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From Major J. O. HASTED, R.E., Officiating Superintending Engineer, 1st Division, Kistna, to the Chief Engineer for Irrigation, dated Masulipatam, 4th November 1874, No. 100.

I HAVE the honor to forward herewith a report by Lieutenant D. McN. Campbell, R.E., together with three plans illustrative of the works proposed for completing the system of irrigation in the Eastern Delta.

3 Plans in one banghy parcel.
1 Lieutenant Campbell's report, No. 140 of 5th September, in one banghy parcel.
12 Appendices from A to M, in five covers, by letter Mail.

2. The Delta has been divided into five sections, the irrigation and drainage of each section being separately treated for convenience. Of these five sections one, viz., that relating to the Kykalur or most eastern portion of the Delta, called here the 4th Division, has been already submitted.

3. The other sections are still in hand and are so far advanced that the general design of the works proposed can be described. It has therefore been thought advisable to submit a report on the whole scheme at once, and any alteration in the figures therein given, which may be necessitated by alterations in the details of work to be made at your suggestion, can be noticed when submitting the last section of the project.

4. There are two sections No. 1 and No. 2 which are far advanced, and in which the arrangements proposed are those decided on in personal consultation with you. In working out these arrangements certain difficulties have been met with, which Lieutenant Campbell has described at length in the report and on which (as the sections give full information) I have the honor to request you will favor me with your opinion as early as possible, to prevent delay and waste of labor in making out the plans and estimates twice over. The points requiring to be settled are—

1*st*.—The height of the aqueduct into Divi which will regulate the fall of the east bank channel and the canals that shall be made navigable.

As regards this I think that, however desirable it may be to raise the aqueduct, the cost of raising the bed of the channel is so great, and the height the water will stand over the country above the aqueduct so considerable, that it would be better to retain the originally proposed bed level of aqueduct, and increase the depth of water flowing through it as also suggested by you. I also think the length of the first reach of the channel (with reduced bed fall) is too great, and that when there is a scarcity of water great difficulty would be experienced in keeping the channel open for navigation. If the central channel in Divi is made navigable I believe, it will be quite sufficient for the wants of this part of the country, especially as the river on each side of the island is navigable throughout the year, and there will be communication with the Western Delta by means of the west bank channel. A navigable canal from Divi to Masulipatam I think is desirable, though it will be an expensive work.

2*nd*.—The arrangements for the Ellore Canal.

Lieutenant Campbell has fully described the difficulties he met with in laying out the canal as suggested in your memorandum No. 309 A, dated 7th May 1874, and I believe that his proposal to alter the water level by a lock near Kasarapilly is the most satisfactory way of dealing with it. I do not approve of interfering with the navigation of this line by a lock, but the frequent alterations of surface fall which would otherwise be necessary are objectionable, and would also make it a difficult matter to keep open the navigation when water is low. By having a lock at Kasarapilly still water may be held up at Ellore when no water is required for irrigation. As the designs of the numerous masonry works on this canal depend on the levels decided on, this point should be settled at once.

5. I have already in my letter* forwarding the 4th section estimates remarked on the extent of cultivation proposed. Appendix D shows the area available for irrigation in the whole Delta as given by the Revenue authorities, and I would only remark that the extent shown therein is far above what I believe can be irrigated for many years to come and until the swamps become so raised as to be effectually drained. We have many applications to take up land in swamps which is quite unfit for irrigation because it cannot be properly drained; these swamps will not for a long time (especially now that Kistna flood water will be kept out of them) be

* No 79 of 6th October 1874.

fit for cultivation, and I think it necessary to provide for irrigating them. High lands also, especially those near the heads of channels, should not, in my opinion, be irrigated, and I have lately refused to allow land thus situated to be irrigated.

6. It must also be noticed again that, unless the main canal is widened, the area to be irrigated cannot be extended beyond 270,000 acres, and as any such widening would render useless much of the work we are now carrying out, it would amount to a reconsideration of the project. I am of opinion that we should not attempt to irrigate more than 270,000 acres.

7. On the other hand I believe that there is every probability of the land being taken up for irrigation as soon as we can supply water regularly. Hitherto the Zemindars have not regarded irrigation favorably, but there are signs of a better appreciation of the benefits of irrigation in Zemindari villages, and land is beginning to be taken up even now. Government villages will, I think, take up fresh land for irrigation readily, as soon as regular supply of water is ensured to them.

8. Appendices A and B show the number of days water has been at different heights within the level required for full supply, and it will be observed that a supply of 2 cubic yards an hour an acre cannot be obtained with water below 4 feet on the crown of the anicut. Under existing circumstances there would be some risk to cultivation if the full extent 270,000 acres were taken up, and it would be desirable that the anicut should be raised as proposed by Lieutenant Campbell. I believe that it could be thus raised without endangering the work, and would recommend the raising to be sanctioned in these estimates.

9. The proposed alterations to the Masulipatam canal have been decided on after much consideration. When a head sluice to the west side channel was provided at Kankipad, it was apparently concluded that the irrigation under it would be so little for some time to come that the Masulipatam canal could supply it without alteration. It is now necessary either to widen the Masulipatam canal considerably or to make a new head to the side channel. The latter course, I think, is most desirable; the cost will be less, and the navigation of eight miles of the Masulipatam canal will be much easier than if the supply were taken from Kankipad. The nearer to the head that the channels can be taken the better it seems to me. It is essential that there be an escape to the first reach of the canal, and this has been provided into the main drain.

10. To make the Masulipatam canal below Kankipad a still water navigation, it will be necessary to alter both the Veeranky and Nedumole locks. These works which are twenty years old were originally constructed very roughly and show cracks in places. I do not think therefore it would be advisable to raise them and have proposed to construct new locks. Further than this a little raising to banks is all that is necessary to the canal.

11. The 1st division I have already remarked on, it being one of the sections of which the main features should be decided on before details are worked out. The drainages of this and all other divisions have been estimated to be cut out to full width through the swamps, but I think it would be sufficient, as proposed in the Kykalur division project already submitted, to cut to full theoretical width to commencement of swamps and continue the channel at this width only through the swamps, allowing the water to spread.

12. The 2nd division I have also referred to above. I think that the proposed arrangement of passing the drainage through the canal is the only one that can be adopted, though when the escapes are open navigation for the time will be a matter of difficulty. The drainages below the canal, at all events those near the Collair, should not, I think, be embanked on both sides, the fall of the country being very considerable, but having been cut out at a fall of about 1 foot a mile, the water must be allowed to spread over the country.

13. 3rd division.—The arrangements proposed necessitate slight alterations to the Ryves' channel, and it has been thought desirable to take all irrigation from this channel off above Komatigunta calingulah; from this point to the Pullairu the channel will only carry the supply required by the Pullairu. At the junction of Ryves' channel and Pullairu it will be necessary to build a regulator. I do not think it advisable to keep the Pullairu as a navigable canal above Pamarru; it is but a short distance from Masulipatam and is now never used; below Pamarru it is part of the connecting line between Kistna and Godavery Deltas. The drainage of this section falls into the Collair lake, and it is therefore desirable that the level of the water in the lake should be kept as low as possible, the lake will then become a reservoir to receive the heavy floods of the Budemair and Tamilair which come down much faster than the Upputeru can carry off the water. For many years to come the lake must be a safety valve for flood water, and I should not recommend any attempt to cultivate it below H.W.M.

14. The 4th division has been already submitted separately.

15. 5th division.—It is proposed to continue the Bantumilly channel and make it navigable into the Upputeru. At first it was thought that a salt water channel would be most suitable, but Lieutenant Campbell has worked out estimates for a fresh water as well as a salt

water canal, and finds that the former will be the cheaper; it has therefore been estimated for. In this division a considerable extent of country is taken up by swamps, which for the present at all events can only be partially drained, and which must always be liable to be submerged during floods; the drainage has always been bad, as the drainage channels are of insufficient capacity and are used indiscriminately as irrigation channels. All the country east of the Hyderabad road drains into the Pedapatam swamp, from which there is an opening to the sea which never closes; the country west of the road has to be drained under the Masulipatam canal, and the water will pass into the Masulipatam creek.

16. With regard to the returns to be expected from the extension of irrigation, I am hardly in a position to state accurately what they will be. As mentioned by Lieutenant Campbell, one arrangement of the east bank channel will cost 4 lakhs more than the other, and if the drainages are not cut to full width through the swamps, there will be a saving of about 6 lakhs On the other hand, the cultivation returns which we have received from the Revenue Department do not make it clear what extent of land is now irrigated and what return is received from it; this subject has been noticed in G.O., No. 2,844, of the 7th October 1874, and I hope that it will be thoroughly explained and we may soon be in a position to give accurate figures. In the mean time there is I think no doubt that Rupees 4 per acre for dry land, and Rupees 6 per acre for waste land irrigated, as stated by the Revenue authorities will be received, and then Lieutenant Campbell's calculations show that in any case the direct return from irrigation would amount to 9·7 per cent. on the expenditure, and if the cost of works used solely for navigation are not taken into account to 10·59 per cent. When the last section is completed, the returns will be again referred to and the calculations more accurately made. At present I believe that we have taken the most unfavorable view of them.

From Lieutenant D. McN. CAMPBELL, R.E., Executive Engineer, 4th Grade, Eastern Delta, Kistna District, to Major J. O. HASTED, R.E., Superintending Engineer, 1st Division, dated Masulipatam, 5th September 1874, No. 140.

I HAVE the honor to forward the following report on the project for perfecting the irrigation and drainage of the Eastern Delta of the Kistna District.

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SECTION I.

GOVERNMENT ORDERS, &c., REGARDING THE PROJECT.

1. *Arrangements proposed by Colonel Anderson approved.*—In G.O., No. 1,861, dated 6th August 1862, Colonel Anderson, R.E., District Engineer of Kistna, was called upon to state his general views of the best mode of completing the system of canals in the Kistna District: this he did in his letter, No. 143, dated 6th January 1863, and the arrangements proposed by him were apparently approved in G.O., No. 430, dated 12th February 1864, and several parts of the general scheme were estimated in detail and sanctioned.

2. *Principal Works already sanctioned.*—The principal of these in the Eastern Delta were as shown in the following table:—

Description of Work.	Amount of Estimate.	Expenditure up to 1873-74.	Remarks.
	RS.	RS.	
Lower Pulleru	1,04,050	1,04,053	Completed.
Upper do.	1,87,990	1,62,672	Nearly completed.
Ryves' Project	4,14,193	2,57,942	In rapid progress.
Masulipatam Canal, East Side Channel	15,610	14,017	Completed.
Masulipatam Canal, West Side Channel	49,860	49,020	Estimate nearly worked out, but more work required.
Main Canal widening	1,13,530	63,942	In rapid progress.

3—5. *Sanctioning the project in portions considered objectionable.—Complete project called for.—Mr. C. G. Master's report.*—The Government of India, having considered that sanctioning the project in portions was objectionable, requested in G.O., No. 163, dated 25th October 1873, that steps might be taken for the preparation of a complete project for the whole system of works for the Kistna Delta, and in consequence of this the Government of Madras called on Colonel Winscom, who was then Superintending Engineer of the 2nd Division, in G.O., No. 3,684, dated 27th November 1867, to prepare the complete project. No special establishment being provided it was of course impossible that such an extensive work could be carried out, and a whole year was wasted, when the Superintending Engineer wrote a letter, No. 87, dated 9th October 1868, stating why he considered it unadvisable to carry out their orders; but Government repeated the call for completing the project in G.O., No. 3,941, dated 17th December 1868, but it was, I believe, on account of the reasons given by Colonel Winscom that Government ordered Mr. C. G. Master to make a report on the irrigation in the Kistna District—*vide* his letter No 50, dated 4th November 1869.

6. *Completion of Western Delta Plans.*—The work still got on very slowly owing to there being no special establishment till May 1870, when Captain Vibart, R.E., undertook the preparation of the plans and estimates of the Western Delta, which were completed in September 1872 and submitted to the Chief Engineer for Irrigation on November 30th, 1872.

7. *Delay in the preparation of Eastern Delta Plans.*—The Eastern Delta Project was more behind hand owing principally to there not being sufficient Surveyors and Draftsmen for both deltas; but, as soon as the Western Delta scheme was completed the work progressed more rapidly, and a great deal has now been done.

8. *Reasons why it was thought advisable to sanction the project in portions, a general report being made first of what was proposed to be done.*—Many alterations being found necessary in the Western Delta plans, owing chiefly to more extended views of the requirements of navigation and drainage causing a great deal of work to be done over twice, thereby wasting time and money, the Chief Engineer deemed it best that a general sketch should be made out of what was proposed to be done, and that then each section could be worked out in detail and sanctioned separately, and this was approved by Government in G.O., No. 976 A., dated 14th April 1874, and it is in obedience to that order that I am now sending you this letter.

SECTION II.

EXPENDITURE ON THE KISTNA WORKS UP TO DATE, REVENUE, &c.

1. *Ascertaining the remunerative character of the old and new works deemed advisable.*—It is advisable before contemplating the extension of the irrigation to ascertain if the works already constructed have proved remunerative and whether new works are likely to prove so also.

2. *Expenditure up to* 1872-73 *and income.*—The expenditure on the Kistna works up to 1872-73 (*vide* Controller's statement of remunerative works, dated 21st March 1874), and embodied in G.O., No. 1,300, dated 13th May 1874, is Rupees 31,53,710; the total income Rupees 78,21,987; from this latter sum the interest on capital, cost of maintenance, and establishment, amounting to Rupees 32,10,269, has to be deducted, leaving a balance of Rupees 46,11,718, which shows that the whole expenditure has been recovered and a balance of Rupees 14,58,008 left in hand, which may be considered satisfactory.

3. *Extent of Wet Cultivation since the construction of the Anicut.*—The following table shows the increase in wet cultivation in the whole district since the construction of the anicut:—

Official Years.	Fashs.	Area.	Assessment.	Remarks.
		ACRES.	RS.	
1855-56	1265	60,961	1,85,274	The whole of the wet cultivation under the anicut is included in this statement, which is a copy of one prepared by the District Engineer for the information of Colonel Rundall.
1856-57	1266	77,610	2,66,379	
1857-58	1267	85,171	3,07,892	
1858-59	1268	97,358	3,88,288	
1859-60	1269	102,387	4,44,541	
1860-61	1270	99,000	4,31,134	
1861-62	1271	106,586	4,73,415	
1862-63	1272	123,635	5,31,051	
1863-64	1273	140,402	6,50,984	
1864-65	1274	147,005	6,01,826	
1865-66	1275	148,288	6,79,917	
1866-67	1276	137,046	7,83,224	
1867-68	1277	141,493	7,84,367	
1868-69	1278	115,386	6,71,294	
1869-70	1279	128,323	7,61,048	
1870-71	1280	151,153	8,48,393	
1871-72	1281	162,552	6,48,277	
1872-73	1282	154,041	5,17,679	
1873-74	1283	176,100	9,74,983	Large remissions had to be given this year owing to floods.

4. *Revenue before construction of Anicut.*—The average revenue prior to the construction of the anicut was Rupees 1,26,020.

5. *General Remarks on Increase of Wet Cultivation.*—It will be observed from the foregoing statement that wet cultivation has been pretty steadily on the increase, and it is almost certain that as the works are extended more land will be taken up. In my opinion defective drainage has been the principal reason why wet cultivation has not been more extended; and, as in this project, very great improvements will be made in the means for discharging surplus water, I think it may be safely conjectured that there would be a rapid increase in the revenue as the works estimated for are carried out.

6. *Remissions owing to defective Irrigation and Drainage.*—The amount of remission which has been given in the last ten years owing to defective irrigation and drainage is Rupees 25,046 annually (average)—*vide* Appendix M containing a statement received from the Collector. From this statement it will be seen that the remissions on account of excess of water are more than twice those on account of deficiency of water. It is hoped that not only will this money be saved, but that large tracts of country which are now left waste owing to excess of water will be rendered fit for wet cultivation.

SECTION III.

Total Area to be irrigated in the Eastern Delta.

1. *Total Area to be irrigated.*—Colonel Anderson took 270,000 acres as the ultimate area to be irrigated in the Eastern Delta, and the calculation by which he arrived at this amount may be seen in paragraphs 3 and 4 of his letter, No. 143, dated 6th January 1863, embodied in Proceedings of Government, No. 430, dated 12th February 1864. The widening of the main canal, which is now being carried out, is to enable it to carry sufficient water for this acreage, and as any enlargement would be enormously expensive and render all the work already done useless, I think it better to assume that 270,000 acres is the ultimate area to be cultivated wet, though 414,963·45 acres are available for wet cultivation.

* With letters, Nos. 216 and 875, dated 18th October 1873 and 22nd May 1874, to the Eastern Delta Range Officer.

by the following statement prepared from the ones received* from the Collectors of the Godavery and Kistna Districts it appears that

2. *Area fit for Wet Cultivation according to Revenue Account*—

Names of Taluqs.		Total Area of each Taluq under Command of Anicut Water.	Available for Wet Cultivation. Present.	Expected.
		ACRES.	ACRES.	ACRES.
Kistna ...	Bandar Taluq	384,841·0	31,148	98,995·
	Gudivada do.	278,187·0	86,624	128,128·
	Bezwada do.	41,983·49	6,353·03	27,650·53
Godavery...	Ellore do.	55,530·44	13,598	22,466·89
Kistna ...	Nuzvid Zemindary	...	...	...
	Total ...	760,541·93	137,723·03	277,240·42

In the above the *Nuzvid* Zemindari is not included. Copy of the totals of Collector's original statement is given in Appendix D.

3. *Area to be irrigated under the Principal Channels.*—Taking 270,000 acres as the total area, Colonel Anderson then divided this between the several principal channels; but the experience gained while surveying has shown that several trifling alterations are necessary. The following are the areas which it is calculated will have to be supplied by the principal channels:—

Name of Channel.	Area to be taken.	Now Irrigated.	Remainder to be Irrigated.	Remarks.
	ACRES.	ACRES.	ACRES.	
Ellore Canal	31,000	19,362	11,638	
Ryves' Channel	35,000	30,000	5,000	
Bandar Canal	6,000	6,000	...	Direct.
East Bank Canal	88,000	11,000	77,000	
Pulleru	110,000	71,361	38,639	
Total Eastern Delta ...	270,000	137,723	132,277	

4. *General Remarks.*—The length of the time over which the survey operations extended allowed of the most careful inquiries being made of the area likely to be taken up for wet cultivation, and I am sure that the area under each channel as given above is as accurate as it is possible to obtain it.

5. *Area to be irrigated in each taluq.*—The acreage to be taken up as shown by the taluqs is as follows:—

Taluqs.	Area in Square Miles including Swamps and Land reserved for Dry.	Area to be irrigated by this Project.	Area fit for Wet Cultivation as per Collector's Statement.	Remarks.
	SQ. MILES.	ACRES.	ACRES.	
Kistna ... Bandar	601·31	126,000	130,143·0	*Vide* Appendix C. 1,160 square miles only are taken by Department Public Works excluding lands too high and swamps not irrigable.
Gudivada	434·66	107,000	214,752·0	
Bezwada	65·59	6,000	34,003·56	
Nuzvid	...	12,000	...	
Godavery Ellore	86·76	19,000	36,064·89	
	1,188·32	270,000	414,963·45	

6. *Average Acres per Square Mile to be irrigated in Zemindari Land.*—The average number of acres calculated to be irrigated per square mile of the zemindari land is 158·73* for the whole Eastern Delta. The Chief Engineer in his memorandum, No. 7, dated 11th January 1871, embodied in G.O., No. 722, dated 10th March 1871, stated that from 250 to 300 acres per square mile might be allowed, but in a subsequent memorandum, No. 309 A, dated 2nd July 1873, he stated that 100 acres per square mile was sufficient in some parts of the delta. This last memo-

* *Vide* Appendix C.

randum was received after all the calculations regarding the areas had been completed, and considering that a good portion of the zemindari land is already cultivated, and that the zemindars appear to be fast getting over their objections to taking water, I do not think that the quantity, acres 158·73 (which is a good deal less than what the Chief Engineer laid down in his first memorandum), is too much.

SECTION IV.

Supply of Water in the River, Head-works, &c.

1. *Head-sluice at Bezwada.*—The main canal is supplied by a head-sluice of 15 vents of 6 feet span each, the level of the floor being + 37·5, or 5 feet 6 inches below the crest of the anicut level + 43·0. There is no doubt that the waterway of this sluice is insufficient, but peculiarities of site would render it very difficult to increase it. Colonel Anderson goes thoroughly into this matter in paragraph 25 of his letter before quoted.

2. *Main Canal.*—The main canal as sanctioned and now nearly completed is to be 200 feet wide at bed, the sides being revetted; the bed of the channel will be level; the depth of water at the head-sluice will be 8¼ feet, and at the head of *Ryves' Channel* 900 yards down; the depth will be 8 feet, giving a surface fall of 3 inches, which is at the rate of about 6 inches a mile, and the discharge will be 4,268·16 cubic feet a second, the required discharge for the 270,000 acres calculated at the rate of 2 cubic yards per acre per hour being 4,050 cubic feet a second.

3. *Depth of Water required on Crest of Anicut.*—The depth of 8¼ feet inside the head-sluices is that assumed by Colonel Anderson, and has been used in calculating the size of the Main, Masulipatam, and Ryves' Channels, all of which are in rapid progress. Now to get a discharge of 4,268 cubic feet a second through the head-sluices with a depth of 8¼ feet inside we must have a depth of 9·562 feet outside, *i.e.*, a head of 1 foot 3¾ inches, which represents depth of 4·06 feet on the crest of the anicut: this result is found using the co-efficient ·625 and taking the tops of the vents as flush with full supply level.

4. *Depth of Water on the Anicut for the last eight years.*—Appendices B show the depth of water on the crest of the anicut for the last eight years, and from this it will be seen that the river does fall for several days together below 4·06 feet.

5. *Present mode of raising the level of water.*—At present the water is kept up towards the end of the irrigation season by building a temporary rough stone dam 4 feet high along the crest of the anicut; but should the river fall in the middle of the irrigation season, it would be impossible to raise it.

6. *Proposal to raise the Anicut.*—It appears to me that the best way to remedy this would be to raise the anicut permanently 3 feet. This was suggested to Government by the Superintending Engineer, 2nd Division, in his letter No. 4, dated 8th April 1867, and by the Order on that letter, No. 1,220, dated 25th April 1867, Government seems to have considered that the proposal might be carried out when the anicut was more settled and consolidated than it was at that time, and it certainly is so now and could, I believe, be raised with perfect safety. I would raise it by building 3 feet height of large blocks of cut stone well clamped together over the front wall, the rough stone behind being raised 3 feet above so as to retain the same slope as at present, and I would lengthen the apron by 50 feet. The cost of this would be approximately Rupees 1,30,000. If this were done the irrigation in the delta would be perfectly safe. It would also take about 2 lakhs off the cost of widening the *Nizampatam* Canal in the Western Delta, as it might then be calculated to run 9 feet or over 9 feet 6 inches deep instead of 8 feet. Colonel Anderson also proposed to enlarge *Sitanagram* under-sluices. This would be a very expensive work, as much blasting would have to be done; and, as no mischief has as yet arisen from the head-sulices silting up, I do not think it is necessary to enlarge the under-sluices.

