of the new cut to the estimate for the canal, which, although it did not provide for this item of work, is now the only sanction available, and the bridge will be useless until the cut is completed and the old line of channel closed. I have asked for an accurate survey showing the arrangements.

17. *Below Jagarlamudi Lock.*—The lock at Jagarlamudi is at present the last on this line of the canal. Its lower sill is at + 21.62, and from this point the canal Datum High Water. was intended to have a fall of 6 inches per mile throughout, this being about the average of the old channel. The canal will water very little land on its right bank, and the country on the left bank is divided into sections by the several cross drainages, which indicate tolerably clearly what the arrangements should be.

The Superintending Engineer, finding it necessary, under present circumstances, to construct dams across the canal to raise the water to a level which would command the ground to be irrigated, thought that it would be better to separate the navigation from the irrigation and to carry the former on a higher level, the whole fall being overcome by drops. The great objection to this plan is that all the drainage would be crossed twice and the additional expense would necessarily be great, while, moreover, the separate line of navigation could not be sanctioned as a Loan work without showing that by itself it would pay the interest on the outlay, and it might be difficult to demonstrate this. If, indeed, a separate line of navigation were in any way necessary, the cheapest, and, at the same time, an efficient, line might be taken from the Nizampatam backwater along one of the depressions, which are very marked in this part of the country, near the coast. It has been noticed, however, that the fall of the canal is now greater than is convenient. To make it efficient, whether navigation be considered or not, the drainages must be disposed of in a suitable manner, and, if this be done, it will be equally well adapted for both purposes. Side channels to carry the irrigation water have also been suggested; but the circumstances are not adapted to an arrangement of this kind, or, at least, not in the way adopted on the Nizampatam Canal—1st, no considerable fall could be given to a side channel, for it has been already noticed that only a small fall is available; 2ndly, the line is intersected by drainages, and it would be expensive to build aqueducts across these. The proper course appears to me to be to deal separately, as regards distribution, with the lands between every pair of considerable drainages by carrying a side channel along close to the Canal Bank and making branches therefrom generally at right angles to the side channel, and a subsidiary drain on one side of each branch; then all that is required for the lands west of the swamp will be secured. The drainage of the uplands does not find any direct outfall to the sea; this is prevented by sand ridges. Some of the water passes northwards into the Toongabuddra, and the rest along the swamp southwards to the Ramperu. It is intended to divide the drainage between the Nullamada and the Sakicalwa, the former and all to the north of it being carried to the Toongabuddra, and the latter and all south of it to the Ramperu. For the irrigation of the land east of the swamp a channel will be carried along this artificial water-shed across the swamp. These remarks will indicate sufficiently clearly, I hope, the proposed arrangements for irrigation distribution. I propose to make the fall of the canal from Jagarlamudi 4 inches a mile, which will keep the supply at a proper level for irrigation. The first considerable drainage, the Nuckavagu,* is crossed by the Kolimerla aqueduct, a well built and efficient work of 75 feet waterway. The next large drainage is the Nullamada,† and it comes into the canal by an opening in the banks, opposite to which there is a powerful escape sluice which acts efficiently and would be quite safe were its roadway raised 3 feet; the shutters are planks, which are raised or lowered by a windlass mounted on a tram truck. A short distance below this is the Sakicalwa, which is passed partly under the canal by an under-tunnel of very small capacity and built of very indifferent rubble masonry and partly across the canal by a sluice of two vents. These works are altogether insufficient, and they are necessarily supplemented by breaches, which

* At 17 miles, 26 chains.

† At 26 " 35 "