7. *Shutters for Under-sluices.*—The anicut will also be greatly improved by shutters being provided for the under-sluices with suitable gearing for working them. I have been unable up to this time to design any good arrangement; but a lump sum will be allowed in the estimates for this purpose.

8. *Improvements to Head-sluice.*—The vents of the main canal head-sluice will be blocked up to full supply level, and the shutters will be worked by screw gearing similar to that proposed for the Nizampatam canal head-sluice.

SECTION V.

Masulipatam Canal from Ryves' Channel to Kankipad Lock.

1. *Surface Fall in Masulipatam Canal.*—It has been mentioned before that the depth of water at Ryves' Channel head-sluice is to be 8 feet, and that the surface fall in the maincanal from its head-slue to this point is 6 inches a mile. Now if this fall were continued down to Kankipad Lock a distanceof 12¼ miles, the fall of the bed being only ·154 feet a mile, the depth of water on the upper sill of the lock, would only be 3¾ feet, which is of course out of the question; it is

therefore evident that the surface fall must be changed or the lock sill lowered, both of which plans are I think objectionable, but of the two I prefer the former, and there are several ways of doing this; but before discussing them it is necessary to mention that it is proposed to take off all the water required for the irrigation of the country between the Masulipatam Canal and the river, from a point near *Yanamalakuduru*, 3½ miles below Ryves' head-sluice, the Masulipatam Canal below this point being used only for navigation and to supply the *Pulleru*, which latter takes off just above Kankipad Lock.

2. *Different modes of changing the surface fall.*—Now the surface fall in the Masulipatam Canal from Ryves' Channel to the head-sluice of east bank channel might be continued at 6 inches a mile, the fall from thence to Kankepad being reduced to 0·253 foot a mile, which would give a depth of 6 feet on the upper sill of the lock, and the discharge at this point would be sufficient for the supply of the Pulleru. Again, the surface fall from Ryves' head sluice to east bank channel might be reduced to 5 inches a mile, which would give a depth of 7·081 feet at the latter place, and from thence a fall ·332 inch a mile would give a depth of 6 feet on Kankepad lock upper sill. This latter plan was suggested by the Chief Engineer, though he did not examine the plans or give any decided opinion on the subject: but in my opinion the former plan is preferable, for the other would necessitate the Masulipatam canal being more widened in the first 3½ miles where the cutting is heavy, and the surface fall would be slightly changed at two places instead of considerably changed at one point, thus making two difficulties in the regulation instead of one. The great difficulty will be when the branch channel at which the change occurs is closed, now Ryves' channels being only for irrigation will be closed early, while the east bank channel will be kept open for navigation as long as the Masulipatam canal, and it will moreover be well provided with escapes.

3. *Proposed alteration to the Masulipatam Canal.*—The fall of 6 inches a mile being continued to the head of the east bank channel, the fall of the bed being ·164 foot, the depth of water at this point will be 6·789 feet. With these data I find the Masulipatam canal will have to be 90·0 feet wide at head and 118·0 feet at 3½ miles, the discharge required being 2,008·11 cubic feet a second made up of 1,327·0 cubic feet a second required for the 88,000 acres under the east bank channel and 681·11 cubic feet a second which will be carried by the Masulipatam canal direct, the dimensions of which below here it is not proposed to alter. The Masulipatam canal from proposed site for east bank channel sluice to Kankepad is now being widened to a bottom width of 66 feet, if a depth of 6 feet be allowed on the upper sill of Kankepad lock the surface fall will be 0·253 foot a mile, velocity 1·456 feet a second, and the discharge 681·408 cubic feet a second; if 81·408 cubic feet a second be deducted for lockage and leakages, 600·0 cubic feet a second are left for irrigation; of this quantity 90· cubic feet a second will be required to irrigate 6,000 acres of land above Kankepad, and the remaining 510· cubic feet a second will pass down the Pulleru (which is amply large), 52·5 cubic feet a second will be taken off above *Marrivada*, the remainder 457·5 cubic feet a second supplying the lower part of the Pulleru. Now the proposed acreage under the Pulleru below Marrivada is 106,500 requiring a supply of 1,597·5 cubic feet a second, and as only 457·5 cubic feet a second will be supplied from the upper part of the Pulleru, the remainder, viz., 1,140· cubic feet a second, will have to be supplied from Ryves' channel. It will be seen hereafter that the latter channel will have to be slightly altered, but I have thought it better to do this than to enlarge the Masulipatam canal from the 4th mile to Kankepad. It might be here objected that if the fall in this portion was increased to 3·32 inches a mile, no alterations would be necessary to Ryves' channel: but the answer to this is that the cost of the extra widening to the Masulipatam canal rendered necessary by the reduction of 1 inch per mile in the fall to the head of east bank channel would far exceed the cost of the proposed alterations to Ryves channel.

4. *Reasons for taking the west side channel from the east bank channel instead of from the Masulipatam Canal at Kankepad.*—It was originally determined to take off all the water required for the irrigation of the country west of the Masulipatam canal by the east bank channel, *vide* paragraph 19 of Colonel Anderson's letter to Government before quoted: but for some reasons which I cannot find out this project was changed and the *west side channel* was taken off from Kankepad, part of the existing weir at that place being turned into a head sluice. If the head of the west side channel is left at Kankepad, the Masulipatam canal from the 4th mile to the 12th will have to be enlarged a good deal, and if the surface fall be not increased (it cannot be much increased as there would not be enough water for navigation in the upper sill of Kankepad lock) the widening will be very considerable, the velocity will also be greater, and navigation will be impeded. There can be no doubt that it is advisable to take the irrigation channels off as high up the Masulipatam canal as possible, and as the cost of taki ng all the water required from Yanamalacudurr will be Rupees 51,443 less than taking part from that place and part from Kankipad, I have no hesitation in recommending the former plan. This appears to have been misunderstood, by the Chief Engineer, who in paragraph 41 of his memorandum No. 309 A, dated 7th May 1874, gives economy as one of the reasons why the head of the West Side Channel should be placed at Kankipad. I am aware, as stated by the Chief Engineer, that the Masulipatam Canal and the West Side Channel are capable of supplying all the water for which there is a demand *at present*; but, as this is a completion

project it is necessary to provide for the land that it is calculated will ultimately be taken up, though it may perhaps be some years before it will be necessary to widen the East Bank Channel to a greater width than is necessary to supply the Island of Divi.

5. *Escape for the Masulipatam Canal.*—There is at present no escape to the Masulipatam Canal, so that in the event of floods the surplus water has to be let down the Pulleru, and into the lower reaches of the canal from the Pulleru it runs into the *Polrazkodu*, *Tadicherlakodu*, and *Bantumalli* Channel causing serious damage; this happened in the year 1872, and is liable to happen any rainy season; it is therefore thought advisable to reconvert the West Side Channel head-sluice into an escape. The manner in which the surplus water will be disposed off will be described further on.

SECTION VI.

Masulipatam Canal from Kankipad Lock to Tidal Lock.

1. *Proposed Improvements.*—It is intended to reserve the Masulipatam Canal below Kankipad Lock to the Tidal Lock, a distance of 37 miles, entirely for navigation and to make it stillwater with a depth of water of 5 feet on the lower sills of all the locks which necessitates considerable alterations to most of the existing masonry works.

2. *Viranki Lock.*—Taking 5 feet of water on Kankipad Lock lower sill (level + 28 feet) the surface of the water will be + 33 feet, which is 2 feet above the upper sill walls and 3 feet 6 inches above the lower ones of *Viranki* Lock; it moreover gives a drop of 12 feet, the lower sill being + 16 feet, depth of water 5 feet, and therefore surface + 21 feet; this lock not being in good repair, it would not be safe either to raise the walls or to allow such a large drop; it will therefore be necessary to build another lock immediately above it, and the channel banks above will also have to be raised.

3. *Pamarru Lock.*—It has been mentioned that the surface level below is + 21 feet, the full supply level in the Pulleru is + 22·42, the level of the top of the chamber walls of *Pamarru* lock is + 22·92 feet, so all that is necessary is to raise the walls by 1 foot.

4. *Nidumole Lock.*—The surface level of + 21 feet is 1 foot below the level of the top of the upper sill walls of *Nidumole* Lock and equal to the height of the lower sill wall; it will therefore be necessary to raise the former by 6 inches and the latter by 1 foot 6 inches; the drop will be 10·5 feet. The lock being in very bad repair and the chamber walls cracked, it would not stand such a large drop; I think it would therefore be advisable to demolish the work and build a new one. The banks above will have to be raised.

5. *Akumarru Lock.*—The level of the lower sill of Nidumole Lock being + 5·5, the surface of water in the lower reach will be + 10·5. The heights of the chamber walls of the next or *Akumarru* Lock are, upper sill wall + 12·43 feet, lower sill wall + 11·18 feet; the latter only will therefore have to be raised to + 12 feet.

6. *Tidal Lock.*—The level of the lower sill of Akumarru Lock being — ·82 foot, the surface level in the lower reach will be + 4·18, and this will necessitate no alterations to the next or Tidal Lock. the chamber walls of which are + 5·18; but the banks in this reach will have to be raised in places.

7. *Headway under existing Bridges.*—The headway under all the bridges is sufficient excepting the iron girder bridge at Chintaguntapalem, which will have to be raised 1 foot, and the bridge over the channel connecting the Pulleru with Masulipatam Canal will have to be raised 3 feet. The canal being a stillwater one, no escape weirs will be necessary; the existing ones will therefore be left as they are at present.

SECTION VII.

Divisions of the Delta proposed in describing the Project.

1. In describing this project it will be convenient to divide the delta into several portions which will be as follows:—

1*st Division.*—Between the Masulipatam Canal and the Kistna river, bounded on the south by the sea from the mouth of that river to the Masulipatam Creek.

2*nd Division.*—Between the *Ellore* Canal and the *Budumeru*, bounded on the east by the east branch of the *Tammeleru*.

3*rd Division.*—Between the Pulleru and the Budumeru, bounded on the east by the Polraz kodu and *Koleru* Lake.

4*th Division.*—Between the Polrazkodu and Bantumalli Channel, bounded on the east by the *Upputeru*."

5*th Division.*—Between the Pulleru with Bantumalli Channel and the Masulipatam Canal, bounded on the east by the sea from Masulipatam to the mouth of the Upputeru river.

1st Division.

1. *Area to be irrigated.*—The total area of this division under command of the anicut is 345 square miles, out of which 185 square miles are zemindari and the rest Government land; in this area it is assumed that 88,000 acres will be cultivated wet, which is at an average rate of 255 acres to a square mile.

2. *Eagerness of Ryots for Water.*—This may seem a high proportion, but I am sure it is not over the mark; the ryots in Divi are eager after wet cultivation; I have never visited the island without receiving numerous petitions for channels, and I believe that nearly every inch of land will be taken up for wet crops; in parts of the zemindari portion the ryots are eager for water, and in many villages they have presented me with statements showing the number of acres they will cultivate if channels be dug to their lands.

3. *Soil.*—The soil throughout the whole of this division is very rich; it is principally alluvial, though in it there are sandy portions. In the south-east part of the Island of Divi there is an extensive swamp; part of this will be drained by the new scheme, but it is not thought advisable to reclaim all of it on the score of expense.

4. *Present Cultivation.*—The land in that portion to the north of the road from Masulipatam to *Kothapalem* is highly cultivated, principally dry; it is subject to occasional floods when the Kistna is in fresh. There is a good deal of wet cultivation in the Island of Divi (11,000 acres); the water is supplied from tanks which are filled by cuts from the Kistna river: the supply is very precarious, and serious damage is often done by floods, and unless there is a fresh of at least 10 feet over the anicut at Bezwada most of the tanks will receive no water.

5. *General Levels of Country.*—From the cross sections it has been found that the level of the country near Bezwada is + 55·0 feet and at the lower part of Divi + 6·0 feet, the total fall in this distance is therefore 49·0 feet or about 1 foot a mile. It will also be noticed that the country falls from the river towards the east, thus the level at *Nadakaduru* is + 26·0 feet and at Masulipatam + 6·0 feet, giving a fall of 8 inches a mile; again, at *Ilur* it is + 26·0 feet and at Nidumole + 13·0 feet, giving a fall of 1 foot a mile. The country also slopes away on both sides from the branches of the Kistna which separate the Island of Divi from the main land. Though the general slopes are as above, it has been noticed that there are two strips of low land, one lying between the Masulipatam Canal and the Kistna river from Yanamalakoduru to a short distance beyond the village of *Bhaddirazupalum*, where a natural drainage channel commences called the *Kannikalamadugu*, and another between the Masulipatam Canal and the *Bhimanadi* from *Inampudi* to near *Yendakuduru* where it joins a natural drainage. It will also be observed that the Kannikalamadugu has several branches, and that these branches do not flow in low ground; but that the general slope of the country is continued across them, thus each branch acts as a catch drain receiving all the drainage to the west of it, the country falling from it towards the next branch to the east. The general features of the country as mentioned indicate clearly how the irrigation and drainage of this division can be best carried out.

6. *General proposals to irrigation and drainage.*—There will be the East Bank Channel which will leave the Masulipatam Canal at Yanamalakuduru and run in a south-easterly direction along the lowest ground till it reaches the river bank, from thence it will run alongside of this bank (advantage being taken of the pits already dug for the bank) as far as the south part of the Island of Divi. At Vallurpalem, about 11 miles from its head, it will throw off the first main branch which will run in an easterly direction along the present *Agakodu* till it reaches the Masulipatam Canal, alongside of which it will be carried as far as Akumarru, from thence it will turn westward and fall into the Agakodu drain at Yendakuduru. This main branch is called the Masulipatam West Side Channel, and has been already excavated from Kankepad to Akumarru; but it will require several alterations and improvements. The East Bank Channel will irrigate all the land to the east of it as far as the Kannikalamadugu. Besides all the land in Divi. The West Side Channel will irrigate all the land to the west of it as far as the Kannikalamadugu. A drainage channel will be dug in each of the hollows before mentioned and the existing drains, viz., Kannikalamadugu and *Dayapu* Calva will be improved. There will also be a surplus channel from Kankipad and several minor drains in Divi which will be described hereafter.

7.—9.—*East Bank Channel.—Six inch a mile considered the best fall.—Why Irrigation was considered of great consequence than Navigation.*—The East Bank Channel commands 345 square miles of land, out of which it is assumed that 68,000 acres will be cultivated wet, of which 45,000 acres will be in Divi. The estimate for this channel was worked out in detail, and it was designed to run 6 feet 6 inches deep with a fall of bed throughout of 6 inches a mile and two locks 2 feet drop each, the fall of 6 inches a mile is that which Colonel Anderson has found was the best for channels of about the width and depth when there was much silt, it was made navigable as far as the *Puligadda* branch of the Kistna, but the requirements of irrigation were considered of paramount importance to those of navigation in accordance with the views expressed in G.O., No. 430, dated 12th February 1864, where it is written in paragraph 6, "By this arrangement even if some of the larger minor channels, such as the Pulleru be made accessible to boats during part of the year, the extent to which it was originally intended

to provide the means of water carriage throughout the delta will be considerably circumscribed: but the Government believe that the change is necessary in order to confine within the smallest practicable limits the great evil of the excessive deposits of silt which is found to take place in the Kistna canals, and moreover to save the labor and expense of the inordinate enlargement of the channels that is necessary to give them sufficient capacity to carry all the water required for irrigation at the low velocity that is indispensable in a navigable canal." I may here mention that this was settled at a time when Colonel Anderson was Chief Engineer for Irrigation and Colonel Orr, Secretary to Government, both of whom knew the Kistna District thoroughly.

10. *Alteration in fall proposed by Chief Engineer.*—The Chief Engineer on looking over the plans last November considered that the channel should be designed more with a view to easy navigation, and that the fall should be reduced from 6 inches to 4¾ inches per mile as far as the aqueduct to be constructed over the Puligadda branch, and that the proposed locks should be omitted; the effect of reducing the fall will be to increase the cost of the channel considerably, the advantage gained being a velocity of 2,000 yards an hour instead of 2,580 yards an hour and the raising of the bed of the aqueduct.

11. *Level of the bed of the Channel over Puligadda Branch, Kistna River.*—Settling the level of the bed of the channel over the Puligadda branch required a great deal of consideration, and I finally came to the conclusion that it would be better to build a very substantial aqueduct and let the water in the river rise above the bed than to incur the expense and danger of high embankment for a long distance above the work. I therefore put the bed of the canal at + 15·09, the maximum flood level in the river being + 19 feet.

12. *Alteration of level proposed by the Chief Engineer.*—With the level of the aqueduct floor raised to + 23 feet as laid down by the Chief Engineer, the bed of the channel for 4½ miles above the aqueduct will be more than 6½ above the level of the country, the surface of the water will therefore be more than 13 feet above the country for that distance, and in one place it will be 15 feet above the country, in addition to this the embankment will be greatly in excess of the cutting for a distance of 23 miles above the aqueduct.

13. *Alternative plan proposed by Chief Engineer.*—The alternative plan proposed by the Chief Engineer of letting the water run 9 feet deep over the aqueduct would increase the amount of banking and would also be more costly owing to the reduction in the surface fall.

14. *Gannavaram Aqueduct in the Godavery District.*—As remarked by the Chief Engineer the Gannavaram aqueduct in the Godavery District has stood floods passing right over it, and the work I designed would be stronger and the water would never rise so high, the velocity would never exceed 6·1 feet a second, and it should not be very difficult to design a work sufficiently strong to withstand this when good materials are procurable. The East Bank Channel will now be estimated in exact accordance with the Chief Engineer's wishes—*vide* paragraphs 41 to 46 of his letter, No. 309 A, dated 7th May 1874.

15. *Navigation in Divi.*—In these he states that there should be three lines of navigation in the Island of Divi; but that if this entailed considerable expense only the central line should be made navigable, and the latter only will be done as the cost of making them all navigable is very heavy; but the other channels can be connected with the river by cutting short channels to it from just above *Suvarnamukki* Channel and locking them into the river.

16. *Anticipated Silting.*—As the channel will be both for navigation and irrigation, as soon as the width necessary for the latter is less than that for the former, viz., 25 feet, the fall of the channel is to be diminished at each offtake thus the velocity will be gradually diminished to the end of the channel, and in my opinion large quantities of silt will be deposited.

17. *Difficulties in the regulation of water.*—I also think that to have one reach (from the head-sluice to the aqueduct) of 35 miles in length will render the regulation of water extremely difficult, and will be most inconvenient when no water is required for irrigation and the channel has to be kept open for navigation.

18. *Cost of East Bank Channel.*—The cost of the east bank channel according to the proposals of the Chief Engineer is Rupees 8,33,140. The cost as originally estimated, *i.e.*, with fall 6 inches per mile is Rupees 4,03,010. The difference is therefore Rupees 4,30,130. Whether the advantages gained by the reduced fall are worth this enormous sum of money is to be settled. The amount above mentioned does not include puddling the banks which I think will be absolutely necessary with the water at such a height.

The cost of the branch channels will also be somewhat increased, as there will be considerable drops in all the head-sluices.

19. *Branches.*—The East Bank Channel will throw off 15 branches, the acreage under each of which is given in Appendix G; two of these, viz., the *Kistna Branch North Bank Channel* and the Suvarnamukki Channel will be navigable.

20. *Branches for Navigation.*—The former will be a useful line of navigation if continued to Masulipatam; but it will have to cross some formidable drainages, and this was the reason why it

was not estimated for navigation in the original project, but the Chief Engineer now wants it made navigable with a view to its being extended hereafter.

21. *Locks required.*—The increased height in the bed of the East Bank Channel will necessitate a double lock being built at the head of this channel, as the drop will be about 13 feet. A lock with a drop of about 11 feet will also be necessary at the head of the Suvarnamukki Channel.

22. *Alterations necessary in Branch Channels.*—All these branch channels were estimated for in detail, but the bed of the bank channel being altered will cause alterations in them.

23. *Masonry works allowed.*—Each channel will be provided with a masonry sluice, tail escapes, and drops where necessary, and cattle-crossings and masonry bridges will be provided at suitable places.

24. *Best method of carrying the water across the Puligadda Branch.*—The best method of carrying the water across the Puligadda branch of the river has been discussed for many years; it has been suggested to bund up the branch entirely to carry the water in iron pipes under the bed of the river, to carry it over in an iron trough on screw piles. The former plan I consider objectionable, as, unless very expensive means were adopted to divert the current, a large area of valuable land would be washed away, and moreover the river would be liable to cut in at some point lower down; the two latter proposals are objectionable only on the score of expense which would be very great, and, as the best bricks in the delta are made at Puligadda within quarter mile of the site of the proposed work, and labor is plentiful, I consider that a masonry aqueduct will be much the cheapest and best method of carrying the water over.

25. *Velocity of Water in Puligadda Branch.*—The mean velocity of water in the Puligadda branch during a fresh of 8 feet over the anicut at Bezwada was found to be 2·315 feet a second. I have had no opportunity of taking the velocity during a greater fresh, but I think it may be safely assumed that the velocity is never greater than 3 feet a second.

26. *Soil in bed of river at site.*—The soil in the bed of the river is firm sand, the bed hae been gradually sanding up, and the villagers, who remember it when it was 20 feet deeper, say it was firm sand then.

27. *Proposed Foundations.*—Taking these circumstances into consideration I think that foundations on wells 8·0 deep, the level of the floor being — 2·66 feet will suffice.

28. *West Side Channel.*—The area commanded by the West Side Channel is 96·92 square miles, of which 96·0 square miles is zemindari, and out of this whole area it is assumed that 28,000 acres will be cultivated wet. All the details concerning this channel can be seen from the section and the tables and appendix.

29. *Branches of West Side Channel.*—It will throw off 14 branches which will be provided with masonry sluices, tail escapes, and drops where necessary. These branches were all designed before I took up the project with a fall of 7 inches a mile, and numerous drops—I think the fall might with advantage be increased to 9 inches or ever—and some of the drops omitted; but this can be done in carrying out the works.

30. *Drainage.*—The principles and data on which drainage channels are to be designed are laid down by the Chief Engineer for Irrigation in paragraphs 2 to 9 of his memorandum, No. 491 F, dated 8th August 1873, and these have been rigidly adhered to in designing the channels for this and all other divisions.

31. *Inampudi Drain.*—The principal drainage channel will be the Inampudi, which will drain 29 square miles of country to the north of the Masulipatam Canal and nearly the whole of the country between the Bhimanadi and the Masulipatam Canal as far south as the road from Masulipatam to *Sallapalli* the total drainage area will be 111 square miles. The drainage water from the 29 square miles north of Masulipatam Canal is now passed under it, and the West Side Channel by an under-tunnel which must be considerably enlarged.

32. *Dayapu Calva.*—The Dayapu Calva is simply a long and deep swamp into which the drainage of a large portion of the country it is now proposed to drain by the Inampudi Channel slowly finds its way, and there being no proper outlet, it floods a large tract of country both above the Sallapalli road, and also as far down as the villages of *Kotha Magiru* and *Chinnapuram*. The Inampudi drain is continued in the lowest part of this swamp for about half a mile below the Sallapalli road, where it is joined by the proposed drainage from the Kannikalamadugu, these two united are carried in one channel called in this project the Dayapu Calva drain, it will be carried along the lowest part of the swamp to the terminus of the latter and will then be taken in a straight line to a small creek near *Garaldibba* from whence it is discharged into the Masulipatam creek near *Gilkaldindi*; the drainage will be carried the whole distance between banks, as the expense of cutting the channel to its full width and depth would be very great. The creek from Garaldibba to Gilkaldindi not being nearly large enough to discharge all the drainage will also be embanked to prevent the water from spreading and induce scouring.

33. *Local Drainage impeded.*—The water being carried above the level of the country will of course impede the discharge of local drainage at times, but this cannot be prevented except at enormous expense, and as the land for some distance of each side of the channel is waste, it will not signify much. Sluices with swing shutters will be used to discharge the local drainage into the channel; by this and the Inampudi drain, it is anticipated that a large tract of country now periodically flooded will be rendered fit for cultivation.

34. *Lankapalli and Sivaganga Drains.*—There is a tract of country north of the Sallapalli road as far as the village of *Mallavole* and Akumarru which cannot drain into the Inampudi channel. The drainage from this portion will be received into the existing *Lankapalli* drain (amply large) by which it will be discharged through the *Sivaganga* self-acting sluice into the Sivaganga drainage channel, which is now being enlarged and will be completed this year; part of the land to the east of the Dayapucalva will also drain into the Sivaganga channel.

35. *Kannikalamadugu.*—The Kannikalamadugu is a natural drain commencing about midway between the Masulipatam Canal and the Kistna river a little above the village of *Penamakur*. It flows in a north-easterly direction for 11 miles, when it divides into two branches; the west branch will be banked across by two of the proposed irrigation channels and will not be required for drainage (in the portions crossed with red lines in the plan), as the water will be led into the west branch by the catch drains on the upper side of the irrigation channels; the east branch will be joined near *Chilakalapudi* by the Bhimanadi. This last was, I believe, a stream from the Pulleru, and was banked across by the Masulipatam Canal, which crosses it in three places.

36. *Bhimanadi and Kannikalamadugu united.*—The Kannikalamadugu and Bhimanadi unite in one channel (known only by the name of the former) and flow in an easterly direction crossing the Sallapalli road near Lankapalli; from thence it used to flow in an easterly direction into the Puligadda branch of the Kistna; but the latter part of the channel being now silted up, it takes a sudden turn northward to *Patha Majeru*, here it turns again and joins the Dayapucalva. The Dayapucalva having no outlet, the water in the Kannikalamadugu is not discharged freely; it consequently overflows its banks and finds its way across country into the Kistna branch when the water in the latter is low. The Kannikalamadugu and the Bhimanadi both before and after they unite are sufficiently large to carry all the drainage they are required to discharge, except in the last mile near the Dayapucalva; therefore, with the exception of this portion, they will not be altered. The former will drain all the country to the west of it as far as the river, the latter all the country to the west of it as far as the former. It will be observed that about half-a-mile beyond Patha Majeru, the Kannikalamadugu crosses the Sallapalli road before it joins the Dayapucalva, the portion for a mile before this bend is also narrow; it is therefore proposed to widen and embank it till the point where it turns to cross the road, and from that point to make a straight cut with banks far apart into the proposed Dayapucalva drain.

37. *Kankipad Surplus.*—It has been mentioned before that the present head sluice of the west side channel at Kankipad is to be turned into an escape from the Masulipatam Canal, the present west side channel for 4 miles will be utilized as an escape channel, no alterations being necessary; at the 4th mile, the surplus channel will leave the line of the west side channel, and be carried under the proposed west side channel by an under-tunnel—in order to do this a drop will be necessary just above the tunnel; from the tunnel the channel will run along the lowest ground into the Kannikalamadugu.

38. *Drainage crossing East Bank Channel.*—I have stated in paragraph 5, Section VII., of this report that there are two low strips of land in this division. The first mentioned will be traversed by the proposed Inampudi drain, the last is traversed partly by the east bank channel and partly by the Kankepad surplus: it is therefore evident that the drainage water from a considerable tract of country will lie up against the banks of the east bank channel. This drainage it is proposed to discharge into the east bank channel by sluices with swing shutters. As this excess water might damage the channel unless an escape were made, it is proposed to build an escape in the east bank channel near Vallur, and carry off the surplus by a cut into the Kankipad surplus channel.

39. *Tabru Drain.*—It can be seen from the map that there is an extensive swamp in the south-east portion of the island of Divi near Kodur, this is excellent soil and the ryots are very anxious to cultivate it. It is proposed to drain this by a channel called the *Tabru* drain running along the lowest part of this swamp and discharging into the Kistna branch.

40. *Gudumotu Drain.*—As the ground falls both from the river and from its branch, it is evident that some drainage water will lie up against the banks of the Suvarnamuklie channel, which runs nearly through the centre of the island. It is therefore proposed to dig a catch drain on each side of that channel; that on the north side will discharge into the Tabru drain, that on the south side will be called the *Gudumotu* drain and will be excavated as far as a small salt creek.

41. *Catch Drains.*—Many of the branch irrigation channels will have catch drains on their upper sides.

42. *Appendix F.*—Details of the principal drainage channels will be found in Appendix F.

SECTION VIII.

1. *Area.*—Second division or that lying between the Ellore canal and the Budumeru bounded on the east by the east branch of the Tammebru. The total area of this division is 140 square miles, of which 100 square miles is Zemindary and the rest Government, and in this area it is calculated that 31,000 acres will be taken up for wet cultivation, which is at the rate of 221·43 acres to the square mile. Most of the land belongs to the Nuzivid Zemindar, who does not appear anxious to take water for the lands in this division; but I have no doubt that when the channels are dug, and the drainage improved, that the ryots will cultivate wet on their own account.

2. *Soil.*—The soil is principally black cotton; in many places near the Ellore canal it is very poor being mixed with small kanker, but near the Budumeru and about the lower part of the canal, it is very rich and especially adapted for wet crops. There is at present hardly any dry cultivation in this division except in the upper portion near Bezavada. There are numerous tanks near Ellore which are at present supplied from the Ellore canal and irrigate about 13,598 acres.

3. *Fall of Country.*—The country falls slightly from Bezavada towards the Tammeleru river, and rapidly from the Ellore canal to the Budumeru river and the Kolleru lake, which latter is the depression formed between the junction of the Delta of the Kistna and Godavery. The country to the north of the Ellore canal is very hilly, and some of the ranges approach very near to the channel, and it is this that causes such destructions after a heavy rain-fall.

4. *Ellore Canal Side Channel.*—It was originally proposed to reserve the Ellore canal from *Kesarapally* to its terminus entirely for navigation, and to carry the water for irrigation by a side channel—*vide* para. 16 of Colonel Anderson's letter, No. 143, dated 6th January 1863, embodied in Proceedings of Government, No. 430, dated 12th February 1864— but the serious damage done to the Ellore canal in recent years, which has proved that the existing means for passing the drainages will have to be enormously enlarged, shows that it would be inadvisable to carry another channel across all these drainages, as the cost of the masonry works required would be very heavy. It has therefore been determined to make the Ellore canal serve the requirements of both navigation and irrigation, the fall being regulated accordingly.

5. *Ellore Canal.*—The Ellore canal leaves the main canal at a distance of half-a-mile from the head sluice and has an open head; it runs in a generally north-easterly direction to the town of Ellore, its length being 40 miles. The average depth of water at head is at present about 8 feet. It has a considerable surface fall as far as Kesarapalli, the velocity being on an average about 2 feet a-second; from this place to Ellore it is nearly still water; its bed width for 10½ miles is 60 feet and 54 feet for the remaining length. It is the only line of communication between the Kistna and Godavery Districts, and the traffic on it is very considerable; see Appendix J.

6. *Faults in Ellore Canal.*—The great fault of the Ellore canal as at present is that the means for passing the drainage across it are altogether insufficient and that the tunnels appear to have been built without any reference to the fall of the channel. The existing masonry works on this canal with their levels are shown on the sections.

7. *Proposed Improvements to the Ellore Canal.*—The proposed improvements to the canal are stated generally in the Chief Engineer's Memorandum, No. 309 A, dated 7th May 1874 and to save reference to that memorandum, I will here enter what he suggests.

8. *Extract from Chief Engineer's Memorandum.*—"The bed level at the head is to be at + 37·5.

And the upper sill of Ellore lock is + 31·95.

The full supply water surface at the head will be + 45·5.

A suitable depth of water on the upper sill of the Ellore lock would be 6 feet, making the water surface there + 37·95.

At present owing to the high level of the Tammebru aqueduct at Ellore, it would not be practicable to fix the water surface at the lock as above mentioned for it would result in a depth of water of only about 2¼ feet on the aqueduct, but the difficulty may be solved by removing the aqueduct or rather by converting it into a set of sluices — an alteration which will result in such important advantages as regards disposal of drainage, that much as I regret advocating the dismantling of a perfectly sound work which has withstood repeated floods, it should be carried out, because practically the aqueduct has been useless for the purpose of passing the floods under the canal, and with frequent alterations it continues to be as ineffective as ever, and its arches are and have been for long entirely blocked up by sand and the freshes go over it occasion breaches, throw much silt into the canal, so that altogether after a full trial the time has come when it will be well to get rid of a work which has not answered its purposes, and which stands in the way of much needed improvements.

The surface fall then available will be 7·55 feet, and the distance being 40 miles, the average will be from 0·189 foot a-mile nearly, the bed fall will be from 37·5 at the head to 31·95 at the Ellore lock, or 5·55 feet, equivalent to an average of 0·139 foot a-mile. The discharge required

in the upper part of the canal is about 62,000 cubic yards per hour, and the bottom width of the canal is at present 60 feet. The surface fall for the first 10 miles will be less than the average, or the discharge would be too great. A surface and bed fall of 0·08 foot a-mile would give about the required discharge, and a mean velocity of about 0·8 foot a-second. Below this point the surface fall available should be distributed with reference to the discharge required in each section, or between each considerable irrigation offtake, and to the present dimensions of the canal which generally or probably are in excess of those required. There will practically be no appreciable surface fall in the last five miles, which may be treated as a still-water canal. The depth of water will be 8 feet in the first section of about 10 miles and then after will decrease as may be found convenient. In the upper 20½ miles the remodelling will not affect the existing under tunnels, but below that there are several which will have to be rebuilt. How the levels of the latter were determined is a mystery, for they have no relation to any possible arrangement of the canal, seeing that some of those in the lower miles are higher than those in the upper miles. No under tunnel on which a depth of 6 feet with a full supply can be obtained need be reconstructed even if the width and waterway be slightly less than that required, and works of this class on which the waterway with a depth of not less than 5 feet will be equal to or in excess of that necessary may be retained. These observations will, it is hoped, enable the remodelling of the levels of the canal to be worked out without difficulty, and the District Engineer may consider himself at liberty to modify the details within reasonable limits, should the distribution arrangements render this necessary or desirable."

9. *Formula used.*—I may here remark that the formula for discharge used by the Chief Engineer differs from that used in this project, which latter is the same as was used in designing the main canal; it would evidently be a mistake to calculate the discharge of the main canal by one formula and that of the branches by another. It will now be shown how these instructions will be carried out in detail.

10. *Branches.*—The proposed branches of the Ellore canal will be as follows:—

Number.	Distance from Head.			Names of Channels.	Acreage.
	M.	F.	FT.		
1	...			Direct under Ellore canal	300
2	13	0	0	Keesarapalli branch	300
3	...			Direct under Ellore canal	200
4	15	0	0	Butumallipad branch	900
5	...			Direct under Ellore canal	150
6	17	4	0	Ponukamad branch	1,350
7	...			Direct under Ellore canal	300
8	20	0	0	Cherivada branch	770
9	21	4	0	Puttaguntla do.	1,000
10	...			Direct under Ellore canal	200
11	...			Do. by tanks adjoining near Kanumole	600
12	26	0	0	Kakulpad branch	800
13	27	2	0	Gogunta do.	1,200
14	...			Direct under tanks adjoining	9,500
15	36	2	0	Mapparru branch	5,430
16	37	0	0	Madepalli do.	3,500
17	...			Direct under the adjoining tanks	4,500
				Total Area ...	31,000

11. *Section from Head to Kesarapalli.*—The distance to Kesarapalli is 10 miles 3 furlongs with the bed and surface fall 0·08 foot a mile, depth 8 feet, the bed level at head being 37·5, that at Kesarapalli would be 36·67, water 44·67, the discharge will be 559·36 cubic feet a-second against 465 cubic feet a-second required for the 31,000 acres; the extra water, viz., 94·36 cubic feet a-second being allowed for lockage and leakage. The level of upper sill of Kesarapalli lock and floor of calingulah is + 35·4; they will therefore have to be raised 1·27 feet; the bed and water level at Ryves' old head sluice (six miles from head) will be 37·02 and 45·02, respectively. The present level of this head sluice is 35·47; so that to enable the channel to silt up, it will have to be raised 1·55 feet. The floors of the aqueduct in this reach are all below this revised bed, consequently they need not be altered as far as level is concerned; any increase to their waterway will be treated of when describing drainages.

12. *Second portion from Kesarapalli to Buttumallipad Branch.*—Above Kesarapalli water for 600 acres is taken off, *i.e.*, 9 cubic feet a-second, the discharge required below here will therefore be 456 cubic feet a-second, the bed here is + 36·67, the upper sill of Ellore lock is + 31·95, therefore the fall of the bed will be 4·72 the distance being 29 miles and 5 furlongs,

18. *Ampapuram Drain.*—Ampapuram drain—Outlet to be lengthened from 50 to 190 feet.

19. *Ramebru Drain.*—Ramebru drain—To build a new outlet 960 feet in length.

20. *Peddapad Drain.*—Peddapad drain—New outlet 395 feet long.

21. *Tammebru East Branch.*—Tammebru east branch—The eastern outlet to be improved the western outlet to be dismantled and rebuilt at a lower level and divided into sluices 6 feet span.

22. *Tammebru West Branch.*—To lower and improve the Aqueduct and Tammebru west branch, to build two outlets of 750 and 360 feet in connection with this and Wutlur.

23. *Channels to be embanked.*—I think it would be advisable to embank the channels below the escapes and tunnels, so as to prevent the water flooding the country and spoiling the crops, banks varying from 100 yards to half-a-mile apart, according to the discharge of the masonry work, would answer; if continued down to the Kolleru.

24. *Budumeru above Bezovada.*—It has been proposed to turn the Budumeru into the Kistna above the anicut, but it has not yet been ascertained if this is feasible; but even if it were, it would make no difference in the proposed arrangement (*vide* paragraph 13 of Chief Engineer's Memorandum before mentioned) for passing the drainage across the Ellore Canal. No alterations are proposed to the Budumeru with the exception of banking it where necessary on the southern side to 3 feet above highest known flood, so as to prevent the water from overflowing and damaging valuable crops in Gudivada taluq, which it sometimes does at present. The approximate cost of proposed improvements to drainage will be Rupees 2,00,000.

SECTION IX.

Third Division or that between the Budumeru and the Pulleru bounded on the east by the Polrazukodu drain and the Kolleru lake.

1. *General Description of 3rd Division and Area.*—The area of this division is 277·0 square miles, out of which 101 square miles is Zemindary and 176 square miles Government land, and it is calculated that 69,000 acres will be cultivated, wet being in the proportion of 249·09 acres to 1 square mile.

The soil throughout the whole of this division is alluvial and well adapted for wet cultivation; the general fall is from the Pulleru and Masulipatam canals towards the Kolleru lake and also from the Budumeru towards the Polrazu kodu. From this it is evident that the irrigation and drainage channels should all run west to east, but this is prevented by the Ryves' channel and Ryves' branch channel, which cross the entire drainage of the division. As these channels are nearly completed, it is not intended to alter their direction, except that of the lower part of the branch channel which obstructs the flow of the drainage so much as to cause serious damage.

2. *Present Cultivation.*—A large area of this division (Acres 49,977)* is now cultivated wet and there are numerous small irrigation channels which are not shown in the map.

* Excluding old or usual Wet.

3. *Supply Channels.*—The two principal channels supplying this division are Ryves' channel and the Pulleru.

4. *Ryves' Channel general direction.*—The former leaves the Ellore canal in the 7th mile and runs in a perfectly straight line to Marrivada, crossing several drainages and some old irrigation channels from Pulleru.

5. *Ryves' project.*—This channel not being sufficiently large and the fall of bed being very great, Ryves' project was prepared and sanctioned in G.O., No. 3,684, dated 27th November 1867. This project, in addition to enlarging Ryves' channel and branch channel and raising their beds, also allows for a new cut from the head of the Masulipatam canal, to join the existing channel near its old head; this cut is to be supplied by a head sluice of 15 vents of 6 feet span each; this project is now in rapid progress, the head sluice is completed, the new cut is about two-thirds finished and the widening nearly completed above *Komatigunta*. According to the book (Madras Irrigation Series No. 3) containing Ryves' project, it appears that the new cut is to be 90 feet wide at bed, with fall 4·29 inches a-mile, and that the existing channel from where the new cut joins to Komatigunta is to be widened to 100 feet bottom width with fall 7 inches a-mile. It is evident, therefore, that there is intended to be a surface fall greater than bed fall in the first portion.

6. *Alterations necessary.*—Below Komatigunta the project allows for widening the channel from 74 feet gradually diminishing to 66 feet at Marrivada. This portion, I find, will require some alteration.

7. *Depth of Water.*—It is difficult to ascertain what depth of water Ryves' channel was intended to carry. Colonel Anderson says in paragraph 7 of his note on the project, "As the depth of water allowed for Ryves' channel is 7 feet, &c. &c," but in the plans for accommodation

the fall per mile will be 0·159 feet a-mile. The fall required in this reach to give the required discharge (width of channel being 54 feet) is about 1 inch or 0·083 foot ; consequently, the surface fall must be less than the bed fall, and the depth of water at the end of this reach (4¾ mile) will be 8 feet 4·332 inches. In the next reach the discharge required is only 439·5 cubic feet a-second and a fall of 3¼ inches or 0·062 foot will suffice, the length of this reach being 1½ mile the depth of water at end would be 8 feet 6·55 inches and so on, the depth of water would keep increasing which would evidently not answer at all. It is probable that the Chief Engineer when he wrote his memorandum was not aware that the existing channel below Kesarapalli was so wide.

13. *Different Methods of improving Ellore Canal.*—There appears to me to be only two ways in which this canal can be managed—

1st—with a depth of 8 feet at head give a considerable surface fall to Kesarapalli, depth there being 6 feet 4 inches, about this depth being continued to Ellore lock, the surface fall being regulated by the offtakes, by this of course the discharge at Kesarapalli would be much more than necessary and the surplus would have to run to waste, the increase to velocity in this reach would be very considerable.

14. *Best Arrangement.*—The 2nd method is to build a lock on the Ellore canal at Kesarapalli and make the bed and surface fall from head to lock 0·08 feet per mile as mentioned by Chief Engineer, the lock to have a drop of 1·27 in sill and 2·94 in water surface, the depth on lower sill being 6 feet 4 inches. Below the lock the surface fall will have to be frequently changed. The level of the lower sill of proposed lock being + 35·4 and the upper sill of Ellore lock + 31·95, the bed fall will be 3·45, and the distance being 29 miles 5 furlongs, the fall per mile will be 0·116.

Regulating the surface fall according as the branches are taken off will give a depth of water varying from 6·33 at Kesarapalli to 6·697 at Ellore lock. The effect of these changes will be to cause silting, but this will be very trifling as there is such a slight difference between the bed and surface fall. The improvement will of course cost little, with the exception of the lock and weir at Kesarapalli, approximate cost of which will be 40,000 Rupees.

When the irrigation season is over and it is desirable to keep the canal open for navigation it will be necessary to hold up the water at Ellore, the depth there with still water will be 9·78 and the canal banks will have to be raised in parts to retain this depth.

15. *Tunnels to be altered.*—The following tunnels will have to be lowered :—

1. Avitipalli.
2. Ampapuram.
3. Veravalli.
4. Narsannapalem.
5. Totagudem.
6. Peddapad.
7. Tammebru.
8. Jalipudi.

The great fall of the country from the canal to the Budumeru and Kolleru lakes will necessitate several drops being built on the branch channels. The approximate cost of all these channels will be Rupees 1,00,000, which is chargeable to Irrigation ; the improvements to the Ellore Canal previously mentioned will also cost approximately Rupees 60,000, chargeable to Navigation.

16. *Drainage.*—The principal drainages which the Ellore Canal crosses are :—

	Square Miles.
1. Budumeru main drain	413
2. Avitipalli affluent of do.	96
3. Athkur do. do.	6·5
4. Ampapuram do. do.	7·0
5. Nellivagu or Viravalli do.	48·25
6. Perikid and 7. Ramebru } do. do.	109.5
Total area (to be drained by Budumeru) above Ellore Canal ...	680·25
8. Wutlur drain	25·0
9. Peddapad do.	37·3
10. Tammberu by three branches	457.0
6. Minor drains	16·25

The existing arrangements for passing the rainfall from such a large extent of country are altogether inadequate ; considerable improvements are necessary. The Chief Engineer for Irrigation has laid down in detail what he considers should be done—*vide* paragraphs 13 to 26 of his memorandum, No. 309 A—so it will be useless to repeat them here ; but to save reference to that memorandum, I may as well state generally what he has detailed.

17. *Budumeru.*—Budumeru drain—Free passage to be allowed for the drainage in the 7th mile. To substitute an aqueduct of 12 spans, 10 feet each, for the Kesarapalli escape.

bridges, the maximum depth of water is put at 6 feet 6 inches above floor. Now in the estimate for widening, it will be seen that no allowance whatever is made for embankment and the cutting is not nearly sufficient to form banks to retain the water at either of the above-mentioned depths, viz., 7 feet or 6 feet 6 inches. At present, Ryves' channel runs about 3 feet deep and does not discharge nearly the amount that will be required, the level of the water also is not sufficiently high for direct irrigation, and it is evident from the channel being reduced in width from 74 feet to 66 feet that it was intended to irrigate direct.

8. *Kunderu Branch Duct.*—The irrigation is at present carried on by a side channel on a high level called the *Kunderu* branch duct, which takes off above Komatigunta weir. As the Kunderu branch duct is large enough to supply the acreage allowed under it in this project, it will still be used as the means of irrigation, the Ryves' channel below Komatigunta weir being only used to carry water to the Pulleru.

9. *Area commanded.*—Ryves' channel and its branches command an area of 146·47 square miles, and out of this it is assumed that 35,000 acres will be taken up for wet cultivation requiring a supply of 525 cubic feet a-second, but besides this it is necessary to provide for 1,140 cubic feet a-second required for Pulleru (*vide* Section, No. V, paragraph 3) ; consequently, the discharge required for Ryves' channel as far as Komatigunta weir (no water being taken off up to this point), will be 525 + 1,140 = 1,665.