occur after each considerable fall of rain. The admission of these large drainages into the canal must greatly affect its efficiency, and, if they can, at a reasonable expense, be passed under it, that arrangement should be preferred; but it may be found necessary to incur the inconvenience of passing the water across the canal in order to avoid a too great outlay. I have, therefore, asked the Superintending Engineer to prepare alternative estimates for this part of the line, the one providing for keeping up the canal bed until after crossing the Sakicalwa and for the necessary aqueducts, the other for dropping the canal by a lock a short distance above the Nullamada and for controlling the flood-waters by inlet and outlet sluices. The latter would be much the cheaper plan; but, if the former does not add more than from 1,200 to 1,500 Rupees a mile to the cost of the whole 46 miles, it should be adopted in preference, as the expenditure on clearances would be considerable with the other arrangement and the traffic would be inconvenienced and the irrigation be for a time rendered less efficient. It may be noticed also that it will be difficult to make convenient arrangements for the distribution if the canal be dropped above these drainages. The chain of tanks south of Bapatla is to be abandoned and their beds irrigated, and the supply for these and for the sand ridge will have to be taken from the high level and consequently from above the drop, and some of this water, and probably a great deal of it, will have to be taken across the drainage outfalls by aqueducts, while, if the canal be carried over the drainages, the distribution can be laid out between the outfalls without difficulty. If inlets and outlets be adopted, the best plan for carrying the water for irrigation across the Nullamada will probably be by aqueduct combined with the outfall sluices. I think that 30 vents of 64 square feet opening each, or say 210 square yards of waterway, will be required for the Nullamada, and that the side walls of the aqueduct should be 6 inches only above full supply-level, while the wings, where they join the earthworks, should be 4 feet higher, so that a yard of water may pass over the work in extraordinary floods without turning the wings. For the Sakicalwa, 15 openings, or say 105 square yards of waterway, will be required. The late Colonel Anderson's scheme of irrigation supposed that 103,000 acres would be irrigated from this canal; but a detailed examination has resulted in 60,000 acres being found to be the area, which is not likely to be exceeded for several years after the completion of the works, though, as that extent includes only lands which the villagers admit to be irrigable, the valuable swamp lands when fully drained, as also a considerable area of ground on the sand ridges, will ultimately be cultivated with the aid of irrigation. The tract of country commanded is 40 miles long and it averages 8 miles in width, so that, at 400 acres to the square mile, 128,000 acres would be the total irrigable area; but, as some of the land near the coast is difficult of access, it may be better to take 300 acres to the square mile, and the 96,000 acres will be the area to be supplied. In the first instance, however, the canal should be constructed for the irrigation of 60,000 acres though it should be arranged in detail, and the plans should exactly define the arrangements, for the larger area. The aqueducts should be built with the full mean width of the canal, at the several sites, for the lesser area, and then the contraction will be moderate when the canal comes to be enlarged. Similarly inlets and outlets should be aligned as they would be for the larger canal. Spoil banks should be placed sufficiently far back to allow of the widening of the cuttings, and embankments should be constructed, where practicable, with the ultimate width

between, or where, from the length of embanked canal this would materially affect the discharge, one embankment should be placed, so that only one would need to be turned over. The smaller drainages, when their beds are not more than one foot below full canal level, can be admitted at simple inlet weirs; but, where the canal water will be considerably above the country, the inlet weir, if one be necessary, must be combined with a culvert, otherwise the drainage of the land above the canal will be blocked. I observed several instances in which this has occurred, and where crops had in consequence been injured. When an inlet weir and culvert are combined, it will generally be advisable to have a shutter for the former, so that it may be used only for passing the balance of the drainage under the canal after the water has been lowered to the crest of the inlet. Only one lock will be required between Jagarlamudi and the Ramperu, and its lift will be moderate, about $6\frac{1}{2}$ feet. A tail lock will connect the canal with tide water and open communication with the coasting trade.

18. *Below Sakicalwa.*—There are no masonry works below the Sakicalwa which are fit for permanent use. The design of the inlets is far from good, and the stone of which they are built is quite unsuited to canal works, it being soft and friable and easily acted upon by air and water. It is not even fit for pitching earthen slopes. There is consequently nothing to prevent the canal below this point being laid out throughout to meet all requirements, and the estimates should provide completely for the disposal of drainage and for distribution works.

19. *Drainage.*—The outlay required on this account will be heavy. The drainage of the Ramperu swamp and the outfalls of the several nullahs crossing the line of the canal have to be provided for. The fall available is very small, and the channels will consequently be large. The Superintending Engineer proposes to place two banks, 200 yards apart, for the drainage of the swamp, cutting trenches just sufficiently wide and deep to form the banks, and this arrangement appears to be the best which can be adopted under the circumstances. Four-fifths of an inch to drain off in the 24 hours seems to be a reasonable allowance, and the details may be worked out accordingly. The levels have all been taken, or but little remains to be done, except at the Bapatla project for watering the sand ridge, which has still to be worked out. Two Surveyors for three months will be ample to complete all the out-door work.

20. *Time of completion of estimates for the Western Delta.*—All the estimates for this part of the delta ought to be completed by July next at latest, which will admit of their submission to the Government of India early enough for their sanction to be obtained in time for the next working season, which begins in January.

21. *Eastern Delta.—Area irrigated and to be irrigated.*—The area at present irrigated in the Eastern Delta is 63,928 acres. The general scheme contemplates the watering of 270,000 acres. This ultimate area has been deduced from the total area commanded, by assuming that for 400 acres in each square mile water will be taken. It is perhaps rather a high estimate; but the irrigation will probably not fall short ultimately of 235,000 acres, though a good deal will depend upon the Zemindars. I am informed that in some cases the ryots have expressed a readiness to take water and pay the water-rate; but that they cannot, or are unwilling to, pay the additional assessment which the Zemindar would demand. These matters will

no doubt receive the attention of the Revenue authorities, with whom the Superintending Engineer should communicate with a view to its being ascertained whether any suitable arrangement can be come to between the Zemindar and the ryots which will be acceptable to both. Unless some assurance that water will be taken be given, it will be unwise to provide at once for the supply of water to more than 100 acres per square mile of zemindary tracts, or there will be considerable risk of useless outlay both on main and branch canals. Something must be done to give the people an opportunity of taking a supply; but it would not be wise to ignore the difficulties which may stand in the way of or prevent the extension of irrigation to such lands.