Now if the depth of water at the head be 8 feet and a surface fall of 7 inches a-mile be given throughout the channel to Komatigunta, the depth of water at junction of new cut with old channel will be 6·42 feet (as the fall of bed in new cut is only 4·20 inches a-mile) ; with this depth, the old channel being widened to 100 feet will discharge 1,700·53 cubic feet a-second. I do not therefore think that any alteration need to be made. Now, as all the water required for irrigation is taken off above Komatigunta weir and the channel below is only required to supply the Pulleru, it is evident that it must discharge 1,140 cubic feet a-second ; if it is allowed to run only 3 feet deep as at present, it would have to be nearly doubled in width : but I see no reason why it should not run 6 feet deep. Taking this depth and a fall of 7 inches a-mile (the greatest fall which I think should be allowed in so deep and large a channel), the width required will be 76 feet at bottom, which will give a discharge of 1,147·5 cubic feet a-second. The widths now allowed are from 74 feet to 66 feet, so that on the average extra widening of 6 feet will be necessary ; this with the clearing now required (the widening already done being almost entirely silted up) will be sufficient to form banks to retain the water at 6 feet. The fall of the country being greater than that of the bed, a drop will be necessary in the 5th mile, the level of the upper floor will be + 25·87, that of the lower + 22·63, which is determined as follows:—The level of the bed of Pulleru near the end of Ryves' channel where *Gandi Kodu* and two other channels take off is + 20·16, if a fall of 7 inches a-mile be allowed from this point up to the Ryves' channel drop, the distance being 4 miles 2 furlongs, the lower floor of the drop will be 20·16 + 2·47 = 22·63. In Ryves' project the channel ends at a level considerably above that of bed of Pulleru, a drop would therefore be necessary ; in this project the drop is placed higher up to save banking.

Now the Pulleru between end of Ryves' channel and Gandikodu head sluice is 105 feet wide, and with the fall 7 inches and depth of water 6 feet will discharge 1,621 cubic feet a-second, the water supplied to it being—

	Cubic Feet.
From Ryves' channel	1147·5 a-second.
„ Upper Pulleru	457·5
	1,605·0

10. *Branches.*—There will be many branches from Ryves' channel which will be as follows :—

	ACRES.
1. Velpur Branch	200
2. Uppulur do.	200
3. Tenneru do.	800
4. Vempad do.	800
5. Komatigunta Branch	2,000
6. Gudivada Branch duct	24,000
7. Kunderu do.	7,000
	35,000

11. *Gudivada Branch.*—The most important of these channels are the *Gudivada* branch duct and the Kunderu ; the former leaves the Ryves' channel just above Komatigunta weir and is at present supplied by a head sluice of 2 vents of 4 feet span ; but allowance is made in Ryves' channel project estimates for increasing this to 4 vents of the same span, which will give sufficient discharge.

12. *General Description of Gudivada Branch Duct.*—The Gudivāda branch at present runs in a south-easterly direction straight to Gudivada, at which place it turns more south and eventually falls into the Polrazkodu.

13. *Dimensions allowed in the Ryves' Channel.*—Ryves' project allows as far as I can make out for widening this channel to a bottom width of 32 throughout, giving the bed a fall of 11 inches a mile and regulating the surface fall by masonry bridges fitted with shutters. This part of the project is completed as far as Gudivada; it is impossible to ascertain from the plans what depth of water it was calculated to carry; but I have taken 4 feet, as this will give the required discharge with the width of 32 feet.

14—17.—*Proposed alterations to Gudivada Branch Duct—Dosapad Channel—Lingavaram Channel—Lellapudi Channel.*—It is now proposed to make the first five miles of the channel supply the Dosapad channel continued by Moparu channel, and a longitudinal section of this is given in the accompanying general sections; the next five miles will be supplied by a new cut from the Kunderu channel and will in its turn supply the Lingavaram and Bhushanagulla channels. The next three miles as far as Gudivada will be used as a drain, the portion from Gudivada to Velpur will be used for irrigation and will be supplied by the Gandikodu, and continued by Lellapudi channel, the remaining portion from Velpur to the Polrazkodu will be abandoned altogether.

18. *Moparru Channel.*—This will be utilized as far as Areperala, from which place a straight cut will be made into the Budimeru; the north bank of this channel will form a flood bank to the Budimeru.

19. *Bhumikodu.*—At Areperala the *Bhumikodu* takes off; this will be left as at present for a distance of two miles and will then be continued by a straight cut in an easterly direction to the Kolleru lake; a considerable portion of the present Bhumikodu (crossed with red lines in the plan) will be abandoned, as it crosses the natural fall of the country; the latter portion will be used a drainage.

20. *Manner in which Moparru Channel and Bhumikodu at present receive their supply.*—The Moparru channel and Bhumikodu are at present supplied by the Budimeru, across which the ryots throw up a bund to raise the water. This system is highly objectionable, as the Budimeru is one of the chief drainages in the delta, the arrangement just described for supplying these channels by the Dosapad channel from Ryves' branch channel will render it unnecessary to bund up the Budimeru and the drainage will be discharged freely.

21. *Branches of Dosapad Channel.*—The Dosapad channel will throw off two other principal channels besides the Bhumikodu, viz.—

		ACRES.
1.	Nandivadu branch	2,000
2.	Tamersa do.	5,000

22. *General Description.*—These will take off from the same point on the Dosapad channel and will run in an easterly direction nearly parellel to one another, the former falling into the Kolleru lake, and the latter into the last portion of the Bhumikodu which it has been before stated will be used as a drainage.

23. *Lingavaram Channel.*—The next branch of the Gudivada channel is Lingavaram channel; this will leave at the proposed termination of the Gudivada branch channel and run in an easterly direction for a distance of five miles ending in the Gandikodu drain.

24. *Bushanagulla Branch.*—The last, viz., the Bushanagulla will leave at the same point as the Lingavaram channel and runs for a distance of three miles to the Gandikodu drain.

25. *Kanderu Channel.*—The Kanderu leaves Ryves' channel just above Komatigunta weir; it runs alongside the Ryves' channel to a short distance beyond the village of Kanderu and then turns eastward and eventually falls into the Chendrayakodu drain.

26. *Branches of Kenuderu.*—This channel will require some slight improvement; it throws off three branches:—

1. Kandanampad.
2. Calavapamula.
3. Zuvanapudi.

All these branches run north-east to a catch drain to be dug along the south side of the Gudivada branch.

27. *Pulleru Main Duct.*—The othermain supply channel to this division is the Pulleru. This leaves the Masulipatam canal immediately above Kankipad lock and is supplied by two sluices, one of six vents of 4 feet span floor + 38·09, the other of six vents of 4 feet span floor + 35·19.

28, 29.—*General Direction—Fault in this Channel.*—The Pulleru was originally an inundation channel from the Kistna and it runs throughout the first thirty miles of its course on a ridge;

the great fault of this channel is that it does not run sufficiently deep, consequently the water does not come to the surface of the country for a considerable distance on each side of it.

30. *Reasons why it does not run sufficiently deep.*—It was I believe designed to be 6 feet deep, but it really never runs more than 4 feet deep and seldom more than 3 feet; the cause of this is I think that it is too wide in comparison with the channels which supply it; for instance it has been widened below Marrivada to its full width of 105 feet, but Ryves' channel and the Masulipatam canal which supply it have not been completed to their full width, consequently the water it receives is not sufficient to fill a channel of such a width to a depth of 6 feet. When this project is finished it is hoped that there will be no difficulty in getting 6 feet of water in the channel, and when that is accomplished the Pulleru will be perfect as an irrigation duct.

31. *Seven inches fall from Kankipad to Wyur.*—From Kankipad to *Wyur* where there is a regulator with a drop of 4 feet the fall of the bed is very irregular varying from 10 inches to 7 inches a mile; it was anticipated I believe that the bed would silt up to a uniform slope of 7 inches and the level of the Wyur regulator was settled accordingly, though it was not raised to its proper height for fear of endangering the embankments with the water 6 feet deep. It is proposed now to raise it to its proper level which is + 29·25; then with a fall of 7 inches and its present width of 60 feet, the water the channel receives from Masulipatam, viz., 510 cubic feet a second, will run about 4 feet deep, and the water surface will be about the same level as it would be were the channel running 6 feet deep with the Wyur regulator at its present height.

32. *Pulleru from Wyur to Marrivada.*—Above Wyur water for 2,000 acres or 30 cubic feet a second is taken off, consequently the channel below as far as end of Ryves' channel will have to carry 480 cubic feet a second, the width of the channel in this portion being 50 feet and the depth of water at the end being 6 feet, *vide* paragraph 9. This depth with a bed-fall of ·77 foot a mile as it is at present would give more than the required discharge; so this part of the channel will regulate itself by silting till it is of the proper capacity for the required discharges; if thought necessary a regulator may be built at Marrivada. In this portion 22·5 cubic feet of water is taken off.

33. *From end of Ryves' Channel to Gundikodu.*—From end of Ryves' channel to head of Gundikodu the Pulleru will require no alteration as mentioned in paragraph 9.

34. *From Gundikodu to Pamarru.*—At Gundikodu water for 18,500 acres is taken off requiring a discharge of 277·5 cubic feet a second; as the Pulleru below here is the same width as above, it will be necessary either to change the surface fall by holding up the water at Pamarru or to build a regulator here. This I consider the better plan; a drop of 1·19 feet will make the bed level + 18·97 and give a fall of 5 inches a mile to Pamarru regulator, and the discharge running 6 feet deep will be 1,320 which will just be sufficient; lowering the bed as proposed will entail no extra expense, as earth would anyhow be required to raise the banks.

35. *Pamarru to East Side Channel.*—At Pamarru water for 5,500 acres or 82·5 cubic feet a second is taken off; the channel below here must therefore carry 1,237·5 cubic feet a second as far as head of *East Side channel*; the present width in this reach is 90 feet, and if it run 7 feet deep with a fall of 4 inches a mile it will give this discharge. This gives a velocity slightly over 2,000 yards an hour, but if the velocity be diminished the channel will have to be widened. The East Side channel takes off water for 9,000 acres or 135 cubic feet a second, therefore from here to the next branch, viz., Butlerkodu, the Pulleru must discharge 1,102·5 cubic feet a second; the width of bed in this portion is 70 feet, and with the depth of 7 feet and fall 4 inches the discharge would not be sufficient. This portion of the channel therefore (length $\frac{1}{3}$ mile) must be widened to 80 feet. The Butlerkodu takes off water for 10,000 acres or 150 cubic feet a second, the discharge required below here to head of Palakodu is therefore 952 cubic feet a second; if the fall be reduced to $3\frac{1}{2}$ inches so as to lower the velocity to 2,000 yards an hour, this part of the channel will have to be widened to 70 feet, the present width as far as Cowtram being 60 feet. The Palakodu takes off 45 cubic feet a second; therefore from here to head of Chittram channel, the Pulleru must discharge 907 cubic feet a second, the width required with the same fall $3\frac{1}{2}$ inches will be 68 feet. Chittram Channel takes off 37·5 cubic feet a second, the discharge required from here to Cowtram is therefore 869·5, the channel in this portion must therefore be 64 feet wide. The level of the upper sill of *Cowtram* Lock is + 11·5, and, as there will be a fall of $3\frac{1}{2}$ inches a mile for $6\frac{1}{4}$ miles above this, *i.e.*, to head of *Butter Kodu* and of 4 inches a mile for $1\frac{3}{5}$ mile more to Pamarru, the lower floor of the proposed drop at that place will be + 13·8, the bed at present being + 16·42, there will therefore be 2·62 feet cutting which in most places will serve to raise the banks. The lock at Cowtram and the masonry works along Pulleru will have to be raised; but this will be necessary under any arrangement of the channel. There will be some difficulty experienced in the regulation of this channel when no more water is required for irrigation, and the only way I see to prevent this would be to build an intermediate lock between Pamarru and Cowtram, but I do not recommend this being done till there is some traffic.

...sons for not making Pulleru navigable above Pamarru.—The Pulleru was intended ... as far up as Wyur, but it is very ill-adapted for navigation, the velocity is very

great, the course is tortuous, and it is difficult for a boat to wind the curves with the stream without being carried against the opposite bank and above Pamarru. I do not think there is any likelihood of there being any traffic at any rate for many years; taking these circumstances into consideration I do not think it would be advisable to incur the expense of building a lock at Gandikodu and another at Pamarru where it is proposed to have drops. At Pamarru there is a short channel connecting the Pulleru with the Masulipatam Canal, and as by the improvements it is intended to make the Bantumalli Canal and Polrazkodu navigable it is hoped that salt will be carried in boats from the pans at Bantumalli, and that there will be some traffic from the Godavery District along the Polrazkodu; it is essential that that portion of the Pulleru between Pamarru and Cowtram should be navigable, and it is for this reason that I have reduced the fall and velocity between Pamarru and Cowtram.

37, 38. *Cost.—Branches of Pulleru.*—The cost of the improvements to the Pulleru as allowed in this project will amount to Rupees 32,000. The branches of the Pulleru in this division are—

	ACREAGE.
1. Mudunur road side channel	2,000
2. Gandikodu branch duct	13,000
3. Golivepalli branch	1,000
4. Peddamaddali do.	1,000
5. Pamarru branch duct	5,500
6. Palakodu	3,000
7. Chittram Channel	2,500
Total ...	28,000

39—41. *Gandikodu, a Branch Duct.—Head Sluice.—General Direction.*—The most importan of these is the Gandikodu. This channel is at present supplied by a head-sluice of 2 vents of 3 feet span. It was originally an inundation channel from the Pulleru, and consequently has a tortuous course. It runs south-east towards Gudivada, and is carried across Ryves' branch channel by inlet and outlet sluices; from this it continues for about three miles and ends in some fields of wet cultivation.

42—44. *Proposed Improvements and Alterations.—Dondapad Channel.—Branches of Gandikodu.*—The following alterations are proposed to this channel. Fall and width of the first part as far as the village of *Sipudi* will be rectified, as the channel has got much silted up beyond Sipudi, the channel will be used as a drainage (to be described hereafter), and from that village a new channel will be made to supply the existing *Dondapad* Channel (at present supplied from that portion of the Gudivada branch which it is proposed to convert into a drainage channel), which channel will be widened and continued to the Kolleru Lake. It will throw off two principal branches.

	ACRES.
1. Lellapudi Channel	3,500
2. Motur Branch	1,500
Total ...	5,000

45. *General Description of Lellapudi Channel.*—These will both leave at the same point near Gudivada, the former will occupy the line now occupied by the Gudivada Branch Channel for a distance of about 2½ miles to the present Lellapudi branch head, and will then be continued along that channel to its terminus, and from thence to the Polrazkodu by a new cut.

46. *General Description of Motur Channel.*—The *Motur* Channel will be an entirely new cut and will run nearly parallel to the *Lellapudi* Channel for a distance of about 10 miles to the Polrazkodu.

47—49. *Pamarru Channel, a Branch Duct.—General Direction.—Improvements proposed.*—The second important branch of the Pulleru is the Pamarru Channel. This will leave immediately above the Pamarru regulator, and will run in an easterly direction to the *Komaravole* drain; this channel is already in existence.

50, 51. *Branches of Pamarru Channel.—Branches.*—The fall and width of the bed will have to be rectified and several new branches will be taken off from it. These will be—

	ACRES.
1. Penjendra	2,500
2. Komaravole	1,000
3. Angalur	1,000
4. Velpur	1,000
Total ...	5,500

52. *Palakodu.*—The last important branch of the Pulleru is the Palakodu; this takes off at present from the 24⅝ mile below Pamarru, but the water does not rise sufficiently to supply the channel; it is therefore proposed to give it a new head.

53. *Present Direction.*—It runs at present nearly due north to near the village of Dondapad crossing Ryves' branch channel by inlet and outlet sluices.

54. *Proposed Alteration.*—It is now proposed to turn it off about three miles from its head and take along some high ground in a more easterly direction for a distance of six miles to the Komaravole drain.

55. *Direct irrigation above Kankipad by Bandar Canal.*—It will be seen from the plans that there is a large extent of the country between Ryves' Channel and the Pulleru which is irrigated direct from the Bandar Canal. The cultivation at present amounts to 6,000 acres. As these channels are large enough to supply this area and answer their purpose well it is not proposed to alter them

56. *Drainage.*—The drainage arrangements of this division are at present very defective. What few natural drains there are are for the most part used for irrigation purposes, and many of the irrigation channels, notably the last part of the Gudivada branch, run at right angles to the direction of the flow of the drainage and consequently obstruct it considerably.

57. *Budumeru Main Drain.*—The principal drain is the Budumeru; but this drains the country to the north of it, and has been described in treating of the 2nd Division.

58, 59, 60.—*Uppulur Drain, an affluent of do.—Drainage intercepted by Ryves' Channel.—Under tunnel.*—There is a tract of country between the Ryves' Channel, Bandar Canal, and *Tenneru* Channel which used to drain into a natural channel called the *Uppulur* drain, and the drainage water was carried by it into the Budumeru. As Ryves' Channel is excavated across this drain of course the flow of the water is prevented; it is therefore proposed to build an under-tunnel; the channel from the under-tunnel to the Budumeru will be improved.

61, 62. *Chendraya Kodu Drain.—Proposed Catch-drain.*—The drainage of that portion of the country south of Tenneru and lying between Ryves' Channel and Pulleru (over nine square miles) at present finds its way slowly across country from west to east till it is stopped by the west bank of Ryves' Channel. There are however some inlets and outlets which prevent much damage being done; it is now proposed to receive all this drainage in a catch-drain to run close alongside the east bank of Ryves' Channel till it meets a natural drain called the Chendrayi Kodu; at this point the water will pass under Ryves' Channel by an under-tunnel.

63, 64. *Under-tunnel.—General course of this Drain.*—From the under-tunnel the Chendrayi Kodu will be continued in its present course to a little beyond the village of *Billapad* where it meets the Gandikodu (the portion to be used for drainage—*vide* paragraph 42), it will follow the course of this channel to near the village of Lingavaram from where it will be continued by a new channel running along the north side of the Dondapad Channel as far as the Kolleru Lake.

65. *Drainage Area.*—This will be one of the largest drains in this division besides the tract of country before mentioned south of Temeru Channel; it will also receive the whole drainage of that triangular piece of country between Ryves' Channel, Ryves' branch, and Gandikodu irrigation channel, and also the drainage of the country to the south-east of Gudivada branch bounded on the north by Dosapad Channel continued by Tamersa branch.

66. *Proposed side drain to Gudivada Branch Channel.*—As the slope of the country is from the Kunderu towards Ryves' Branch Channel the drainage will be up against the banks of the latter; it is therefore proposed to excavate a side drain to the Gudivada branch from the village of *Calavapamula*, and from where it is proposed to end the Gudivada Channel, the drainage water will be carried in the old course of that channel till it falls into the Chendrayi Kodu Drain.

67—70. *Komaravole Drain.—Intercepted by Gudivada Branch.—Present state of this channel.—Improvements.*—The Komaravole Drain is a natural drainage channel commencing near the village of *P. Maddali*. It is now let into the Gudivada branch by an inlet, and then out again some two miles down by an outlet. The course of this channel is hardly to be seen in parts, and it only feebly answers the purpose of a drainage channel. It is intended to improve this channel by widening it and instead of letting it in and out of the Gudivada branch (or rather that portion of it called in this project the Lellapudi branch) it will be carried along the west side of it as far as the village of Velpur, and as the latter part of the Gudivada branch is to be abandoned it can be carried on to the Polrazkodu without obstruction.

71. *Drainage Area.*—It will drain the whole of the country to the east of the Pulleru and included between the Gandikodu continued by Lellapudi branch and the Palakodu continued by Kodur branch.

72. *Drainage of land between Motur and Lellapudi Channel.*—The piece of country between Motur Branch Channel and Lellapudi Branch Channel will be drained by a catch drain along the upper side of the latter channel formed by the cutting required for the banks.

73. *Drainage of land between Palakodu and Chittram Channel.*—The country between the Palakodu and the Chittram Channel will be drained by a catch-drain along the upper side of the latter.

74. *Old Polrazkodu Drain.*—The Polrazkodu is the most important drain to be described.

75. *Drainage Area.*—It receives the whole drainage of the country to the south of the Gandikodu continued by Dondapad Channel.

76. *Present Dimensions.*—It is joined during its course by the Komaravole Drainage Channel and many small catch-drains.

77. *Proposed Improvements.*—Its present dimensions are not nearly sufficient; the fall is also very irregular and in many places it has no banks; it is now intended to give the bed a good fall throughout, and make it sufficiently wide to discharge the required quantity of water.

78. *New Catch-Drains.*—In addition to the drainages already mentioned there will be catch-drains on the upper side of the following channels:—Bhumikodu, Nandivada Channel, and Lingavaram Channel.

79. *Self-acting Outlets to Drains.*—All the channels mentioned in this report are provided with self-acting sluices where they fall into other drains.

80. *General Remarks on the Drainage of this Division as connected with the Kolleru Lake and Upputeru.*—The drainage of this division with the proposed arrangements will be very perfect so long as the water in the Kolleru Lake is not above its ordinary level; but when that lake is full the channel will not discharge feely; this happened in 1872, when the water in the lake rose to a great height and flooded the country for miles around, doing immense damage, the amount of remissions given for the crops being as much as 82,000. Now it must be remembered that last year the flow of the drainage water from the country above Ellore Canal (which drainage flows into the Kolleru Lake) was much obstructed by that Canal and flooded an extensive tract of waste land and lay there for weeks before it found its way across the canal, and a large quantity of water never reached the Kolleru Lake, but backed up the Ellore Canal, from thence ran down the Bandar Canal, and was distributed amongst the Pulleru and other channels, and yet that lake overflowed and did serious damage. Now it is the wish of Government—*vide* G.O., No. 3,005, dated 18th December 1872, that the drainage across the Ellore Canal should be improved, and this is now being estimated for; the effect of this will certainly be to prevent damage being done to the Ellore Canal, but it will also bring more water into the delta and instead flooding the waste land above Ellore Canal will flood the valuable wet crops round the Kolleru Lake and about Gudivada. It is no doubt very desirable that the drainage across the Ellore Canal should be improved, but I think the project for doing this should also include improving the outlet from the Kolleru Lake. The lake at present receives the drainage of 1,779 square miles of country, and the only outlet from the lake is the Upputeru river which for the first seven or eight miles of its course is very narrow; tide water also comes up it as far as the lake, the water from the lake is discharged into the Upputeru over a weir which is built to a certain level to retain water for cultivation. To improve the discharge from the Kolleru I would suggest that the existing weir be destroyed and several open cuts made in the lake bund where the ground is lowest and the water led between banks to the Upputeru. This river which has a winding course should, I think, be straightened, the fall and discharge would thereby be greatly increased, and it should also be banked to induce it to scour out. These improvements would no doubt be very expensive, and they, except banking the Upputeru, have not been included in this project; if it is thought that they should be carried out a detailed survey must be made of the lake and Upputeru which will occupy many months. There can be no doubt that unless they are carried out, or some plan adopted for improving the outlet from the Kolleru Lake, the drainage of the 2nd and 3rd Divisions of the delta will always be defective. The Chief Engineer states his views about the Kolleru Lake in paragraphs 36 to 40 of his memorandum, No. 309 A, dated 7th May 1874. I think that no attempt should be made to hold up the water in the lake for the sake of the Dalva crop; the reason why the ryots cultivate this crop is generally because the first or sarva crop has been destroyed by floods. Now if the arrangements for drainage as proposed in this project are carried out and the water from the lake allowed to run off freely, there will be but a small chance of the first crop being drowned, and the ryots will consequently not care about cultivating the Dalva crop which is very inferior. A depth in the lake of 2 feet above high water mark will not interfere materially with the flow of water from the proposed drainage channels, and it is therefore desirable to keep the water below this level instead of letting it rise to +7·0 feet as it does sometimes now; cuts in the bank aggregating in length 900 feet would suffice.