22. *Main Canal.*—This is a short canal of rather less than three-quarters of a mile in length. It then divides into the Masulipatam Canal, Ryves' Canal, and Ellore Canal.

23. *Masulipatam Canal.*—The Masulipatam Canal is 48 miles in length. It occupies for some miles the bed of the old Pulleru; but from Kunkipad it takes a line of its own, and the Pulleru becomes a branch canal, supplied by the Masulipatam from two sets of sluices a short distance above the Kunkipad Lock. The left bank of the Pulleru at its head requires revetment. Both sluices want repair. The lower one has been damaged by boats; the shutters of the upper one are not very manageable. On the right bank of the canal the Kunkipad weir was originally built with ten bays of 12 feet each. Two bays will suffice to pass water into the lower reach, and three at the upper end are being converted into the head-sluice of the western side channel, and will be divided into nine vents of $2\frac{1}{2}$ feet square. This work is not included in any sanctioned estimate. The new masonry has not been very well fitted to the old. There are five locks on this canal, namely, Kunkipad, Verunki, Nidamole, Ankamurru, and the tidal lock at Masulipatam. The last-named I did not see; all the others want more or less repair, as the leakage is very considerable, owing, in some measure, to the softness of the stone, which requires wooden sill bars to prevent cutting out at the joints; these bars should be inserted at all the gates as opportunities offer, and, as this canal is closed to navigation for some weeks each year, there will be no difficulty in making this addition. Some of these locks take a long time to fill. That at Verunki, for instance, occupied 8 minutes, and side culverts might be added on the right side. They all empty sufficiently rapidly. The gearing of all the valves and culvert gates should receive attention and be kept always in good working order; that of the gate valves is of one pattern almost everywhere, and worn parts can easily be re-placed. Grass, rushes, etc., should be entirely removed from the waterway of the canal; these seed and spread rapidly if anything short of extermination be allowed. The aqueduct by which the canal crosses the Sektanagram swamp drainage needs repair. The canal has been under improvement on an estimate, Rupees 1,77,000, for "improving the Masulipatam section" of the Kistna Delta, which forms Item No. 82 of the Budget of this year. The estimate provides for the following works:—

- 1.—Widening the canal for the first four miles.
- 2.—Do. from this point to Kunkipad Lock, $4\frac{1}{2}$ miles.
- 3.—Improving the Pulleru from Kunkipad to Murryvada.

4.—A weir on the Pulleru at Weyur.

5.—Improving the Pulleru to Pamurru.

6.—A regulating weir at Pamurru.

7.—Improving Lower Pulleru to Cowntaram.

8.—A bridge for the Hyderabad road at Pamurru.

Items 1, 2, 3, 5, and 7 are all in progress, and the work is likely to be finished within the estimate. Very little work has been done this year, and the Executive Engineer thinks that he will not be able to spend more than 15,000 Rupees this year below Murryvada.

Item 83 of this year's Budget is an estimate, Rupees 49,860, for a western side channel. The work has been completed as far as the estimate provided. It included only earthworks and something for sluices, and the necessary masonry works have yet to be sanctioned. The estimates, except for the branches, are nearly ready, and their submission has been delayed because, while the general scheme estimated the area of irrigation at 42,000 acres, the village accounts showed only 12,000 with a possible addition of 4,000, or altogether 16,000 acres. This channel will command all the land lying between itself and the Bimanuddi, which latter will form the general drainage of all the land west of the Masulipatam Canal, and the division between the irrigation under this and that under the proposed Bank Canal. The area is about 65 square miles, or 41,600 acres. All the land is zemindary, and, for the reasons mentioned at the head of paragraph 18 above, it will not be safe to calculate on more than 250 to 300 acres per square mile being brought under irrigation, though perhaps hereafter three-fourths of the total area may be watered from the canal. The earthwork estimate is, as already noticed, nearly half lac, and the works still required will cost one lac. 16,000 acres will give a gross return of 64,000 Rupees; but there are at present 9,000 acres of irrigation, so that the returns from the expenditure may be expected to be about 28,000 Rupees, or 28 per cent. on the one lac required. Of course, this return will have to be taken in connexion also with the outlay on the main canal and the upper works generally, but still it promises to be very satisfactory.

24. *Bank Canal.*—Another part of the Eastern Delta Completion Project is the Bank Canal, which is to start somewhere above Kunkipad on the Masulipatam Canal and to occupy generally the line of the excavations for the embankment. It will cross the Divi or eastern branch of the Kistna, and water the island of Divi. Very little time will be required for completing the estimate down to the Kistna branch. This canal was originally intended to water 45,000 acres. All to the north of the Kistna branch is zemindary, but Divi is Government land. The area of the zemindary lands is about 80 square miles, and hardly any appreciable extent of irrigation exists at present. I would allow 100 acres per square mile for this tract as the probable area of irrigation. The irrigable part of Divi is 55 square miles, and, including 12,000 acres of existing irrigation, I think 400 acres a square mile may be counted on. The total under the Bank Canal will then be 30,000 acres, which is much below the original estimate. Nearly the whole of the necessary investigations for the Divi extension have yet to be made. One Surveyor will be required for one month for the surveys and levels connected with the crossing of the Divi branch

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of the Kistna and for two months for the Divi island levels, and one Surveyor will also be necessary for the upper part of the Bank Canal. The estimates ought to be ready by September next. In Divi there are numerous large but shallow tanks, which will no longer be required when Kistna water is available. The beds can then be disposed of, and the value of the land, which is considerable, should be credited to the estimates.