SECTION X.

Fourth Division or that between the Polrazkodu and Bantumalli Channel bounded on the east by the Upputeru river. The detailed report on this division has already been sent in, so it will only be necessary to give abstracts from it.

1. *Area.*—The area of this division is 201 square miles—all Government land; and out of this area it is calculated that 46,000 acres will be cultivated wet, which is at the rate of about 228·85 acres to the square mile. This is a very moderate allowance; but there are some high sand ridges which cannot be watered by the Kistna, and also some swamp land which is under the influence of high tides, and which it would be too expensive to reclaim.

2. *Soil.*—The soil in this division is partly black cotton and partly sand. There is very little cultivation of any sort; but what there is is chiefly wet, and the ryots are very anxious for water, and for years past have been sending in petitions for more channels.

3. *Fall of Country.*—The general fall of the country is from the Bantumalli Channel towards the Upputeru, and also from the Polrazkodu towards the sea. It consists of alternate ridges and swamps running from south-west to north-east, and nearly parallel to one another. This renders settling the lines of irrigation and drainage of this division easy. The Upputeru partakes of the nature of a deltaic river, and the country falls away from it for some distance.

4. *Pulleru.*—The main supply channel of this division is the Pulleru (which has been described in the 3rd Division). This divides into three channels at Cowtram, viz., Polrazkodu, Lower Pulleru, and Bantumalli Channel. The first two will be used entirely to irrigate this division, the Polrazkodu being made navigable, while the latter will be reserved for navigation, as it is not well suited for an irrigation channel. It will be fully described when treating of the 5th Division.

5. *Land now irrigated.*—The total area of land watered at present under the principal channels as per a statement* received from the Collector is as follows:—

* For Fasli 1281 or 1871-72.

No.	Channels.	Old Wet.	New Wet.	Dry watered.	Total.
		ACRES.	ACRES.	ACRES.	ACRES.
1	New Polrazkodu	4,482	103	136	4,721
2	Lower Pulleru	4,632	14,655	3,827	23,114
3	Bantumalli Channel	2,605	111	99	2,815
4	Old Polrazkodu	2,677	1,146	205	4,028

6. *Proposed Area to be irrigated.*—But as the last three channels irrigate land in other divisions, the area irrigated in this portion can only be taken approximately, as the revenue accounts do not contain the necessary figures, and the following table shows as nearly as possible the present and proposed irrigation under the several main channels:—

No.	Channels.	Old Wet.	New Wet.	Dry watered.	Total.	Proposed.	Yet to be taken.
		ACRES.	ACRES.	ACRES.	ACRES.	ACRES.	ACRES.
1	Polrazkodu	4,482	103	136	6,735	20,000	13,265
2	Old do.	1,339	573	102			
3	Chevurkodu	...	...	...	...	14,000	14,000
4	Lower Pulleru	772	2,442	638	5,260	12,000	6,740
5	Bantumalli Channel ...	1,302	56	50			
	Total ...	7,895	3,174	926	11,995	44,000	34,005

The old Polrazkodu will be kept entirely for drainage and the Bantumalli Channel for navigation, the lands under them being supplied by the new Polrazkodu and the lower Pulleru, respectively. The following table shows the proposed acreage per square mile under the principal channels:—

No.	Channel.	Area in Square Miles.	Acreage.	Per Square Mile.
1	Polrazkodu	74·0	20,000	270·27
2	Chevurkodu	67·0	14,000	208·95
3	Lower Pulleru	60·0	12,000	200·0
	Total ...	201·	46,000	228·85

7. *New Polrazkodu, an Irrigation Branch Duct.*—The Polrazkodu was designed to irrigate 20,000 acres of land and also to serve as a 2nd-class line of navigation. It has been made 30 feet wide at bed with a fall of 5 inches a mile, the water running 4 feet deep, the banks not being sufficiently high to retain a greater depth. It has only been excavated as far as *Vingirampad*, a distance of 16⅔ miles from its head at Cowtram. In the Chief Engineer's circular it is laid down that a channel for 2nd-class navigation should not be less than 25 feet wide at bed, and that the water should run at least 5 feet deep, with a velocity not greater than 2,000 yards an hour; this necessitates raising the banks of the channel as well as the face walls of the masonry works constructed along it. The reduced fall of 4 inches a mile (which gives velocity less than 2,000 yards an hour) renders an increase of 6 feet width at head necessary. The channel will also be continued from Vingirampad to the Upputeru so as to unite the system of canals in the Eastern Delta, Kistna, with that of the Western Delta, Godavery. The length of this channel will be 26⅓th miles; it will be provided with three locks—one at the head at Cowtram without any drop in sill, but 1 foot in surface of water, one at Ratchapatnam drop 3 feet and one at end drop 8·25. The proposed arrangements for getting rid of surplus water from the channel are as follows:—

In the 7th mile near *Mudinepalli* bridge there will be an outlet discharging 147·84 cubic feet a second, with a channel from it leading to the Polrazkodu drain, a distance of ¼ mile. The full discharge of the head-sluice is 360 cubic feet a second, so that the capacity of the outlet is ample and the rest of the water will pass lower down the channel. From this point to Rachapatnam is a distance of 11⅔ miles, and the water if held up would rise to 7·84 above the bed at the latter place, that is to a level of +12·92, the crest of the lock chamber is + 16·08 and the top of the banks + 15·92. In this reach there are three escapes:—

1*st.*—*Keykalur* Channel head-sluice capable of discharging 105 cubic feet a second into the channel from whence it will be discharged by an outlet of 34 square feet waterway, (near *Atupaka* in the 6th mile) into the *Kavitikodu* which runs into the Kolleru Lake.

2*nd.*—An outlet similar to the one at Mudinepalli immediately above the lock discharging into a channel leading to the *Chinna Kommeleru* drain.

3*rd.*—An escape weir similar to the above discharging into the lower reach.

In order to keep the requisite depth for navigation in this reach, *i.e.*, a depth of 5 feet, it will be necessary, owing to there being a fall of 4 inches a mile, to have a constant discharge of 300 cubic feet a second, but at the end of the season it may be impossible to insure the supply, and if water were not required for irrigation it would be folly to let so much run to waste; in order therefore to keep the canal open for navigation it would be necessary to shut all the escapes and hold up the water. An estimate has therefore been prepared for raising the banks so as to keep still water, as this is found to be cheaper than building an intermediate lock. The last reach of the canal with the given dimensions is capable of discharging 122 cubic feet a second; the supply weir gives a discharge of 147·84 cubic feet a second, and the escape weir at the end the same, so there is no necessity for making further provisions for surplus as no drainage will enter the channel in this reach. Boats passing out of this canal will enter the Godavery District by the *Yelurpad* lock. In addition to the masonry works mentioned, there will be an accommodation bridge near *Lingala* on the road to *Gannavaram*.

8. *Branches of Polrazkodu.*—The principal branches of the Polrazkodu are—

	ACREAGE.
1. Chegurukota Channel	4,000
2. Keykolur Channel	7,000

Besides the two channels mentioned above there are several others which take off from the Polrazkodu.

9. *Chevurkodu, a proposed Branch Duct.*—The total area under this channel is 67 square miles, and out of this it is calculated that 14,000 acres will be cultivated wet, which is in the proportion of about 209 acres to the square mile. The channel at present leaves the Polrazkodu at the 3rd mile, where it is supplied by a head-sluice, and it has a most tortuous course as far as the village of *Chevur*. Its great fault is that the bed is too low and that it is constantly silted up, the consequence is that there is but little cultivation under it. It is now proposed to give the channel a new head at Cowtram, the present Polrazkodu head-sluice being divided so as to supply both the Polrazkodu and this channel, for which purpose it is amply large. From this new head it will be carried alongside the Polrazkodu as far as its old head, from which point it will run in its old course for a distance of 3½ miles, from whence it will continue along high ground till it approaches the Upputeru beyond the village of *Potumarru*, and from here it will follow the general direction of the river and finally tail into its branch near the village of *Peddalanka*. The total length of this channel will be 30 and ⅝th miles. All details regarding width, fall, &c., are given in Appendix E. This will be one of the most useful channels in the division, as the lands at present are very poorly supplied with water, in fact in most of the area Kistna water is not received at all, and the ryots are most anxious for wet cultivation, as the soil is more suited for that than for dry. The following masonry works will be required

on this channel:—A bridge of 3 arches of 18 feet span each on the Bantumalli road; a regulator in the 12½ mile; a bridge in the line of the proposed road from *Tummidi* to Mandavalli Gannavaram, three arches of 16 feet span; a bridge in the line of the proposed road from Tummidi to Kykalur in 18th mile, three vents of 16 feet span each; a regulator and bridge in 23rd mile, where it meets the Upputeru bank; a regulator below *Mattigunta* branch in 29th mile, and a tail escape weir at the end in 31st mile.

10. *Kealdindikodu.*—The *Kealdindikodu*, which is a prolongation of the Lower Pulleru, is at present the supply channel to this portion; but it is so very low that the crops under it rarely receive sufficient water. It is now proposed to give up the latter portion of this channel, a better line being chosen near the village of *Vonudurru* to the Peddalanka drain. The following branches take off from the Chevurkodu, besides many other small ones which are not shown in the plan to avoid confusion:—

	AVERAGE.
1. Kealdindi Branch	2,000
2. Kondangi do.	4,000
3. Mattagunta do.	2,400
Direct	5,600
Total ...	14,000

11. *Lower Pulleru, a Branch Duct.*—The area under this channel is 60 square miles, and it is calculated to irrigate 12,000 acres or 200 acres to the square mile; this low acreage is taken owing to the swampy nature of a good portion of the country through which it will run. It is supplied by a head-sluice above Cowtram Lock, and runs on the north of Bantumalli Channel as far as Tadicherla supplying the Tadicherlakodu; here it is cut off by the Bantumalli Channel, the part of it to the south of that channel being supplied by a head-sluice from it. About three miles further on again it is intercepted by the Bantumalli Channel and the Kealdindikodu which is a continuation of it. It is supplied by the Bantumalli Channel. It is now proposed to retain the head-sluice and old course as far as Tadicherla, and then make a new cut along the north side of the Bantumalli Channel to the Kealdindikodu and from thence to continue it in nearly a straight line to the Peddalunka drain. The objection to this channel as at present is, that it is too low; it is therefore proposed to raise the bed and build regulators where necessary. It will be provided with the following masonry works:—

Drop of 1 foot	in 3rd mile.
Do. 1½ ,,	in 5th do.
Bridge	in 14th do.
Regulator	in 17th do.

12. *Branches of Lower Pulleru.*—The principal branches of the channel will be —

	AVERAGE.
Tadicherlakodu	3,000
Kealdindikodu	3,000
Pedda Tummidi branch	2,000
Direct	4,000

There are besides these numerous other small channels which must be improved and head sluices provided.

13. *Upputeru Embankment.*—Serious damage is now caused by the floods of the Upputeru. In the year 1872 this river rose unusually high and spread over the country as far as the Bantumalli and Mudenepalli road, submerging most of the crops. To prevent this happening it is proposed to embank the river from the Kolleru Lake down to the Peddalunka drain; the first part of it would be exclusively a flood bank, to where it meets the Chevurkodu, but from this point the eastern bank of the latter channel will serve the purpose. It has been found that the Upputeru at *Kottada* rises during ordinary floods to + 7·0 feet, and it is assumed that the water in the river has a surface fall of 0·3 feet a mile in heavy floods; this is rather greater than what is perceptible by the water marks; but as no reliable information can be obtainable on this point it is better to err on the safe side. The banks at the commencement will be 3 feet above flood level and will be sloped down to meet the Chevurkodu bank, which is 2 feet above flood level; the top width will be 6 feet and the side slopes 2 to 1.

14. *Drainage.*—The general levels of this division indicate very clearly the proper lines for the drainage channels, but the fall of the country being so slight renders it impossible to carry off the rainfall at a moderate cost. The principles and data on which the dimensions of the channels have been calculated may be seen in paragraph 5 of Chief Engineer's memorandum, No. 491 F, dated 8th August 1873, the instructions therein contained being closely adhered to.

The principal channels are—

	Drainage Area.
1. Pullava with two affluents	18·36 sq. miles.
2. Dammidi	2·41 do.
3. Pedda Kommeleru with one affluent	42·25 do.
4. Peddalanka with six affluents	107·31 do.

15. *Pullava.*—The first will drain all the country between the Kykalur Channel and the *Ramavaram* Channel; it commences immediately to the north of the Polrazkodu and runs along the lower line of the *Pullava* swamp for eight miles, where it turns southward into the Vedurava swamp receiving the drainage of the latter by means of an affluent of the same name; it runs along the lowest line of this swamp for about a mile where it again turns and receives the drainage of the Annava swamp by an affluent, it continues along the swamp for about a mile to the Upputeru. It will be provided with an accommodation bridge at the second mile on the proposed road from Buntumalli to Kykalur and a tail escape weir into the Upputeru.

16. *Dammidi.*—The second will drain all the country between the Ramávaram Channel and the Polrazkodu extension; it will run along the lowest line of the swamp of the same name, and after a course of 7½ miles will discharge into the Upputeru, an outlet being provided there.

17. *Peddakommeleru.*—The third will drain all the country between the Polrazkodu and the Chevurkodu; it will commence at the end of the *Dakeru* Channel, and after a course of 16½ miles will tail into the Upputeru. At 8½ miles it will receive the Chinna Kommeleru Channel, which will take all the rainfall of the country between Polrazkodu and *Chegurkota* Tummidi to Gunnavaram, another on the road from Bantumalli to Kykalur, and a third on the road from Kaldindi to Kykalur; it will also have a tail escape into the Upputeru river. There will be an accommodation bridge on the affluent at the 8th mile on the road from Bantumalli to Kykalur.

18. *Peddalanka Drain.*—The fourth channel with its affluents will drain the remainder of this division; it commences near the village of *Korukollu* and runs through the lowest line of the swamp for a distance of 10 miles where it discharges into the Upputeru through an open cut.

19. *Singarayapalem Affluent.*—At its very commencement it receives the *Singarayapalem* affluent and the latter part of the Kaldindikodu which will be used as a drain. These are both in existence, the latter requires no alterations, but the former will be enlarged and made to commence higher up, as a drainage channel is much required there; it will be carried across the Bantumalli and Mudinepalli road by a road dam, the depth of water being trifling; there will also be two accommodation bridges, one at the 4th mile on the road from Tummidi to Gannaveram, and the other in the 18th mile on the road from Bantumalli to Kykalur.

20. *Affluents of the Peddalanka Drain.*—The other affluents of the Peddalanka drain are—

1. Utukur affluent.
2. Kondangi do.
3. Pedda Tummidi affluent.
4. Mattagunta do.
5. Amudalapalli do.

These will all run along the lowest line of the swamps they drain.

SECTION XI.

5th Division or that lying between the Pulleru with Bantumalli Channel and the Masulipatam Canal bounded on the east by the Sea from Masulipatam to the Upputeru river.

1. *Area.*—The total area of this division is 197·0 square miles, of which 118 is Zemindari and the rest Government, and it is calculated that out of this area 36,000 acres will be cultivated wet, which is at the rate of 182·74 acres to the square mile.

2. *General Fall of Country.*—In the upper part of this division as far as Pamarru the ground slopes from the Pulleru towards the Masulipatam Canal below Pamarru, the country falls from the Pulleru and Bantumalli Channels towards the sea in a direction nearly parallel to the Masulipatam Canal; but beyond the *Lazabandakodu* this slope though continued generally is broken by alternate ridges and swamps running parallel to the sea and having a fall towards the large swamp near *Peddapatnam*.

3. *Soil.*—The soil is rich and well suited for wet cultivation; in the portion north of the Lazabandakodu it is black cotton, and in the portion below it is principally sand.

4. *Present Wet Cultivation.*—The amount of wet cultivation at present is 2,744 acres exclusive of the Zemindari and Inam usual wet, and the whole country is intersected with numerous channels running in all directions without any reference whatever to the flow of the drainage; it is this that renders improving the irrigation and drainage of this division a matter of considerable difficulty. There are a number of channels now used for irrigation which were inundation channels from the Pulleru and the courses of which are extremely tortuous and as a consequence they silt up every season and have to be cleared at considerable expense.

5. *Pulleru.*—The main supply channel of this division is the Pulleru, and the proposed improvements have been already stated.

6. *Branches of Pulleru.*—This channel has three principal branches in this division:—

1. Masulipatam Canal East Side Channel.
2. Butterkodu.
3. Bantumalli Canal.

These by means of branches from them supply in a manner water to the whole of the existing wet cultivation.

7. *East Side Channel, Branch Duct.*—First East Side Channel continued by *Ramarazupalam* Channel. This channel leaves the Pulleru about one mile below the Pamarru regulator and runs alongside the Masulipatam Canal to a little beyond the village of *Gudur*, from whence it is continued in a north-easterly direction for 13 miles more by the Ramarazupalem Channel; it has a masonry drop of 2 feet at Nidumole. The faults of this channel at present are, firstly, that it is too low, in consequence of which bunds have to be erected across the channel where water is taken off for irrigation; this leads to silting and to endless disputes between the ryots, as those whose fields are near the lower part of the channel do not receive a proper supply; secondly, the water in the Pulleru never running 6 feet deep, as it was calculated to do when the head-sluice for this channel was built, the discharge through the sluice is insufficient. The first fault will be remedied by raising the bed and building masonry drops where necessary, and also by making the channel run deeper. The second fault will be corrected when the improvements to the Pulleru are carried out.

There will be many branches from the Ramarazupalem Channel, one of which called the *Cappaladoddi* branch will supply the Ottukodu which now receives water from the Lazabanda drain. By means of the branches on the south side the lower parts of the sand ridges near Masulipatam will be watered, and it is certain that a good deal of the land will be taken up.

8. *Butterkodu.*—This leaves the Pulleru about half a mile below the East Side Channel and runs along the south side of the Pulleru throwing off numerous branches. The latter part of this channel is also too low; it is therefore proposed to abandon this portion from about the 25th mile of the Pulleru and continue the channel by the *Nessenkeraye* kodu and *Vemavaram* Channel to the *Vadlamanad* drain. The first branch of Butterkodu called the *Malapaharykodu* will be improved by having its course strengthened between the 2nd and 4th mile, and it will be prolonged from near the village of *Schapurlapalem* to the village of *Nadupur*, where it will tail into an affluent of Lazabanda drain. The *Mamella* kodu, an important branch of the Malapahari Channel, will be ended in a swamp about two miles of its length, which at present interferes with the drainage being given up, and the remaining portion of it being again supplied by the Malapaharikodu. The Nessenkeraikodu, which at present supplies the Vemavaramkodu, will have a new head from the Butterkodu, and it will end at the Vadlamanad drain, the latter portion of it being supplied from the proposed extension of the Malapaharikodu. A suitable fall will be given to all these channels and drops built where necessary.

9. *Bantumalli Channel.*—Bantumalli Channel, as mentioned before this, is one of the three channels into which the Pulleru divides at Cowtram; it has a second-class lock at its head, and is supplied by a head-sluice of 3 vents of 10 feet span; it was intended to serve both as a navigation and irrigation channel, but the fall 6 inches and the width 30 feet being continued throughout rendered it almost useless for the latter purpose, as any large channel taking off reduced the depth below; this is obviated in a manner at present by erecting stone dams across the channel (there are now three), but this of course prevents all navigation. The bed of the channel is also somewhat low. It is proposed to irrigate all the land now under this channel by a south side channel with its head above Cowtram Lock, thereby having a greater command over the country, and to reserve the Bantumalli Channel almost entirely for navigation, only giving it sufficient fall to carry water for two channels which will take off at its present termination. At the 12th mile there is a still water channel running to the Bantumilli Salt Cotaur and it is proposed to continue that to the Upputeru thereby connecting the Godavery District with the Kistna. The level of the lower sill of the lock at Cowtram is +7·5; from here the channel will have a fall of bed of 0·08 foot a mile for a distance of 5½ miles; at which point, as the surface of water becomes too high, a lock with a drop of 4 feet will be necessary. The banks above and the lock being made sufficiently high to hold up still water when the irrigation season is over; from here to the present terminus weir the same fall will be continued, viz., 0·08 a mile, and at the 12th mile the still water channel with level bed takes off and will be prolonged to the Upputeru; it was proposed by the Chief Engineer to place another lock near *Barrinkulapaya* Cotaur with the lower sill —7 feet or 3 feet below the low water, the remainder of the channel to the Upputeru about 7½ miles being a salt water one; this would give an average cutting of more than 5 feet for that distance, 3 feet of which would be below low water, and the difficulty of executing the work would be considerable as the experience gained on the East Coast canal has shown. If the above project is carried out the excavation of the latter part of the channel should not be included in the completion estimates, as it will have no connection with the anicut water. In my opinion it would be better to have two locks, one at *Pondraka* lower sill about —3 feet, and another at the terminus lower sill —7 feet and make the channel a fresh water one throughout. The cost of the

former project would be Rupees 58,953; that of the latter Rupees 36,230, showing a saving of Rupees 22,723 on the latter.

10. *Bantumilli South Side Channel, a branch duct.*—The South Side channel will run alongside the Bantumilli canal for a distance of 11¼ miles, where it will turn eastward and tail into the Peddapatnam swamp. It will supply the following existing channels:—

Sairazulalanka channel which will be provided with a new head and have its course straightened.

Chevendra channel, the latter part of which will be used as a drain.

Keansadamkodu will be prolonged to the Munjulur swamp.

All these channels will have their beds regulated and drops built where necessary. There will also be the following new channels:—

Kongancherla which will supply a channel now filled from the Chevendra channel.

Arthamur channel which will water some lands which at present have no proper source of supply.

11. *Direct Branches from Pulleru.*—There will be two small irrigation channels branching direct from the Pulleru, one near Wyur called the *Capelaiswarapuram* channel, and the other near Marrivada called the *Kurumaddali* channel; these two will water lands which are but poorly supplied at present from the Capelaiswarapuram tank.

12. *Drainages.*—The drainage of this portion is at present very bad, though I think it is better than most of the other divisions.

13. *Lazabundakodu, a Main Drain.*—The principal channel, the Lazabandakodu, which with its affluents the Vudlamannad channel and the *Isukaparra* channel will drain nearly all the country between the Bantumilli, Masulipatam, and Ramarazupalem channels. The channel as at present is not nearly large enough and it is moreover used for irrigation which greatly interferes with its usefulness as a drain. It is now proposed to enlarge it considerably and extend it further into the Munjulur swamp, the waterway of the bridge near the village of that name being increased. The Vadlamanad channel will be an entirely new drain and will run along low ground draining country which now constantly suffers from floods. The Isukaparra affluent will be enlarged and have a suitable fall; there will also be catch drains on the upper sides of the latter portion of the Cheleru and Kansadam Kodu.

14. *Sardaipett Drain.*—There is an existing channel called the *Sardaipett* drainage which is now intercepted by Ramarazupalem channel, and it is now proposed to lead the northern portion of the channel into the Lazabanda drain and the southern part into the *Sultanagram* swamp drain. There is a swamp to the south-east of Gudur; the half of this to the east of the Hyderabad road will be drained into the channel above-mentioned, and the half to the west will be carried under the Masulipatam canal by an under tunnel and will discharge into the Mallavole tank, the water from which flows into the Dayapu calva.

15. *Sultanagram Swamp.*—The next important channel is the Sultanagram swamp drain; there is a channel in existence here, but owing to its small size it is nearly useless; it is now proposed to enlarge it and give it a better fall; the channel will be taken under the Masulipatam canal by the existing Sultanagram tunnel, from whence it will be discharged into the Masulipatam salt creek by the existing Sivanganga drainage channel which will require no alteration; it is found from the levels that the swamp falls in this direction from the road from Masulipatam to Cowtram, consequently the channel will commence at that road, and no masonry works will be necessary on this road or on the Chilakalapudi irrigation channel. The rest of this swamp will be drained into the creek near Peddapatnam by the *Gokavaram* channel.

16. *Drain.*—There will also be a drain running alongside the Masulipatam canal from *Kanakavalli* to the Inampudi under-tunnel, through which the water will be discharged into the channel of that name already described in section VII, paragraph 31. This channel will be a most useful one, as the crops in this part suffer yearly from floods.

SECTION XII.

1. *Cost of Works.*—I will now endeavor to show the probable returns to be derived from this project:—

	Rs.
Amount chargeable to this Delta on account of raising of anicut...	68,823
Improvements to Bezwada under sluice shutters	12,500
Improvements to head sluice	9,800
Widening Masulipatam canal from head to 4th mile	1,20,000
Improvements to Masulipatam canal from Kankipad to Tidal lock.	80,000
Total ...	2,91,123

			Rs.	
Cost of works in 1st division ...	Irrigation...	...	*12,33,870	
	Navigation	...	*53,130	
	Drainage...	...	5,65,000	
				18,52,000
Do. in 2nd do. ...	Irrigation...	...	1,00,000	
	Navigation	...	1,00,000	
	Drainage...	...	2,00,000	
				4,00,000
Do. in 3rd do. ...	Irrigation...	...	2,08,000	
	Navigation	...	32,000	
	Drainage...	...	4,60,000	
				7,00,000
Do. in 4th do. ...	Irrigation...	...	3,00,187	
	Navigation	...	76,335	
	Drainage...	...	9,73,478	
				13,50,000
Do. in 5th do. ...	Irrigation...	...	2,00,000	
	Navigation	...	1,38,000	
	Drainage...	...	3,47,000	
				6,85,000
		Total Cost ...		52,78,123
		Or say ...		53,00,000

2. *Time required to complete Project.*—I do not think it will be possible to spend more than out 2 lakhs a year; it will therefore take, say, twenty-six years to complete the works. The erage cost of Repairs, Maintenance, and Conservancy from 1869-70 to 1873-74 is Rs. 62,000 a total expenditure of Rupees 20,00,000 or at the rate of 3·1 per cent.

3. *Cost of Repairs, &c. during Construction.*—Calculating by this as 2 lakhs are spent arly, the cost of repairs, &c., for the works in this project during construction will be—

	Rs.
For first year	6,200
For second year	12,400

For twenty-sixth year Rupees 1,64,300, and the total cost in the twenty-six years will be upees 21,76,200; but, as the rates will probably increase before then, I think it safe to allow upees 23,93,820, or 10 per cent. in excess, say 24 lakhs.

4. *Loss of Assessment.*—The following lands (approximately) will be occupied by the annels:—

	Rs.
4,684 Acres, dry, at Rupees 2...	9,368
2,391 ,, wet, at ,, 6...	14,346
Total ...	23,714

If one-twenty-sixth of this extent be taken up yearly, the loss of assessment for the twenty-x years will be Rupees 3,20,000.

5. *Tools and Plant.*—Cost of tools and plant at 8 per cent. = 4,24,000, say 4 lakhs.

	Rs.
6. *Hutting Money.*—Hutting money at Rupees 1,000 per year ...	26,000
7. *Total Cost of Project.*—Total cost of project	84,46,000

alue of waste land irrigated and land in bed of tanks should be deducted from this, but I have information on this point and I do not think it would make much difference in total cost.

8. *Revenue from proposed Works.*—The revenue to be derived from the works will be as llows:—

	Rs.
86,660 Acres, dry, watered at Rupees 4 = ...	3,46,640
45,617 Do. waste, do. at do. 6 = ...	2,73,702
Add average remission during last five years on account of defective irrigation and drainage	25,000
Total Returns ...	6,45,342

* Revised amount according to Colonel Mullins' proposal is Rupees 16,64,000.

9. *Deductions from Revenue.*—From the amount the loss of assessment on dry lands occupied by the channels must be deducted ... 9,368
Cost of Maintenance, Repairs and Establishment, at 10 Annas per acre (being slightly more than the average for the last five years) = ... 82,673
Say 83,000

10. *Net Revenue.*—The net revenue will therefore be Rupees 6,45,342 — Rupees 92,368 = 5,52,974 or 6·54 per cent.

11.—*Establishment and Interest on Capital not included.*—No extra establishment has been allowed for carrying out the works. The interest on capital has not been added to the cost, as it is certain that this will be paid off by the revenue from the lands taken up as the works are carried on.

12. *Returns supposed land to be taken up as the works are carried out.*—And it has been assumed that no land but what will pay this will be taken up till the whole works are completed; this is very unlikely, and if it be assumed that one twenty-sixth of the land to be irrigated be taken up each year, the revenue derived therefore would amount to Rupees 74,25,054, which would much more than cover the cost of Repairs, Maintenance, Conservancy, &c., during construction as well as loss of assessment and interest on capital. The return on the project would therefore be 9·7 per cent.

13. *Returns omitting Navigation.*—Again, the returns from navigation are not taken into account, as it is impossible to estimate what they will be; but in my opinion the cost of works of navigation should not be included with those of irrigation and drainage. If the cost, viz., Rupees 4,79,465, were omitted the returns on the project would be Rupees 10·59 per cent.

14. *Reduction in cost of Drainage proposed.*—The small return on this project is owing to the enormous cost of drainage. I have proposed an alternative plan in the detailed report on the 4th division for reducing this cost, and if this were carried out in other divisions, where possible I think a saving of about Rupees 6,00,000 might be effected, the returns on the project (omitting cost of navigation) would then be 11·9 per cent.

15. *Saving to be effected by importing labor.*—It is evident that the more rapidly the works are carried out the greater will be the saving; every endeavor should therefore be made to import labor; supposing a little over Rupees 10,00,000 could be expended each year, the project would take only five years to complete, by this there would be saving of Rupees 21,77,720 on repairs during construction, &c.; there would also be a saving on the rates of say 5 per cent., as 10 per cent. has generally been allowed to cover increased rates during the time of construction, and during five years I do not think the rates would rise so much.

The total saving would therefore be Rupees 24,42,720. Now to execute Rupees 10,00,000 of works a year would require a body of at least 12,000 workmen. The total amount of earth-work to be excavated is approximately 42,000,000 of cubic yards at an average rate of 1¼ Annas per cubic yard; with the saving above-mentioned Rupees 10 might be paid for each man imported, and the rate for earthwork increased by 10¼ Pies per cubic yard.

16. *Order of carrying out the works.*—In carrying out the project I think the following works should be put in hand, first, raising anicut, east bank channel, Polrazkodu extension, Kykalur channel extension, and Chivurkodu; during the season when the irrigation channels are closed all available labor should be employed on Pulleru, Ryves' channel, Masulipatam canal, from 1st to 4th mile and Ellore canal. The principal drainages to be commenced as soon as possible are Lazabanda, Inampudi, old Polrazkodu and Singarayepalem.

17. *Present state of the project.*—The state of the project at present is as follows:—

In the 1st division all the plans, estimates, reports, &c., are ready, but the alterations to the east bank channel proposed by the Chief Engineer will necessitate most of them being done over again.

In the 2nd division all the out-door work has been done, but the plans and estimates according to the arrangements proposed by the Chief Engineer have to be made in detail; the cost as entered in this report has only been estimated approximately.

In the 3rd division the whole of the earthwork, plans and estimates and most of the masonry ones have been finished, but drainage plans have to be revised in accordance with the Chief Engineer's Circular on drainage.

The 4th division is completed and has already been sent in in detail.

The 5th division is in the same state as the 3rd.

The cost of the improvements to the head works and Masulipatam canal has been estimated approximately, but detailed estimates have to be made. So much work having been done rendered it easy to estimate the approximate cost of the whole project, and the amount entered in this report, viz., Rupees 53,00,000, will be found very correct.

18. *Remarks on Navigation combined with Irrigation.*—I cannot conclude this report without making a few remarks on combining navigation with irrigation, as it appears from Colonel Rundall's last report on the Kistna District that he is greatly in favor of this, and it may perhaps induce the Chief Engineer to allow more lines of navigation than have been estimated for in this project. Colonel Rundall argues from the fact that the system of combining navigation and irrigation has succeeded in the Godavery; but it appears to me that it might as well be assumed that because a bridge with two feet foundation has been found to stand in the Godavery District a similar bridge in the Kistna would also stand with the same foundation, no inquiries being made as to the difference of soil, &c. He also states that in France efforts are being made to connect the system of canals; but I cannot see that this proves that the same thing should be done in the Kistna District. The circumstances of the Kistna and Godavery are entirely different; in the former there are two important sea ports, Cocanada and Narsapur; the quantity of rice grown is and will be more than double that in this district, and there is not half the quantity of silt in the river. I am by no means against navigation, for I consider that through lines like the Masulipatam, Ellore, Polrazkodu and the Bantumilli canals will be very useful and will pay for the extra clearance required owing to their being made navigable; but I am convinced that local channels will be utterly useless. Colonel Rundall states that the cost of conveyance by land is Annas 3 per ton. I do not know how this is arrived at, but I am persuaded that land carriage costs the cultivators hardly anything; they are obliged to keep cattle for ploughing and they use them for conveying the grain to where they desire to send it; if they used the canals they would have to pay all the same for the feed of the bullocks. This is the reason why there is scarcely any local traffic on the canals; thus though there is lots of cultivation near the Masulipatam canal hardly any of the grain is conveyed by water from any of the villages between Masulipatam and Bezwada; there has never been a boat with grain on either the Pulleru or Polrazkodu, though even in their present imperfect state goods could be carried on them for much less than Annas 3 per ton. That the local cultivation does not effect the traffic can be seen by comparing the cultivation return with the traffic returns. The evil effect of silting in navigable canals in this district are very much felt, and it was for this reason that all the officers who have had any experience of the district (I may mention Colonels Orr, Anderson, and Winscom) decided that it was better to separate the irrigation and navigation; it is strange if these officers come to a wrong conclusion after so many years experience of the district.

That it is essential to keep down the amount of annual clearance is evident from the facts that it is even now found impossible to clear the channels to anything like their full width, and of course when there are some hundreds of miles more of channels the difficulty will be still greater.

19. *Cost of maintaining Pulleru compared with that of Masulipatam Canal.*—I will here compare the cost of maintaining the Masulipatam canal and the Pulleru, the former being for navigation and irrigation combined, and the latter for irrigation only. (It can be navigated but its primary object is irrigation.)

Average cost of three years of repairs, conservancy and maintainance of Masulipatam canal from head of Ellore canal to tidal lock, 48 miles ... ... Rs. 14,843.
= Rupees 309 nearly per mile.

Average cost of 3 years of maintenance and repairing Pulleru from Kankipad to Cowtram, 26 miles ... ... Rs. 1,376

Cost per mile = Rupees 53 nearly.

Showing a difference of Rupees 256 per mile. It must also be mentioned that the Masulipatam canal has never been cleared to more than half its full width; so, if cleared properly, the cost would be about Rupees 300 per mile.

The Pulleru moreover is not a good example of a channel designed entirely for navigation, as the bed has never been raised to its correct level.

20. *Cost of making East Bank channel navigable and benefit thereform.*—I will now show that there will be nothing gained by making the East Bank channel navigable by the means proposed by Colonel Mullins.

	Rs.
The extra cost for navigation is Rupees 4,30,000 (exclusive of extra cost of branch channels owing to bed of East Bank channel being raised). Interest on this sum at 4 per cent. = ...	17,200
Lock establishments at Rupees 180 per month	2,160
Maintenance at Rupees 30 per mile	1,560
Annaul clearances and repairs taken at what it would cost in Masulipatam canal is properly done (the channel being wider it would really cost more).	15,600
Total ...	36,520

Now if it is assumed that there would be half as much traffic on this canal as on the Masulipatam canal during the best year 1869-70 (in my opinion there will not be nearly half) the

tonnage will be 8,516, and carried 26 miles (half length of canal) this will represent a ton mileage of 221,416; if the saving over land carriage be taken at 2½ Annas per ton mile (with which I do not agree) the total saving to the community will be Rupees 34,596, which does not cover the expense of making the canal navigable. I hope it may not be considered presumption on my part giving an opinion contrary to Colonel Rundall on so important a point; but as I have had 5½ years' practical experience of this district and know the great difficulty and expense of effecting the annual clearances at all satisfactorily, and also am well acquainted with the lines the traffic takes, I think it only proper that I should record my opinion.

21. *Report purposely made detailed.*—It may be considered that this report is too detailed. I have made it so purposely, in order that the Chief Engineer may see plainly what is proposed to be done and make any alterations he considers advisable at once and thereby save doing work twice over.

22. *Requesting early orders on report.*—In conclusion I request that early orders may be passed on this report, otherwise I will be at a loss to know what estimates to prepare in detail.

(Sd.) J. O. HASTED, Major, R.E., Supg. Engr., 1st Divn., Kistna. (Sd.) D. McNEIL CAMPBELL, Lt., R.E. Executive Engineer, 4th Grade, Kistna.

P.S.—Since writing the report the Kistna river has risen to a height of 39 feet 5 inches, being 1 foot 11 inches higher than the greatest fresh on record since the construction of the anicut; this will necessitate the river bank being made 2 feet higher than is allowed in this project; and will probably add about Rupees 12,000 to the cost of the project; but as this will make a very slight difference in the returns, I have not thought it necessary to alter the report or plans.

(Signed) D. McNEIL CAMPBELL, Lieut., R.E., Executive Engineer, 4th Grade.

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ENCLOSURES.—12 Appendices.

1 A. Depth of water required on Kistna Anicut.
2 B. Do. that actually received with discharge.
3 C. Area in the Eastern Delta and Acreage proposed.
4 D. Area available for Irrigation according to Revenue Accounts.
5 E. Table of Velocity and Discharge for Irrigation.
6 F. Do. of Drainage Channels.
7 G. Statement of Water Distribution.
8 H. Cost of Works up to date and approximate cost of those proposed.
9 I. Area commanded, the present and the expected increase of wet cultivation by proposed works.
10 J. Traffic Returns of Ellore Canal.
11 K. Do. of Bandar Canal.
12 L. Cost of Repairs in the Eastern Delta Completion Report of the *Eastern Delta* Projects in Kistna.
13 M. Statement of Remissions.

(Signed) D. McNEIL CAMPBELL, Lieut., R.E., Executive Engineer, 4th Grade, Kistna.

APPENDIX B.

STATEMENT showing the Depth of Water on Bezwada Head-sluice Front Floor during the Irrigation Season.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
		Days more than 7 feet 0 inch and less than 7 feet 3 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 7 feet 3 inches and less than 7 feet 6 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 7 feet 6 inches and less than 7 feet 9 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 7 feet 9 inches and less than 8 feet 0 inch on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.
		No.	From what date to what date.	Velocity = 2·38 feet and discharge = 3529·18 cubic feet a second. = 470,439 cubic yards or 1·74 cubic yards per hour per acre.		No.	From what date to what date.	Velocity = 2·42 feet and discharge = 3,713·060 cubic feet a second. = 496,218 cubic yards = to 1·83 cubic yards per hour per acre.		No.	From what date to what date.	Velocity = 2·46 feet and discharge = 3,903·27 cubic feet a second. = to 520,672 cubic yards = to 1·92 cubic yards per hour per acre.		No.	From what date to what date.	Velocity = to 2·6 feet and discharge = to 4,100·0 cubic feet a second. = to 546,530 cubic yards = to 2·02 cubic yards per hour per acre.	
For 1864.																	
July	..	..	..	..	..	3	11, 12, 13	..	..	2	10, 14	..	..	2	9, 15	..	..
August	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
September	..	..	..	..	..	..	..	..	..	3	12, 23, 25	..	..	6	11, 26, 27 28, 29, 30	..	..
October	..	..	..	..	..	4	13, 14, 22, 24	..	..	5	8, 13, 23, 24, 30	..	..	3	27, 28, 29	..	..
November	..	..	..	..	..	5	9, 14, 15 25, 26	..	..	8	1, 2, 3, 4, 5, 8, 16, 19	..	..	9	9, 10, 11, 12, 13, 14, 15, 16, 17	..	..
December	..	..	..	..	..	5	6, 7, 20, 21, 22	..	..	..	..	..	..	..	..	..	..
		5	15, 16, 17, 20, 21	..	..	5	10, 16, 17, 21, 22	..	..	..	..	..	..	..	..	..	..
		4	23, 24, 25, 26	..	..	..	..	..	..	..	..	..	..	..	..	..	..

Bottom width of channel at head 200 feet; side slopes 1½ to 1 river side and 1 to 1 town side; acreage 270,000.

N.B.—Appendix A will be found at the end of this report.

STATEMENT showing the Depth of Water on Bezwada Head-sluice Front Floor during the Irrigation Season.—(*Continued*).

—	Days more than 8 feet 0 inch and less than 8 feet 3 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 8 feet 3 inches and less than 8 feet 6 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 8 feet 6 inches and less than 8 feet 9 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 8 feet 9 inches and less than 9 feet 0 inch on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.
	No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.		
	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
For 1864.																
July	2	2, 8	Velocity = to 2·53 feet and discharge = to 4,952·1,000 cubic feet a second.	= to 570,804 cubic yards = to 2·11 cubic yards per hour per acre.	1	7	Velocity and discharge in Main Canal with this depth in cubic feet per second.	= to 597,855 cubic yards = to 2·21 cubic yards per hour per acre.	3	1, 3, 6	Velocity = to 2·61 feet and discharge = 4,692·36 cubic feet a second.	= to 625,491 cubic yards = to 2·31 cubic yards per hour per acre.	1	5	Velocity = to 2·65 feet and discharge = to 4,904·15 cubic feet a second.	= to 653,723 cubic yards = to 2·42 cubic yards per hour per acre.
August	..	..			..	..			..	..			..	..		
September	3	22, 23, 24			4	20, 21, 25, and 30			2	19, 29			4	17, 18, 26, 28		
October	5	3, 4, 5, 10, 31			2	1, 2			1	9			..	..		
November	4	1, 2, 7, 12			1	11			..	..			..	..		
December	..	..			..	..			..	..			..	..		

Bottom width of channel at head 200 feet ; side slopes 1½ to 1 river side and 1 to 1 town side ; acreage 270,000.

STATEMENT showing the Depth of Water on Bezwada Head-sluice Front Floor during the Irrigation Season.—(*Continued*).

—	Days more than 9 feet 0 inch and less than 9 feet 3 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 9 feet 3 inches and less than 9 feet 6 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 9 feet 6 inches and less than 9 feet 9 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 9 feet 9 inches and less than 10 feet 0 inch on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.
	No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.		
	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
For 1864.																
July	1	4	Velocity = to 2·69 feet and discharge = to 5,120·32 cubic feet a second.	= to 682,538 cubic yards = to 2·52 cubic yards per hour per acre.	1	16	Velocity = to 2·73 feet and discharge = 5338·246 cubic feet a second.	= to 711,588 cubic yards = to 2·63 cubic yards per hour per acre.	..	..	Velocity = to 2·77 feet and discharge = to 5,565·9756 cubic feet a second.	= to 741,944 cubic yards = to 2·74 cubic yards per hour per acre.	..	..	Velocity = to 2·81 feet and discharge = 5,793·625 cubic feet a second.	= to 772,556 cubic yards = to 2·86 cubic yards per hour per acre.
August	..	..			..	..			..	..			2	12, 13		
September	1	16			1	15			1	27			1	14		
October	1	8			..	..			..	..			..	..		
November	1	6			..	..			..	..			1	3		
December	..	..			..	..			..	..			..	..		

Bottom width of channel at head 200 feet ; side slopes 1½ to 1 river side and 1 to 1 town side ; acreage 270,000.

STATEMENT showing the Depth of Water on Bezwada Head-sluice Front Floor during the Irrigation Season,—(*Continued*).

1	Days more than 7 feet 0 inch and less than 7 feet 3 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 7 feet 3 inches and less than 7 feet 6 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 7 feet 6 inches and less than 7 feet 9 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 7 feet 9 inches and less than 8 feet 0 inch on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.
	No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.		
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
For 1865.																
July	..	..	Velocity = 2·38 feet discharge = 3,529·18 cubic feet a second.	= 470,439 cubic yards or 1·74 cubic yards per hour per acre.	..	..	Velocity = 2·42 feet discharge = 3,715·069 cubic feet a second.	= 495,218 cubic yards = to 1·83 cubic yards per hour per acre.	..	..	Velocity = 2·46 feet and discharge = 3,905·27 cubic feet a second.	= to 520,672 cubic yards = to 1·92 cubic yards per hour per acre.	..	..	Velocity = to 2·5 feet and discharge = to 4,100·0 cubic feet a second.	= to 546,530 cubic yards = to 2·02 cubic yards per hour per acre.
August	..	..			..	..			..	..			..	..		
September	..	..			..	..			..	..			..	..		
October	..	..			6	5, 6, 7, 8, 9, 10			5	2, 3, 4, 11 and 12			4	1, 13, 14, 15		
November	..	..			..	..			..	..			..	..		
December	3	29, 30, 31			4	15, 16, 27 28			9	11, 12, 13, 14, 17, 23 24, 25, 26			14	2, 3, 4, 5, 6, 7, 8, 9, 10, 18, 19, 20, 21, 22		

Bottom width of channel at head 200 feet ; side slopes 1½ to 1 river side and 1 to 1 town side ; acreage 270,000.

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STATEMENT showing the Depth of Water on Bezwada Head-sluice Front Floor during the Irrigation Season,—(*Continued*).

1	Days more than 8 feet 0 inch and less than 8 feet 3 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 8 feet 3 inches and less than 3 feet 6 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 8 feet 6 inches and less than 8 feet 9 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 8 feet 9 inches and less than 9 feet 0 inch on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.
	No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.		
	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
For 1865.																
July	..	..	Velocity = to 2·53 feet and discharge = to 4,282·1,009 cubic feet a second.	= to 570,804 cubic yards = to 2·11 cubic yards per hour per acre.	..	..	Velocity = to 2·57 feet and discharge = to 4,485·04 cubic feet a second.	= to 597,855 cubic yards = to 2·21 cubic yards per hour per acre.	1	7	Velocity = to 2·61 feet and discharge = 4,692·36 cubic feet a second.	= to 625,491 cubic yards = to 2·31 cubic yards per hour per acre.	..	..	Velocity = to 2·65 feet and discharge = 4,904·15 cubic feet a second.	= to 653,723 cubic yards = to 2·42 cubic yards per hour per acre.
August	..	..			..	..			..	..			2	8, 9		
September	2	29, 30			1	28			2	16, 17			3	15, 19, 27		
October	1	16			5	17, 18, 20, 21, 22			7	19, 23, 24, 25, 26, 30, and 31			3	27, 28, 29		
November	2	29, 30			2	27, 28			15	1, 2, 3, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26			2	13, 14		
December	1	1			..	..			..	..			..	..		