25. *Drainage.*—The drainage of this part of the Eastern Delta will certainly require improvement; but, as it is nearly all zemindary, it is difficult to say what will be feasible. The part of the country between the roads from Masulipatam to Pamurru and that to Cowntaram requires only minor improvements to its drainage.

26. *Protection of Divi Division from high freshes.*—In G. O., No 2,937, of the 3rd ultimo, I was directed to report, after communication with the Superintending Engineer, what measures it will be feasible to carry out for the protection of the island of Divi. The measures suggested by the Executive Engineer and recommended for execution by the Collector are—

(1.) The use of rough-stone at the heads of the river channels and at the head of all tanks to enable the villagers to regulate the supply.

(2.) The thorough repair of the river bunds.

(3.) The planting of Lunka grass to protect exposed parts of the river banks with perhaps some stone groynes.

(4.) The separate bunding of villages on the lunkas and those on the island which cannot be brought within the general embankments.

All these measures are perfectly feasible, and some of them desirable, if money can be made available. No. 4 is not, I think, properly chargeable to Works or Repairs, Agricultural, as irrigation is not responsible for the floods, and generally obtains no returns whatever from the isolated villages which it is proposed to protect. Agricultural repairs are deducted from Irrigation Revenue in estimating the results of expenditure, and it is clear, therefore, that they should not be debited with miscellaneous improvements. The

Embankments.

repair of the present embankments can be undertaken if money can be given for the purpose; but the grant is at present altogether inadequate to maintain the delta and other irrigation works in an efficient state. This work would be beneficial if done in connexion with the completion of the banks; but the outlay required would not be likely to be of much advantage unless, first, they be made complete, and, secondly, unless the practice of cutting them be given up. The circumstances of the cultivation are peculiar: the ryots want moderate floods all over their lands, and their tanks are simply traps which are left open to admit the water when standing all over the country and then bunded across the open part to prevent the water running out on the fall of the river. The ryots are by no means particularly anxious for the repair of these bunds; what they want is moderate freshes, and these do no harm. They must be admitted through the banks freely by large openings, and, of course, if the freshes rise unusually high, these large openings cannot be closed, and loss results. It appears to me, however, to be quite open to question whether, so long as the cultivation is dependent on river inundation, the loss would not be greater were the banks repaired than while left as they are. We cannot provide for submerging the island, or a very large part of it, and for keeping the inundation within bounds should the river rise a little too

high. The best approximate estimate which I was able to obtain indicates that 15 miles of embankment must be maintained on the west of the island, and 15 miles on the north and east. Of the former 10 miles are partly embanked, and of the latter 7 miles, so 13 miles of new embankments are needed. About 28,000 Rupees would be needed for the repair of the existing banks and 38,610 for the new banks, or together Rupees 66,610. Both would have to be sanctioned as new works, as, to be of use, the old banks must be greatly enlarged and raised, and about 3,000 Rupees yearly would be the total grant available for irrigation works in Divi, taking the present total grant for the Presidency as a guide to the allotment.

Channel Heads.—Something may at once be done to prevent large quantities of water entering at the regular channel heads: of these there are 12. A rough palmyra framing, dividing the opening into vents of 3 or 4 feet in width and about the same in height, can easily be constructed, and, if tied by waling pieces and strutted, it will make a pretty good temporary head-sluice: it should have a rough-stone flooring 6 yards wide, and the sides also should be revetted. It is calculated that 50 cubic yards of stone will be required for each head, and that the rough-stone work will cost 5 Rupees a cubic yard, the island being at present a particularly inaccessible place. The palmyras will come to about 50 Rupees for each channel, or the outlay at each head will be, on the average, 300 Rupees, or Rupees 3,600 for the whole. I have no information as to the number of isolated villages which would have to be ring-banded, and the probable cost of the work cannot, therefore, be given.

Lunka Grass.—The planting of Lunka grass, as a simple means of protection and regulation of the margin of the river, should be carefully and annually carried out, and it should not be overlooked that all such operations require to be planned with the aid of large scale surveys. The Revenue Survey maps will afford a great deal of the information required.

Altogether, unless the Government desire to carry out improvements to the condition of the island of Divi at a very considerable cost and can provide the funds required, I would recommend that, until the works for bringing Divi under the Kistna Anicut are carried out, which should be at latest at the beginning of 1872, the improvements be confined to the makeshift sluices at the heads of the channels; to such moderate repairs of the existing embankments, without raising them above their general level, as may be necessary; and to planting Lunka grass. The last two items can be carried out from Repairs, Agricultural; but for the first the Superintending Engineer will need an extra grant under Minor New Works.