Bottom width of channel at head 200 feet ; side slopes 1½ to 1 river side and 1 to 1 town side ; acreage 270,000.

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STATEMENT showing the Depth of Water on Bezwada Head-sluice Front Floor during the Irrigation Season.—(*Continued*).

—	Days more than 9 feet 0 inch and less than 9 feet 3 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 9 feet 3 inches and less than 9 feet 6 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 9 feet 6 inches and less than 9 feet 9 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 9 feet 9 inches and less than 10 feet 0 inch on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.
	No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.		
—	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
For 1865.																
July	..	..	Velocity = to 2·69 feet and discharge = to 6,120·32 cubic feet a second.	= to 682,538 cubic yards = to 2·52 cubic yards per hour per acre.	1	31	Velocity = to 2·73 feet and discharge = 5,338·246 cubic feet a second.	= to 711,588 cubic yards to 2·63 cubic yards per hour per acre.	1	30	Velocity = to 2·77 feet and discharge = to 5,565·9756 cubic feet a second.	= to 741,944 cubic yards = to 2·74 cubic yards per hour per acre.	1	29	Velocity = to 2·81 feet and discharge = to 5,796·625 cubic feet a second.	= to 772,556 cubic yards = to 2·86 cubic yards per hour per acre.
August	..	..			..	..			4	2, 3, 7, 14			1	13		
September	..	..			3	14, 19, 26			1	13			..	..		
October	..	..			..	..			..	..			..	..		
November	2	11, 12			1	10			1	9			1	8		
December	..	..			..	..			..	..			..	..		

Bottom width of channel at head 200 feet; side slopes 1½ to 1 river side and 1 to 1 town side; acreage 27,0000.

STATEMENT showing the Depth of Water on Bezwada Head-sluice Front Floor during the Irrigation Season.—(*Continued*).

—	Days more than 7 feet 0 inch and less than 7 feet 3 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 7 feet 3 inches and less than 7 feet 6 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 7 feet 6 inches and less than 7 feet 9 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 7 feet 9 inches and less than 8 feet 0 inch on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.
	No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
For 1866.																
July	..	..	Velocity = to 2·38 feet and discharge = to 3,529·18 cubic feet a second.	= 470,439 cubic yards = to 1·74 cubic yards per hour per acre.	..	..	Velocity = to 2·42 feet and discharge = 3,715·069 cubic feet a second.	= 495,218 cubic yards = to 1·83 cubic yards per hour per acre.	1	12	Velocity = to 2·46 feet and discharge = to 3,905·27 cubic feet a second.	= to 520,572 cubic yards = to 1·92 cubic yards per hour per acre.	3	10, 11, 13	Velocity = to 2·5 feet and discharge = to 4,100·0 cubic feet a second.	= to 546,630 cubic yards = to 2·02 cubic yards per hour per acre.
August	..	..			..	..			..	..			..	..		
September	..	..			..	..			..	..			1	22		
October	..	..			..	..			..	..			..	..		
November	..	..			..	..			9	5, 6, 7, 8, 9, 10, 11, 12, 13			2	4, 14		
December	..	..			..	..			2	30, 31			5	17, 18, 19, 28, 29		

Bottom width of channel at head 200 feet; side slopes 1½ to 1 river side and 1 to 1 town side; acreage 270,000.

STATEMENT showing the Depth of Water on Bezwada Head-sluice Front Floor during the Irrigation Season.—(*Continued*).

—	Days more than 8 feet 0 inch and less than 8 feet 3 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 8 feet 3 inches and less than 8 feet 6 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 8 feet 6 inches and less than 8 feet 9 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 8 feet 9 inches and less than 9 feet 0 inch on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.
	No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.		
	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
For 1866.																
July	1	9	Velocity = to 2·53 feet and discharge = to 4,282·1009 cubic feet a second.	= to 570,804 cubic yards = to 2·11 cubic yards per hour per acre.	2	8, 14	Velocity = to 2·57 feet and discharge = to 4,485·04 cubic feet a second.	= to 597,855 cubic yards = to 2·21 cubic yards per hour per acre.	2	7, 17	Velocity = 2·61 feet and discharge = 4,692·36 cubic feet a second.	= to 625,491 cubic yards = to 2·31 cubic yards per acre per hour.	2	15, 16	Velocity = to 2·65 cubic feet and discharge = 4,904·15 cubic feet a second.	= 653,723 cubic yards = to 2·42 cubic yards per hour per acre.
August	..	..			..	..			..	..			..	..		
September	5	18, 19, 20, 21, 23			3	17, 24, 25			..	..			3	4, 16, 28		
October	2	19, 20			..	..			2	18, 21			3	1, 2, 3		
November	2	3, 15			3	2, 16, 17			2	18, 19			5	1, 20, 21, 22, 30		
December	5	14, 15, 16, 26, 27			10	6, 7, 8, 9, 10, 11, 12 13, 20, 25			5	3, 4, 5, 23, 24			4	1, 2, 21, 22		

Bottom width of channel at head 200 feet; side slopes 1½ to 1 river side and 1 to 1 town side; acreage 270,000.

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STATEMENT showing the Depth of Water on Bezwada Head-sluice Front Floor during the Irrigation Season.—(*Continued*).

—	Days more than 9 feet 0 inch and less than 9 feet 3 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 9 feet 3 inches and less than 9 feet 6 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 9 feet 6 inches and less than 9 feet 9 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 9 feet 9 inches and less than 10 feet 0 inch on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.
	No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.		
	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
For 1866.																
July	1	6	Velocity = to 269 feet and discharge = to 5,120·32 cubic feet a second.	= to 682,528 cubic yards = to 2·52 cubic yards per hour per acre.	..	..	Velocity = to 2·73 feet and discharge = 5,338·24 cubic feet a second.	= to 711,588 cubic yards = to 2·63 cubic yards per hour per acre.	..	..	Velocity = to 2·77 feet and discharge = to 5,565·976 cubic feet a second.	= to 7,41,944 cubic yards = to 2·74 cubic yards per hour per acre.	1	5	Velocity = to 2·81 feet and discharge = to 5,795·625 cubic feet a second.	= to 772,556 cubic yards = to 2·86 cubic yards per hour per acre.
August	..	..			..	..			..	..			1	31		
September	5	2, 3, 5, 27, 30			4	1, 15, 26, 29			..	..			1	14		
October	1	17			2	16, 31			..	..			1	15		
November	5	23, 24, 25, 26, 27			..	..			..	..			..	..		
December	..	..			..	..			..	..			..	..		

Bottom width of channel at head 200 feet; side slopes 1½ to 1 river side and 1 to 1 town side; acreage 270,000

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STATEMENT showing the Depth of Water on Bezwada Head-sluice Front Floor during the Irrigation Season.—(*Continued*).

—	Days more than 7 feet 0 inch and less than 7 feet 3 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 7 feet 3 inches and less than 7 feet 6 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 7 feet 6 inches and less than 7 feet 9 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 7 feet 9 inches and less than 8 feet 0 inch on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.
	No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
For 1867.																
July	1	19	Velocity = to 2·38 feet and discharge = 3,529·18 cubic feet a second.	= 479,439 cubic yards = to 1·74 cubic yards per hour per acre.	1	18	Velocity = 2·42 feet and discharge = 3,715·069 cubic feet a second.	= 495,218 cubic yards = to 1·83 cubic yards per hour per acre.	2	4, 17	Velocity = to 2·46 feet and discharge = to 3,905·27 cubic feet a second.	= to 520,572 cubic yards = to 1·92 cubic yards per hour per acre.	..	..	Velocity = to 2·5 feet and discharge = to 4,100 cubic feet a second.	= to 546,930 cubic yards = to 2·02 cubic yards per hour per acre.
August	..	..			..	..			..	..			..	..		
September	..	..			..	..			..	..			1	24		
October	..	..			1	10			2	8, 9			1	7		
November	..	..			..	..			..	..			8	9, 10, 11, 12, 13, 14, 15, 16		
December	..	..			..	..			..	..			..	..		

Bottom width of channel at head 200 feet ; side slopes 1½ to 1 river side and 1 to 1 town side ; acreage 270,000.

STATEMENT showing the Depth of Water on Bezwada Head-sluice Front Floor during the Irrigation Season.—(*Continued*).

—	Days more than 8 feet 0 inch and less than 8 feet 3 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 8 feet 3 inches and less than 3 feet 6 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 8 feet 6 inches and less than 8 feet 9 inches on floor.		Velocity and Discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 8 feet 9 inches and less than 9 feet 0 inch on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.
	No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.		
18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
For 1867.																
July	2	10, 16	Velocity = to 2·53 feet and discharge = to 4,282·1009 cubic feet a second.	= to 571,864 cubic yards = to 2·11 cubic yards per hour per acre.	3	8, 9, 11	Velocity = to 2·57 feet and discharge = to 445·04 cubic feet a second.	= to 597,855 cubic yards = to 2·21 cubic yards per hour per acre.	3	5, 7, 15	Velocity = to 2·61 feet and discharge = to 4,692·36 cubic feet per second.	= to 625,491 cubic yards = to 2·31 cubic yards per hour per acre.	3	6, 13, 14	Velocity = to 2·65 feet and discharge = 4,904·15 cubic feet a Second.	= to 653,723 cubic yards = to 2·42 cubic yards per hour per acre.
August	..	..			..	..			..	..			..	..		
September	5	23, 25, 26, 27, 28			2	22, 29			2	21, 30			4	7, 10, 12 20		
October	1	1			1	6			3	2, 19, 31			2	5, 18		
November	7	2, 3, 7, 8, 17, 18, 19			3	1, 6, 20			2	21, 22			3	4, 5, 23		
December	..	..			3	29, 30, 31			4	10, 11, 27, 28			6	5, 6, 7, 8, 9, 26		

Bottom width of channel at head 200 feet ; side slopes 1½ to 1 river side and 1 to 1 town side ; acreage 270,000.

STATEMENT showing the Depth of Water on Bezwada Head-sluice Front Floor during the Irrigation Season.—(*Continued*).

—	Days more than 9 feet 0 inch and less than 9 feet 3 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 9 feet 3 inches and less than 9 feet 6 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 9 feet 6 inches and less than 9 feet 9 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 9 feet 9 inches and less than 10 feet 0 inch on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.
	No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.		
	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
For 1867.																
July	1	12	Velocity = to 2·69 feet and discharge = to 5,120·32 cubic feet a second.	= to 682,538 cubic yards = to 2·52 cubic yards per hour per acre.	..	..	Velocity = to 2·73 feet and discharge = 5,338·24 cubic feet a second.	= to 711,583 cubic yards = to 2·63 cubic yards per hour per acre.	..	..	Velocity = to 2·77 feet and discharge = to 5,565·9756 cubic feet a second.	= to 741,944 cubic yards = to 2·74 cubic yards per hour per acre.	..	..	Velocity = to 2·81 feet and discharge = to 5,796·625 cubic feet a second.	= to 772,556 cubic yards = to 2·86 cubic yards per hour per acre.
August	..	..			2	2, 3			3	4, 8, 19			2	1, 18		
September	3	8, 11, 13			3	4, 6, 9			..	..			2	3, 19		
October	2	3, 17			2	4, 30			1	16			2	11, 29		
November	3	24, 25, 30			4	26, 27, 28 29			..	..			..	..		
December	7	1, 2, 3, 4 12, 24, 25			3	21, 22, 23			2	19, 20			3	16, 17, 18		

Bottom width of channel at head 200 feet ; side slopes 1½ to 1 river side and 1 to 1 town side ; acreage 270,000.

APPENDIX B.

STATEMENT showing the Depth of Water on Bezwada Head-sluice Front Floor during the Irrigation Season.—(*Continued*).

—	Days more than 7 feet 0 inch and less than 7 feet 3 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 7 feet 3 inches and less than 7 feet 6 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 7 feet 6 inches and less than 7 feet 9 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 7 feet 9 inches and less than 8 feet 0 inch on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.
	No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
For 1868.																
July	..	..	Velocity = to 2·38 feet and discharge = to 3,529·18 cubic feet a second.	= to 470,439 cubic yards = to 1·74 cubic yards per hour per acre.	2	20, 21	Velocity = to 2·42 feet and discharge = 3715·069 cubic feet a second.	= to 495,218 cubic yards = to 1·83 cubic yards per hour per acre.	1	19	Velocity = 2·46 feet and discharge = to 3,905·27 cubic feet a second.	= to 520,572 cubic yards = to 1·92 cubic yards per hour per acre.	1	18	Velocity = to 2·5 feet and discharge = to 4,100·0 cubic feet a second.	= to 546,530 cubic yards = to 2·02 cubic yards per hour per acre.
August	..	..			..	..			..	..			..	..		
September	..	..			3	25,26,27			3	23, 24, 28			2	22, 29		
October	..	..			..	..			..	..			5	20, 21, 22 23, 24		
November	..	..			2	29, 30			3	26, 27, 28			2	24, 25		
December	4	5, 6, 7, 8			4	1, 2, 3, 4			..	..			..	..		

Bottom width of channel at head 200 ; feet side slopes 1½ to 1 river side and 1 to 1 town side ; acreage 270,000.

STATEMENT showing the Depth of Water on Bezwada Head-sluice Front Floor during the Irrigation Season.—(*Continued*).

—	Days more than 8 feet 0 inch and less than 8 feet 3 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 8 feet 3 inches and less than 8 feet 6 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 8 feet 6 inches and less than 8 feet 9 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 8 feet 9 inches and less than 9 feet 0 inch on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.
	No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.		
	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
For 1868.																
July	..	..	Velocity = to 2·63 feet and discharge = to 4,382·1,009 cubic feet a second. = to 570,804 cubic yards = to 2·11 cubic yards per hour per acre.		1	17	Velocity = to 2·67 feet and discharge = to 4,485·04 cubic feet a second. = to 597,355 cubic yards = to 2·21 cubic yards per hour per acre.		..	..	Velocity = to 2·61 feet and discharge = to 4,692·36 cubic feet a second. = to 625,601 cubic yards = to 2·31 cubic yards per hour per acre.		..	..	Velocity = to 2·65 feet and discharge = to 4,904·15 cubic feet a second. = to 653,723 cubic yards = to 2·42 cubic yards per hour per acre.	
August	..	..			..	..			..	..			1	30		
September	2	21, 30			1	20			..	..			..	..		
October	3	18, 19, 25			1	17			2	16, 26			1	15		
November	2	22, 23			2	20, 21			5	15, 16, 17, 18, 19			5	1, 2, 12, 13, 14		
December	..	..			..	..			..	..			..	..		

Bottom width of channel at head 290 ; feet side slopes 1½ to 1 river side and 1 to 1 town side ; acreage 270,000.

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STATEMENT showing the Depth of Water on Bezwada Head-sluice Front Floor during the Irrigation Season.—(*Continued*).

—	Days more than 9 feet 0 inch and less than 9 feet 3 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 9 feet 3 inches and less than 9 feet 6 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 9 feet 6 inches and less than 9 feet 9 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 9 feet 9 inches and less than 10 feet 0 inch on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.
	No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.		
	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
For 1868.																
July	1	16	Velocity = to 2·69 feet and discharge = to 5,120·32 cubic feet a second. = to 682,538 cubic yards = to 2·62 cubic yards per hour per acre.		1	3	Velocity = to 2·73 feet and discharge = to 5,338·24 cubic feet a second. = to 711,588 cubic yards = to 2·63 cubic yards per hour per acre.		3	4, 13, 15	Velocity = to 2·77 feet and discharge = to 5,565·9,758 cubic feet a second. = to 741,944 cubic yards = to 2·74 cubic yards per hour per acre.		2	5, 22	Velocity = to 2·81 feet and discharge = to 5,795·625 cubic feet a second. = to 772,556 cubic yards = to 2·86 cubic yards per hour per acre.	
August	2	29, 31			..	..			1	28			1	27		
September	1	19			2	1, 9			1	8			..	..		
October	2	10, 31			6	1, 9, 12, 13, 14, 30			3	6, 8, 29			3	7, 27, 28		
November	6	3, 4, 5, 9, 10, 11			3	6, 7, 8			..	..			..	..		
December	..	..			..	..			..	..			..	..		

Bottom width of channel at head 200; feet side slopes 1½ to 1 river side and 1 to 1 town side; acreage 270,000.

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STATEMENT showing the Depth of Water on Bezwada Head-sluice Front Floor during the Irrigation Season.—(*Continued*).

—	Days more than 7 feet 0 inch and less than 7 feet 3 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 7 feet 3 inches and less than 7 feet 6 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 7 feet 6 inches and less than 7 feet 9 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 7 feet 9 inches and less than 8 feet 0 inch on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.
	No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
For 1869.																
July	..	..	Velocity = to 2·38 feet and discharge = to 3,529·18 cubic feet a second.	= to 470,439 cubic yards = to 1·74 cubic yards per hour per acre.	3	3, 11, 12	Velocity = to 2·42 feet and discharge = to 3,713·069 cubic feet a second.	= to 495,218 cubic yards = to 1·83 cubic yards per hour per acre.	2	19, 20	Velocity = to 2·46 feet and discharge = to 3,905·27 cubic feet a second.	= to 520,572 cubic yards = to 1·92 cubic yards per hour per acre.	2	10, 15	Velocity = to 2·5 feet and discharge = to 4,100·0 cubic feet a second.	= to 546,530 cubic yards = to 2·02 cubic yards per hour per acre.
August	..	..			..	..			..	..			..	..		
September	..	..			..	..			..	..			..	..		
October	..	..			..	..			..	..			5	23, 24, 25, 26, 27		
November	..	..			..	..			..	..			..	..		
December	..	..			..	..			..	..			..	..		

Bottom width of channel at head 200; feet side slopes 1½ to 1 river side and 1 to 1 town side; acreage 270,000.

STATEMENT showing the Depth of Water on Bezwada Head-sluice Front Floor during the Irrigation Season.—(*Continued*).

—	Days more than 8 feet 0 inch and less than 8 feet 3 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 8 feet 3 inches and less than 8 feet 6 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 8 feet 6 inches and less than 8 feet 9 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 8 feet 9 inches and less than 9 feet 0 inch on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.
	No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.		
18	19		20	21	22	23	24	25	26	27	28	29	30	31	32	33
For 1869.																
July	4	9, 14, 16, 18	Velocity = to 2·53 feet and discharge = to 4,282·1,009 cubic feet a second.	= to 570,804 cubic yards = to 2·11 cubic yards per hour per acre.	1	2	Velocity = to 2·57 feet and discharge = to 4,485·04 cubic feet a second.	= to 597,855 cubic yards = to 2·21 cubic yards per hour per acre.	3	8, 13, 17	Velocity = to 2·61 feet and discharge = to 4,692·36 cubic feet a second.	= to 625,491 cubic yards = to 2·31 cubic yards per hour per acre.	1	4	Velocity = to 2·65 feet and discharge = to 4,904·15 cubic feet a second.	= to 653,723 cubic yards = to 2·42 cubic yards per hour per acre.
August	..	..			..	..			..	..			1	26		
September	..	..			1	18			3	14, 15, 17			2	16, 19		
October	4	20, 21, 22 28			2	18, 19			3	15, 17, 29			2	14, 30		
November	..	..			..	..			6	15, 16, 17 18, 19, 20			4	13, 14, 21 22		
December	..	..			..	..			..	..			..	..		

Bottom width of channel at head 200 feet; side slopes 1½ to 1 river side and 1 to 1 town side; acreage 270,000.

STATEMENT showing the Depth of Water on Bezwada Head-sluice Front Floor during the Irrigation Season.—(*Continued*).

—	Days more than 9 feet 0 inch and less than 9 feet 3 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 9 feet 3 inches and less than 9 feet 6 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 9 feet 6 inches and less than 9 feet 9 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 9 feet 9 inches and less than 10 feet 0 inch on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.
	No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.		
	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
For 1869.																
July	..	..	Velocity = to 2·69 feet and discharge = to 5,120·32 cubic feet a second.	= to 682,538 cubic yards = to 2·52 cubic yards per hour per acre.	1	7	Velocity = to 2·73 feet and discharge = to 5,388·24 cubic feet a second.	= to 711,588 cubic yards = to 2·63 cubic yards per hour per acre.	..	..	Velocity = to 2·77 feet and discharge = to 5,465·9,756 cubic feet a second.	= to 741,944 cubic yards = to 2·74 cubic yards per hour per acre.	1	6		
August	..	..			1	25			1	8			2	7, 9		
September	1	13			1	12			..	..			2	11, 20		
October	3	13, 16, 31			1	12			..	..			1	11		
November	2	12, 30			2	11, 29			2	10, 28			1	27		
December	4	1, 2, 3, 4			5	12, 13, 14, 22, 23			7	5, 10, 11, 15, 16, 17, 21			5	6, 8, 9, 18, 20		

Bottom width of channel at head 200 ; feet side slopes 1½ to 1 river side and 1 to 1 town side ; acreage 270,000.

STATEMENT showing the Depth of Water on Bezwada Head-sluice Front Foor during the Irrigation Season.—(*Continued*).

—	Days more than 7 feet 0 inch and less than 7 feet 3 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 7 feet 3 inches and less than 7 feet 6 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic foot per second.	Available discharge in cubic yards per hour per acre.	Days more than 7 feet 6 inches and less than 7 feet 9 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 7 feet 9 inches and less than 8 feet 0 inch on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.
	No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
For 1870.																
July	..	..	Velocity = to 2·38 feet and discharge = to 3,529·18 cubic feet a second.	= to 470,439 cubic yards = to 1·74 cubic yards per hour per acre.	..	..	Velocity = 2·42 feet and discharge = to 3,715·069 cubic feet a second.	= to 495,218 cubic yards = to 1·83 cubic yards per hour per acre.	..	..	Velocity = 2·46 feet and discharge = to 3,905·27 cubic feet a second.	= to 520,572 cubic yards = to 1·92 cubic yards per hour per acre.	2	8, 9	Velocity = to 2·5 feet and discharge = to 4,100·0 cubic feet a second.	= to 546,530 cubic yards = to 2·02 cubic yards per hour per acre.
August	..	..			..	..			..	..			..	..		
September	..	..			..	..			..	..			1	15		
October	..	..			..	..			..	..			..	..		
November	..	..			..	..			..	..			4	14, 15, 16 17		
December	..	..			..	..			..	..			..	..		

Bottom width of channel at head 200 feet ; side slopes 1½ to 1 river side and 1 to 1 town side ; acreage 270,000.

STATEMENT showing the Depth of Water on Bezwada Head-sluice Front Floor during the Irrigation Season.—(*Continued*).