27. *The Pulleru.*—The remaining branch of the Masulipatam Canal is the Pulleru, with its head at Kunkipad. It is connected with the Masulipatam Canal by a locked junction at Pamurru, and the water-levels vary somewhat, either canal being at times the higher. Just above this junction there is a new bridge of four bays; one bay is a drawbridge, the roadway being intended to turn on a horizontal axis. The road is not properly counterbalanced, and so the arrangement has not proved successful. It can be altered, but bridges of this kind should, when practicable, be avoided. The old bridge is not yet removed. The navigation is pretty good, but the current is rather strong. At Cowtaram the canal divides into three branches—(1), the most southern, the Buntoomilly Channel, which has a lock (100 × 15) at its head and is navigable, and which has a branch to the salt-pans. To maintain water for irrigation at a proper level, however, several loose stone-

ms, which injure the channel and make navigation almost impracticable, have been constructed. A second lock is much wanted below the head of the salt branch, and it is intended to continue the line to the Oputeru, a lock into which will connect Masulipatam with Nursapore and the Western Delta of the Godavery. The extension will be inexpensive, and a good deal of additional land will be brought under irrigation. (2.) The Lower Pulleru, which terminates near Kuldindy and is not navigable. (3.) The Polerazkodu, a canal which can be navigated, as the Superintending Engineer's boat took us down it for a good many miles, but which is not considered and maintained as a line of navigation, though, I think, it will be of considerable use, and, as a head lock is alone required to make it sufficiently convenient, this may be given. Bushes and prickly-pear should be removed from the banks. There is not much of the latter at present, but it will spread rapidly and not exterminated.

28. The completion estimates for this part of the delta present no difficulties. A good deal has been either done or provided for, and the rest, whether as regards distribution or drainage, can easily be worked out. The Buntoomilly and Oputeru Canal should be a second class line of navigation.

29. *Drainage outfall near Masulipatam.*—There has been at different times some discussion as to the funds from which provision should be made for the outfall channel* from the Shevagunga Sluice. I think the better drainage of

the Sectanagram swamp will be sure to lead to an extension of cultivation, and, as the sluice has been built, it is a pity that for want of an outfall the lands should still be undrained. I would suggest, therefore, a grant from the Reserve under Agriculture, so that a cut may be made after the 1st April and before the setting in of the south-west monsoon.

30. *Ryves' Canal.*—The head of this canal is now near Ramarampad, in the 7th mile of the Ellore Canal; but a new head is under construction at the lower end of the main canal in order that it may obtain a better supply. The head-sluice is nearly finished, and it will be a handsome work, the masonry facing being very good. Its site is not a convenient one as there was but very little room, and the Hyderabad road has to make two or three awkward ends. The sluice shutters should be modified so as to work the shutters by crews. Angle iron bearings are the best, and save work in dressing the face of the grooves. These works are being carried out on the estimate, Rupees 4,08,090 forming Item No. 88 of this year's Budget. This canal tails into the Pulleru at Turryvada; but, some 8 miles above this point, or at the same distance from the head, it throws off the branch called "Ryves' Branch Channel." The lower miles of this run across the drainage of the country and greatly obstruct it, and, as a considerable outlay has been incurred on this part, and as the carrying out of the drainage arrangements will be much facilitated by irrigating the land under its part from the Pulleru or from the lower part of the canal, I have, after much consideration and discussion, come to the conclusion that the Superintending Engineer is right in wishing to revise the arrangements, and the estimates will be prepared accordingly. All the irrigation channels to the east of Gudivada will then be nearly parallel to the drainage, and the latter will be made as complete as the former. At the head of the branch channel on the canal there is a sluice of three

and, as mentioned previously, the Eastern Bank Canal and the Divi extension will need	120
	720
	2,910
One Surveyor for five months	RS. 375
Lascars	150
Contingencies, say	525
	535
Total ..	4,000

The *Boodemair Aqueduct* has ten vents of 10 feet span each. All the arches were under water. The left lower wing return has separated from the wing; 7 feet 2 inches of water in the canal at this point. The pool at the aqueduct should be drained, and the flooring, etc., examined, and all necessary repairs executed, and it may be noticed that works of this kind require annually to be carefully examined, or, at least, in those years in which rainfall has been considerable, and this cannot be done properly unless the water be baled out at the commencement of the dry season.

Lock into Boodemair—6 feet 11 inches on upper sill, and only 1 foot 10 inches on lower sill. This lock, which is near Casarapilly, is very seldom used. The lock is in good order, but the gearing was rusty and not in an efficient state.

The Navigation Superintendent should be required to look after such matters, and also to see that the banks are at a proper level. At one place, just above Casarapilly, at a crossing, the right bank was only a few inches, and the left bank one foot, above water. Such a thing should be an impossibility with establishments whose duty it is to attend to the canals and the works belonging to them, and who have lascars at their disposal to carry out forthwith emergent work.

The *surplus weir below lock* is much out of repair. The platform bridge requires re-construction; the beams in front of the shutter groove should be securely bolted down: the piers between the sluice and centre bays are very thin, but, as they have lasted for many years, they will do very well if kept in repair.

In the 32nd mile there is one of Captain Ryves' self-acting inlets and outlets. All the shutters of the outlet were in proper line, but one or two of the inlet shutters have not turned back into their intended position. These works want some little modification to ensure their proper action, and the Superintending Engineer may ask Captain Ryves, on his return to India, to see whether such improvement as may be required cannot be effected without difficulty. Works of this kind can hardly be expected to be fully efficient at their first introduction, and the designer should have the opportunity of making such alterations as experience may suggest. Either both the inlet and the outlet, or, at least, one of them, should in future always be bridged to carry the tow-path.

Under-tunnel, 36th Mile.—Five vents of 10 feet; a very suitable design. The filling in at the wings was indifferent, or perhaps puddle was required, the leakage should be attended to. About $2\frac{1}{2}$ feet of silt and 2 feet of water on aqueduct, which on a first class line of navigation is not as it should be.

Timalair Aqueduct.—This work has not been damaged by the late heavy rains; but the drainage, as has often happened before, went over it, and also entered the canal and breached the banks above. The water at the time of my visit, though there was no fresh in the river, was just running over the upper side wall, and what water there was in the river below the aqueduct consisted of leakage from the outlet sluices that were placed in the lower side walls and spandrils. The water runs over the aqueduct; in fact, just as if there were no water-way provided, or, I should say, no arches below. Sections of the outfall and of the bed of the river above the aqueduct should be taken, that it may be seen what can be done to put matters to rights. Also the banks of the canal, where breaches have so often occurred, should be so far strengthened as to render another accident very improbable. The banks there are at present composed of loose sandy soil, and they must inevitably give way with a very small pressure. Five years ago I had an opportunity of inspecting this aqueduct and the river above it up to the bifurcation, and I was then of opinion that the only efficient remedy was the raising of the upper side wall of the aqueduct and of the left bank of the canal to a height sufficient to make the water go under the former, instead of allowing the arches to be choked and the water to go over the parapets. At that time the sluices

were just about to be inserted in the face walls, and I was only a traveller in search of information, so that I could only say what I thought would be the result. The difficulty cannot be met by half measures, and no more time should be lost in arranging for the creation of a head of water which will ensure the arches clearing themselves should they have any tendency to silt up or rather choke up with sand. Probably the raising of the upper side wall 6 feet, of the ends of the wings 8 feet, and of the embankments to 1 foot above the latter level will suffice, though without surveys and levels I cannot exactly indicate these details, or determine whether training banks to the river or other subsidiary works will, or will not, be necessary. The arches should then be completely cleared, the weir above the aqueduct should be removed, and the sand cleared away for 200 to 300 yards above the aqueduct, and an outfall channel, 10 yards wide at bottom, with a bed slope of 2 feet a mile should be cut through the sand to, or as far below, the junction with the old bed of the river as may be requisite. When the next fresh occurs the stream may be assisted in widening the outfall by loosening the sand, beginning at the lower end and working upwards towards the aqueduct. The Superintending Engineer should take immediate steps for carrying out these alterations, and I believe, when they are completed, there will be no more breaches, and no difficulty whatever in providing for the passage of the flood-waters. The original arrangements at this part of the canal were not very judicious; but I do not apprehend that there will be any serious difficulty, or any great expense, in making them efficient. I understand that the foundations and flooring of the

aqueduct are quite secure; but, if there be any doubt on this point on further inquiry and upon examination of the plan of the work, a rough-stone apron*

* 7 yards wide.
1 yard deep at aqueduct.
 $\frac{1}{2}$ " " at outer edge.

should be placed immediately below the masonry flooring.

Inlet and outlet, Old Timalair.—The inlet is some little way from the line of the canal. The self-acting shutters do not right themselves, and the channel of the river is bunded to prevent the spread of the canal water. The outlet shutters act pretty well; but there is a great deal of leakage, which, however, is, in this case, utilized by an irrigation channel, having its head in the wing wall. Care should be taken to clear mud and silt away from the neighbourhood of these self-acting weirs each year. Piers for a bridge were built originally at the outlet; but the spans are too great for economy, and light intermediate piers should be inserted, and then the tow-path may be carried across.

Ellore Lock.—This has a lift wall of 8 feet. The difference of water-level was 12 feet. It filled in $6\frac{1}{2}$ and emptied in 8 minutes. The lock is an excellent piece of masonry. It is unfortunately only 15 feet wide though of ample length, and its upper sill was built on too low a level.

34. *Establishments required for completion estimates*.—I have in paragraphs 14 and 19 indicated what establishments are required for the surveys and levels for the completion estimates of the western section of the delta. The western section is naturally and conveniently divided into two sub-divisions by the Toongabuddra, and for the eastern sub-division the establishment needed is—

	RS.	RS.
2 Surveyors for six months, at 75 Rupees	...	900
10 Lascars, at 6 Rupees	...	360
		1,260
<i>Western Sub-Division.</i>		
2 Surveyors for 3 months, at 75 Rupees	...	450
10 Lascars, at 6 Rupees	...	180
		630
Contingencies, including variation of salaries at the discretion of the Superintending Engineer, Coolies, etc.	...	310
		2,200
The details for the eastern part of the delta are given in paragraph 31 above, and the total is.		4,000
		6,200
I would also allow 2 Draughtsmen for three months to expedite the preparation of the designs of the several works, and a salary of Rupees 50 will probably suffice	...	300
		6,500
Total...		

I find that Rupees 3,100 are available and at the disposal of the Superintending Engineer during the current year, so that Rupees 3,400 will require to be provided in 1871-72. Colonel Moberly was under the impression that the provision for temporary establishments for these investigations was much less than the sum above mentioned, and, now that he knows that he has funds sufficient for all the Surveyors required, and that the work to be done has in its general outline been fully discussed and settled, no time will be lost in getting on with the surveys and levels.

35. *Anicut and Head-works.*—The *anicut* appeared, so far as it could be seen from the rough-stone dam on its crest, to be in good order. The supply of water in the river was abundant, and a gap had to be left in the dam to prevent the water passing over the latter generally. The bed of the river above the *anicut* has altered very much this year. The great sand bank or shoal, the highest part of which was 16 to 18 feet above the crest of the *anicut*, is now only 2 feet above that level, and no part of it was visible. There is a deep channel on the left bank above the quarry hill, and a lot of sand has been deposited on the apron immediately to the right of the under-sluiques. The chart of the river for the season will shortly be prepared, and this will show more clearly the alterations.

The *under-sluique shutters* are in bad order. I think they may be made far more convenient and manageable by giving angle* iron bearings at the sides and by having the shutters made of planks in 3 feet lengths (height) and about 3½ inches on each side longer than the clear opening of the vent, the overlap corresponding to the depth of the angle iron inside. The shutters would be easily raised by a winch, and they would be depressed by two levers, one end of which would be

* 4 inches.

hooked into a ring staple inserted in the masonry, and which would act on two upright movable bars placed upon each shutter near the ends: the lever would have a slot through which the upright bar would pass, and in the latter iron pins would be placed at about six inch intervals. This arrangement would be simple, and, I think, as effective as circumstances will allow, for, without a bridge, it is not practicable to make use of fixed gearing.

A *fish ladder* was constructed before the freshes of the past season. The upper part has been washed away, and the lower part has been more or less damaged. The side walls of the ladder should be either flush with the apron, or, at most, one foot above it, and the surface should in the latter case, slope parallel to the apron. The whole work throughout should be constructed with massive cut stone, very carefully bedded on concrete. The fish ladder, as it is, is a source of danger to the anicut, and this should be remedied before the next freshes. It must be noticed that the rough-stone dam which is annually placed on the crest of the anicut should, when the ladder is in working order, have a gap left in it at the head of the ladder; otherwise, at the only time when the fish require any such assistance, they will be unable to make use of it.

Head-sluique, Bezoarah.—A second line of shutters running on rollers has been provided, but there are no proper appliances for working them. The wretched apology for a winch which I saw in use is altogether out of place, and it is not a good plan to leave shutters which, with the additions made to the masonry, cost a large sum, to remain almost useless for want of such a simple thing as a good winch. The winch should be mounted on tram wheels, and a tram should be laid from end to end of the sluique. The winch can then be placed so as to keep the chain vertically over the centre of the shutter, and thus the only objection to this form of power will be removed. It should also have an efficient brake for lowering the shutters, and the latter, when fully raised, should be held by iron cross bars. The man-holes are unnecessarily large, and an arch should be thrown across to carry one side of the tram, leaving enough space for the lascars to go down when necessary to clear or fix chains, etc., though, if proper shackles be attached to the shutters, this will but seldom be necessary. The front line of shutters should run or slide upon angle irons, and the valves in them should be worked by screws. The needles of these valves can then be done away with, and the shutters, like those of the second line, may be raised and lowered by a winch.

Basin above Head Lock.—The revetted bank on the river side should be raised to 3 feet above flood-level, and the nose should be re-built. Repairs to the entrance also are required.

Lock Dredge.—This is much in need of repair. The machinery is out of order, and is said to need thorough repair. The bucket links and pins are nearly worn through, and should have been looked some time ago, as the wear and tear upon them greatly increases when they get out of form.

Head-sluique, Sectangram.—The shutters, of which there is only a single line, are in very fair order, and many of the valves have recently been renewed. With the present extent of irrigation the large shutters do not require to be lifted at all. When this becomes necessary angle irons should be put in and the other improvements mentioned for the Bezoarah front line of shutters carried out.

Head Lock, Seetanagram.—Masonry in good order. A great deal of leakage through the gate valves, although the head of water was small; this should be remedied. The gearing acts fairly.

Workshops.—Very little work going on, but there will in the future be a great deal to be done in preparing sluice fittings and other gearing, which is much needed. The patterns of the cast-iron uprights or standards for weirs, rack, and pinion frames, sluice screw gearing, etc., used in the Godavery, should be obtained from that district.

36. *Main Canal Wharf.*—There has been some discussion* as to the proper height for the wharf wall, with reference to the description of boats which are used for the conveyance of produce and merchandize. I have waited until I had gone through the Godavery as well as the Kistna Delta before forming an opinion on this point. In the Kistna the majority of the boats in use are dhonies, for which a wall, having its top considerably above water-level, is decidedly the most convenient: a good many boats which were built for carrying passengers now convey grain and cotton, and for them steps are the more convenient arrangement. They are, however, not a good pattern of cargo boat, and, if they are to be permanently used for this purpose, they would be much more efficient were the sides built up and were hatchways opened in the roof of the cabins. I do not think it is necessary to provide for the exceptional use of a particular description of boat, and all that is requisite is to give steps for the passenger boats and a wharf wall for the dhonies and barges. I would, therefore, construct the wharf with a wall 4 feet high, in continuation of the present stepped ghaut, for a length of 150 feet, and the rest of the wharf should have its coping at 1 foot above the average level of the water from June to January, all depths above $8\frac{1}{2}$ feet being taken as that in striking the average as, when the canal has been enlarged, it will not be necessary to admit more than that depth of water. The lower steps of the present ghaut may be removed up to the line of the new wall.

37. *Labour.*—The subject of the provision of labour for the delta works has been discussed with the Superintending Engineer. Labour appears to be tolerably plentiful from January for several months; but it is extremely scarce during the irrigation season, during which, however, for some years to come a great deal of work must be done if the completion of the canals and their subsidiary works is to make fair progress. Hitherto no organized system has been made use of for obtaining labour from a distance; but I think a great deal in this direction may be accomplished if the Executive Engineers first find out what works they require to carry out during each part of the year and what labour of different kinds is necessary, and if then labour be sought for in the south-western parts of the old Guntoor District, in the north of Nellore, and in the north-east of Kurnool. Officers should exert themselves to overcome difficulties, whether of this or of other kinds, and it can hardly be expected that sufficient labour will be obtainable on the spot in a well-cultivated country for extensive works, or that such as may be available elsewhere will find its way to the Kistna unless the terms on which,

1871 Dept
No. of Govt for March
No. 804.

From
The Chief Eng^r
for Irrigation
to the Secretary to Govt
P.M.V.

Dated 11th January 1871
Recd 20th February 1871
Recd 23rd
N^o 7.

Report on the
Kistna Delta after
a tour of inspection.

N

No 722. 10 March 1871

No 264

to 26 Feb 1871 D. 2d March

Proceedings of the Madras Government
No 722 D. No. D. 13

Read the following
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From
The Chief Engineer } (L. E. Secy 7 11th Jan 1871)
for Irrigation }

This report, which
the Government have perused
with much interest, will be
communicated to the Super-
intendent of the 2^d Division
with a view to his taking
the various suggestions and
recommendations of the
Chief Engineer for Irrigation
into consideration in pre-
paring the plans and
estimates which are now
in hand for the completion

N.

of the irrigation and drainage of the Kistna Delta and the adaptation of the larger channels for the purposes of navigation.

The Project for the delivery of Water from the Kistna Ancient Channels to the lands now irrigated by tanks dependant on the Dronpaw Cadas Calini-gulab for their supply having been sanctioned, and an allotment of funds * Rs 8,000 made for the immediate commencement of the work, an early removal of the objectionable obstruction which that work

see telegram dated 20 July 1911

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offers to Drainage will it is hoped be effected.

The Govt are of opinion that, pending the bringing of the Island of Divi under the influence of the Kistna Ancient it will ^{not} be expedient to incur the heavy expense of carrying out the works for the protection of that Island from the effects of floods suggested by the Sd/- Engineer and recommended by the Collector, but His Excellency in Council agrees with the Chief Engineer for Irrigation that such minor improvements as the construction of the makeshift

sluices at the head of
the channel, which Major
Mullins describes, and the
immediate repair of
the embankments may
advantageously be under-
taken, and the Supergr.
will give his attention to
the subject.

As regards the estab-
lishment required to assist
the Supergr. in com-
pleting the Scheme, the
Govt. Secy. states that Rs 1800
have been provided in
the Budget, and if this be
found insufficient the
Govt. will endeavour to
provide the means of

employing such additional
funds as may be needed.

89

W. B.

To the Supergr. Secy.
Rev. Secy.
Ch. Engineer for the Govt.

Decr 12/91

Govt. of {1871} Madras.

PUBLIC WORKS.

To
The Superintendent
2nd Division

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Reord.

G. O., 10 March 1871 No. 722.

Nos. 264-265

The Bitter. Papineau writes
to Richard, intimates my
disapproval of Briggs, & a
bitter letter.