	Days more than 8 feet 0 inch and less than 8 feet 3 inches on floor. No.	Days more than 8 feet 0 inch and less than 8 feet 3 inches on floor. From what date to what date.	Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 8 feet 3 inches and less than 8 feet 6 inches on floor. No.	Days more than 8 feet 3 inches and less than 8 feet 6 inches on floor. From what date to what date.	Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 8 feet 6 inches and less than 8 feet 9 inches on floor. No.	Days more than 8 feet 6 inches and less than 8 feet 9 inches on floor. From what date to what date.	Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 8 feet 9 inches and less than 9 feet 0 inch on floor. No.	Days more than 8 feet 9 inches and less than 9 feet 0 inch on floor. From what date to what date.	Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.
	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
For 870.																
July	1	7	Velocity = to 2·53 feet and discharge = to 4,282·1,009 cubic feet a second.	= to 570,804 cubic yards = to 2·11 cubic yards per hour per acre.	1	6	Velocity = to 2·57 feet and discharge = to 4,485·04 cubic feet a second.	= to 5,97,855 cubic yards = to 2·21 cubic yards per hour per acre.	2	5, 10	Velocity = to 2·61 feet and discharge = to 4,692·36 cubic feet a second.	= to 625,491 cubic yards = to 2·31 cubic yards per hour per acre.	4	4, 16, 17, 20	Velocity = to 2·65 feet and discharge = to 4,904·15 cubic feet a second.	= to 653,723 cubic yards = to 2·42 cubic yards per hour per acre.
August	..	..			..	..			..	..			..	..		
September	3	7, 13, 14			2	6, 16			2	12, 17			2	5, 8		
October	..	..			..	..			..	..			..	..		
November	5	12, 13, 18, 19, 20			2	11, 21			6	6, 7, 9, 10, 22, 23			5	5, 8, 24, 25, 26		
December	..	..			..	..			..	..			5	27, 28, 29, 30, 31		

Bottom width of channel at head 200 feet; side slopes 1½ to 1 river side and 1 to 1 town side; acreage 270,000.

STATEMENT showing the Depth of Water on Bezwada Head-sluice Front Floor during the Irrigation Season.—(*Continued*).

	Days more than 9 feet 0 inch and less than 9 feet 3 inches on floor. No.	Days more than 9 feet 0 inch and less than 9 feet 3 inches on floor. From what date to what date.	Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 9 feet 3 inches and less than 9 feet 6 inches on floor. No.	Days more than 9 feet 3 inches and less than 9 feet 6 inches on floor. From what date to what date.	Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 9 feet 6 inches and less than 9 feet 9 inches on floor. No.	Days more than 9 feet 6 inches and less than 9 feet 9 inches on floor. From what date to what date.	Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 9 feet 9 inches and less than 10 feet 0 inch on floor. No.	Days more than 9 feet 9 inches and less than 10 feet 0 inch on floor. From what date to what date.	Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.
	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
For 1878.																
July	4	3, 11, 19, 21	Velocity = to 2·69 feet and discharge = to 5,120·32 cubic feet a second.	= to 682,538 cubic yards = to 2·62 cubic yards per hour per acre.	3	12, 15, 18	Velocity = to 2·73 feet and discharge = to 5,388·24 cubic feet a second.	= to 711,588 cubic yards = to 2·63 cubic yards per hour per acre.	1	14	Velocity = to 2·77 feet and discharge = to 5,565·9,756 cubic feet a second.	= to 741,944 cubic yards = to 2·74 cubic yards per hour per acre.	1	2	Velocity = to 2·81 feet and discharge = to 5,795·625 cubic feet a second.	= to 772,556 cubic yards = to 2·86 cubic yards per hour per acre.
August	..	..			..	..			..	..			..	..		
September	2	4, 11			2	9, 18			2	3, 10			1	2		
October	..	..			1	5			3	4, 20, 24			3	6, 19, 25		
November	1	27			3	4, 28, 29			1	30			1	3		
December	2	25, 26			4	21, 22, 23, 24			5	1, 17, 18, 19, 20			7	2, 3, 12, 13, 14, 15, 16		

Bottom width of channel at head 200 feet; side slopes 1½ to 1 river side and 1 to 1 town side; acreage 270,000.

STATEMENT showing the Depth of Water on Bezwada Head-sluice Front Floor during the Irrigation Season.—(*Continued*).

—	Days more than 7 feet 0 inch and less than 7 feet 3 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 7 feet 3 inches and less than 7 feet 6 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 7 feet 6 inches and less than 7 feet 9 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 7 feet 9 inches and less than 8 feet 0 inch on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.
	No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
For 1871.																
July	..	..	Velocity = to 2·38 feet and discharge = to 3,529·18 cubic feet a second.	= to 470,439 cubic yards = to 1·74 cubic yards per hour per acre.	..	..	Velocity = to 2·42 feet and discharge = to 3,715·069 cubic feet a second.	= 495,218 cubic yards = to 1·83 cubic yards per hour per acre.	..	..	Velocity = to 2·46 feet and discharge = to 3,906·27 cubic feet a second.	= to 520,572 cubic yards = to 1·92 cubic yards per hour per acre.	..	..	Velocity = to 2·5 feet and discharge = to 4,100·0 cubic feet a second.	= to 546,830 cubic yards = to 2·02 cubic yards per hour per acre.
August	..	..			..	..			..	..			..	..		
September	..	..			..	..			..	..			..	..		
October	..	..			..	..			..	..			4	22, 23, 24, 25		
November	..	..			..	..			..	..			..	..		
December	1	20			2	18, 19			1	17			4	6, 14, 15, 16		

Bottom width of channel at head 200 feet ; side slopes 1½ to 1 to the river side and 1 to 1 town side ; acreage 270,000.

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STATEMENT showing the Depth of Water on Bezwada Head-sluice Front Floor during the Irrigation Season.—(*Continued*).

—	Days more than 8 feet 0 inch and less than 8 feet 3 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 8 feet 3 inches and less than 8 feet 6 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 8 feet 6 inches and less than 8 feet 9 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 8 feet 9 inches and less th 9 feet 0 inch on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.
	No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.		
	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
For 1871.																
July	3	11, 12, 15	Velocity = to 2·53 feet and discharge = to 4,282·1,009 cubic feet a second.	= to 570,804 cubic yards = to 2·11 cubic yards per hour per acre.	3	10, 14, 16	Velocity = 2·57 feet and discharge = to 4,495·04 cubic feet a second.	= to 597,865 cubic yards = to 2·21 cubic yards per hour per acre.	2	9, 13	Velocity = to 2·61 feet and discharge = to 4,692·36 cubic feet a second.	= to 625,491 cubic yards = to 2·31 cubic yards per hour per acre.	..	..	Velocity = to 2·65 feet and discharge = to 4,904·15 cubic feet a second.	= to 653,723 cubic yards = to 2·42 cubic yards per hour per acre.
August	..	..			..	..			2	30, 31			1	29		
September	2	17, 18			4	16, 25, 26, 27			3	1, 19, 28			4	2, 15, 20, 24		
October	2	21, 26			4	20, 28, 30, 31			2	27, 29			2	7, 19		
November	..	..			1	1			7	2, 3, 4, 5, 26, 27, 28			14	6, 7, 14, 15, 16, 17, 18, 19, 20, 23, 24, 25, 29, 30		
December	2	5, 31			4	3, 4, 7, 12			3	1, 2, 11			1	10		

Bottom width of channel at head 200 feet ; side slopes 1½ to 1 river side and 1 to 1 town side ; acreage 270,000.

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STATEMENT showing the Depth of Water on Bezwada Head-sluice Front Floor during the Irrigation Season.—(*Continued*).

—	Days more than 9 feet 0 inch and less than 9 feet 3 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 9 feet 3 inches and less than 9 feet 6 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 9 feet 6 inches and less than 9 feet 9 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 9 feet 9 inches and less than 10 feet 0 inch on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.
	No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.		
	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
For 1871.																
July	2	8, 17	Velocity = to 2·69 feet and discharge = to 5,120·52 cubic feet a second.	= to 682,538 cubic yards = to 2·62 cubic yards per hour per acre.	..	..	Velocity = to 2·73 feet and discharge = to 5,388·24 cubic feet a second.	= to 711,588 cubic yards = to 2·63 cubic yards per hour per acre.	1	7	Velocity = to 2·77 feet and discharge = to 5,565·9,766 cubic feet a second.	= to 741,944 cubic yards = to 2·74 cubic yards per hour per acre.	..	..	Velocity = to 2·81 feet and discharge = to 5,795·625 cubic feet a second.	= to 772,556 cubic yards = to 2·86 cubic yards per hour per acre.
August	1	28			1	27			2	25, 26			1	24		
September	4	3, 14, 22, 23			1	21			2	4, 13			2	12, 30		
October	2	6, 18			2	2, 10			4	1, 5, 16, 17			6	3, 4, 9, 12, 13, 14		
November	6	8, 9, 10, 11, 12, 13, 21, 22			..	..			..	..			..	..		
December	2	8, 9			..	..			..	..			..	..		

Bottom width of channel at head 200 feet; side slopes 1½ to 1 river side and 1 to 1 town side; acreage 270,000.

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STATEMENT showing the Depth of Water on Bezwada Head-sluice Front Floor during the Irrigation Season.—(*Continued*).

—	Days more than 7 feet 0 inch and less than 7 feet 3 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 7 feet 3 inches and less than 7 feet 6 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 7 feet 6 inches and less than 7 feet 9 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 7 feet 9 inches and less than 8 feet 0 inch on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.
	No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
For 1872.																
July	..	..	Velocity = to 2·38 feet and discharge = to 3,529·18 cubic feet a second.	= to 470,439 cubic yards = to 1·74 cubic yards per hour per acre.	..	..	Velocity = to 2·42 feet and discharge = to 3,715·069 cubic feet a second.	= to 496,218 cubic yards = to 1·83 cubic yards per hour per acre.	..	..	Velocity = to 2·46 feet and discharge = to 3,905·27 cubic feet a second.	= to 520,572 cubic yards = to 1·92 cubic yards per hour per acre.	..	..	Velocity = to 2·5 feet and discharge = to 4,100·0 cubic feet a second.	= to 546,530 cubic yards = to 2·02 cubic yards per hour per acre.
August	..	..			..	..			..	..			..	..		
September	..	..			..	..			..	..			..	..		
October	..	..			..	..			..	..			5	24, 25, 26, 28, 29.		
November	..	..			..	..			..	..			..	..		
December	..	..			..	..			..	..			..	..		

Bottom width of channel at head 200 feet; side slope 1½ to 1 river side and 1 to 1 town side; acreage 270,000.

63

STATEMENT showing the Depth of Water on Bezwada Head-sluice Front Floor during the Irrigation Season.—(*Continued*).

—	Days more than 8 feet 0 inch and less than 8 feet 3 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 8 feet 3 inches and less than 8 feet 6 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 8 feet 6 inches and less than 8 feet 9 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 8 feet 9 inches and less than 9 feet 0 inch on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.
	No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.		
	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33
For 1872.																
July	1	2	Velocity = to 2·53 feet and discharge = to 4,282·1,009 cubic feet a second.	= to 570,804 cubic yards = to 2·11 cubic yards per hour per acre.	..	..	Velocity = to 2·57 feet and discharge = to 4,486·04 cubic feet a second.	= to 597,855 cubic yards = to 2·21 cubic yards per hour per acre.	..	..	Velocity = to 2·61 feet and discharge = to 4,692·36 cubic feet a second.	= to 625,491 cubic yards = to 2·31 cubic yards per hour per acre.	..	..	Velocity = to 2·65 feet and discharge = to 4,904·15 cubic feet a second.	= to 653,723 cubic yards = to 2·42 cubic yards per hour per acre.
August	..	..			..	..			..	..			..	..		
September	..	..			..	..			..	..			..	..		
October	5	21, 23, 27, 30, 31			2	20, 22			..	..			1	19		
November	2	1, 2			3	3, 4, 5			6	6, 7, 26, 27, 28, 29			4	8, 9, 25, 30		
December	..	..			..	..			..	..			1	1		

Bottom width of channel at head 200 feet; side slopes 1½ to 1 river side and 1 to 1 town side; acreage 270,000.

64

STATEMENT showing the Depth of Water on Bezwada Head-sluice Front Floor during the Irrigation Season.—(*Continued*).

—	Days more than 9 feet 0 inch and less than 9 feet 3 inch on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour	Days more than 9 feet 3 inches and less than 9 feet 6 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour	Days more than 9 feet 6 inches and less than 9 feet 9 inches on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.	Days more than 9 feet 9 inches and less than 10 feet 0 inch on floor.		Velocity and discharge in Main Canal with this depth in cubic feet per second.	Available discharge in cubic yards per hour per acre.
	No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.			No.	From what date to what date.		
	34	35	36	38	38	39	40	41	42	43	44	45	46	47	48	49
For 1872.																
July	..	..	Velocity = to 2·69 feet and discharge = to 5,120·32 cubic feet a second.	= to 682,538 cubic yards = to 2·52 cubic yards per hour per acre.	..	..	Velocity = to 2·73 feet and discharge = to 5,388·24 cubic feet a second.	= to 711,588 cubic yards = to 2·63 cubic yards per hour per acre.	..	..	Velocity = to 2·77 feet and discharge = to 5,565·9756 cubic feet a second.	= to 741·944 cubic yards = to 2·74 cubic yards per hour per acre.	2	11, 12	Velocity = to 2·81 feet and discharge = to 5,795·625 cubic feet a second.	= to 772,556 cubic yards = to 2·86 cubic yards per hour per acre.
August	..	..			..	..			..	..			3	12, 21, 22		
September	..	..			..	..			..	..			..	..		
October	1	18			..	..			1	17			1	16		
November	3	10, 23, 24			4	11, 12, 21, 22			5	13, 14, 15, 19, 20			1	18		
December	3	29, 30, 31			6	9, 10, 11, 26, 27, 28			3	7, 8, 25			4	2, 5, 6, 24		

Bottom width of channel at head 200 feet; side slopes 1½ to 1 river side and 1 to 1 town side; acreage 270,000.

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(Signed) D. McNEIL CAMPBELL, Lieut., R.E.,
Executive Engineer, 7th Range.

(Signed) J. O. HASTED, Major, R.E.,
Superintending Engineer, 1st Division.

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DEPTH required on Anicut to give Full Discharge in Channel = 4·06. Number of Days on which water was less than this is shown in the following Table :—

—	1865.		1866.		1867.		1868.	
	Number of Days.	Dates.	Number of Days.	Dates.	Number of Days.	Dates.	Number of Days.	Dates.
July	1	7	12	6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17.	16	4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19.	6	16, 17, 18, 19, 20, 21.
					..	....	3	29, 30, 31.
August	2	8, 9	..	....	17	7, 8, 10, 11, 12, 13, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30.	12	19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30.
September	8	15, 16, 17, 19, 27, 28, 29, 30.	17	2, 3, 4, 5, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 27, 28, 30.				
October	31	Whole month	8	1, 2, 3, 17, 18, 19, 20, 21.	13	1, 2, 3, 5, 6, 7, 8, 9, 10, 17, 18, 19, 31.	14	10, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 31.
November	23	1, 2, 3, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30.	28	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 30.	26	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 30.	27	1, 2, 3, 4, 5, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30.
December	31	Whole month	31	Whole month	20	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 24, 25, 26, 27, 28, 29, 30, 31.	8	1, 2, 3, 4, 5, 6, 7, 8.
Days below required height ..	96		96		92		70	

DEPTH required on Anicut to give Full Discharge in Channel = 4·06. Number of Days on which Water was less than this is shown in the following Table :—

—	1869.		1870.		1871.		1872.	
	Number of Days.	Dates.	Number of Days.	Dates.	Number of Days.	Dates.	Number of Days.	Dates.
July	16	2, 3, 4, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20.	14	3, 4, 5, 6, 7, 8, 9, 10, 11, 16, 17, 19, 20, 21.	10	8, 9, 10, 11, 12, 13, 14, 15, 16, 17.	1	2.
					4	28, 29, 30, 31	..	*Nil.*
August	1	26	..	....	17	1, 2, 3, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28.	..	*Nil.*
September	7	13, 14, 15, 16, 17, 18, 19 ..	12	4, 5, 6, 7, 8, 11, 12, 13, 14, 15, 16, 17.				
October	19	13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31.	..	....	16	6, 7, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31.	14	18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31.
November	12	12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 30.	23	5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27.	30	Whole month	18	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 23, 24, 25, 26, 27, 28, 29, 30.
December	4	1, 2, 3, 4	7	25, 26, 27, 28, 29, 30, 31 ..	20	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20.	4	1, 29, 30, 31.
Days below the required height ..	59		56		97		37	

(Signed) D. McNEIL CAMPBELL, Lieut., R.E.,
Executive Engineer, 7th Range.

(Signed) J. O. HASTED, Major, R.E.,
Superintending Engineer, 1st Division.

APPENDIX C.

SHOWING the Area of the Five Divisions of the Eastern Delta in Square Miles and the Acreage proposed in each.

Description of Land.	First Division, East Bank Channel.		Second Division, Ellore Canal.		Third Division, Ryves' Channel and Pulleru.		Fourth Division, Pulleru.		Fifth Division, Pulleru.		Total Eastern Delta.	
	Government.	Zemindari.	Government.	Zemindari.	Government.	Zemindari.	Government.	Zemindari.	Government.	Zemindari.	Government.	Zemindari.
Total area of the delta within bounds of the divisions	210	220	40	100	192	109	201	...	104	143	747	572
Deductions.												
Lands beyond reach of Kistna water...	...	35	...	...	16	8	...	...	...	...	16	43
Swamp lands subject to sea inundations.	50	...	...	...	...	...	..	...	25	25	75	25
	50	35	...	...	16	8	...	...	25	25	91	68
Net Square Miles ...	160	185	40	100	176	101	201	...	79	118	656	504
Proposed Acreage ...	55,000	33,000	14,000	17,000	57,000	12,000	46,000	...	18,000	18,000	1,90,000	80,000
Per Square Mile ...	343·75	178·36	350·0	170·0	323·86	118·81	228·8	...	227·85	152·54	289·63	158·73
Average per Square Mile in each Division ...	255·0		221·43		249·09		228·85		182·74		232·76	

(Signed) J. O. HASTED, Major, R.E.,
Superintending Engineer, 1st Division.

(Signed) D. McNEIL CAMPBELL, Lieut., R.E.,
Executive Engineer, 4th Grade.

APPENDIX D.

STATEMENT showing the Area available for Irrigation in Acres under the Kistna Canals in the Eastern Delta as per accounts received from the Collectors of Kistna and Godavery Districts.

No.	Names of Taluqs.	Area of Zemindari Lands.	Area of Government Lands.	Area of Inam Lands.	Total Area.	Deduct.					Total.
						Area reserved for Public Purposes, Village Tanks.	Area not fit for Cultivation.	Wet Land under Anicut.			
								Government Lands.	Inam Lands.	Zemindari Lands.	
1	2	3	4	5	6	7	8	9	10	11	12
	Eastern Delta.	A. C.	A. C.	A. C.	A. C.	A. C.	A. C.	A. C.	A. C.	A. C.	R. S.
1	Bezwada Taluq for Fasli 1283. { Government .. / Zemindari .. }	16,113 56	18,772 20	7,097 73	41,983 49	1,340 2	6,639 91	4,552 49	937 7	863 47	14,332 96
2	Gudivada Taluq for Fasli 1282. { Government .. / Zemindari .. }	6,413 0	216,135 0	55,639 0	278,187 0	55,192 0	8,243 0	60,837 0	22,484 0	3,303 0	150,059 0
3	Bandar Taluq for Fasli not given. { Government .. / Zemindari .. }	130,788 0	226,242 0	27,811 0	384,841 0	126,398 0	128,300 0	5,861 0	7,186 0	18,101 0	285,846 0
	Total, Kistna District ..	153,314 56	461,149 20	90,547 73	705,011 49	182,930 2	143,182 91	71,250 49	30,607 7	22,267 47	450,237 96
4	Ellore Taluq for Fasli 1282 .. { Government .. / Zemindari .. }	14,408 62	35,474 2	5,647 80	55,530 44	11,033 38	8,432 17	9,930 6	1,442 37	2,225 57	33,063 55
	Total, Godavery District ..	14,408 62	35,474 2	5,647 80	55,530 44	11,033 38	8,432 17	9,930 6	1,442 37	2,225 57	33,063 55
5	Nuzvid Zemindari in Kistna District	..	..	..	..	..	..	..	..	..	..
	Total, Eastern Delta of Kistna ..	..	..	..	..	..	..	..	..	..	..

STATEMENT showing the Area available for Irrigation in Acres under the Kistna Canals in the Eastern Delta, &c.—(*Continued*).

No.	Names of Taluqs.	Remainder available. — Government Land. Waste Land fit for Wet Cultivation.	Dry Land.	Average Revenue for the last 5 Years.	Wet Land not under Anicut.	Average Revenue for last 5 Years.	Zemindari Land. Waste Land fit for Wet Cultivation.	Dry Land.	Average Revenue for last 5 Years.	Garden Land.
		13	14	15	16	17	18	19	20	21
	Eastern Delta.	A. C.	A. C.	RS. A. P.	A. C.	RS. A. P.	A. C.	A. C.	RS. A. P.	A. C.
1	Bezwada Taluq for Fasli 1283 .. Government .. Zemindari ..	1,730 31	10,225 14	16,643 15 3	..	..	868 08	8,224 59	20,684 14 3	401 75
2	Gudivada Taluq for Fasli 1282 .. Government .. Zemindari ..	46,376 0	50,075 0	59,627 0 0	..	..	210 0	2,166 0	3,145 0 0	..
3	Bandar Taluq for Fasli not given.. Government .. Zemindari ..	30,639 0	21,682 0	29,916 0 0	16,915 0	43,445 0 0	377 0	10,206 0	16,831 0 0	..
	Total, Kistna District ..	78,745 31	81,982 14	1,06,186 15 3	16,915 0	43,445 0 0	1,455 08	20,596 59	40,660 14 3	401 75
4	Ellore Taluq for Fasli 1282 .. Government .. Zemindari ..	1,685 0	11,632 40	5,948 13 6	2 0	5 0 0	3,920 79	2,838 37	541 10 4	..
	Total, Godavery District ..	1,685 0	11,632 40	5,948 13 6	2 0	5 0 0	3,920 79	2,838 37	541 10 4	..
5	Nuzvid Zemindari in Kistna District	..	..	..	..	..	..	..	..	..
	Total, Eastern Delta of Kistna ..	..	..	..	..	..	..	..	..	..

1. Present wet is made up of figures in Columns 9, 10, and 11 equal to 137,723·03.
2. Total area from Columns 4, 5, and 6 equal to 760,541·93.
3. Expected increase is made up from Columns 13, 14, 16, 25, 26, 28, 18, 19, 21, and 23 equal to 277,240·42.

STATEMENT showing the Area available for Irrigation in Acres under the Kistna Canals in the Eastern Delta, &c.—(*Continued*).

No.	Names of Taluqs.	Remainder available—(*Continued*). — Zemindari Land—(*Continued*). Average Revenue for last 5 Years.	Wet Land not under Anicut.	Average Revenue for last 5 Years.	Inam Land. Waste Land fit for Wet Cultivation.	Dry Land.	Average Amount of Quit-rent paid for last 5 Years.	Wet Land not under Anicut.	Average Amount of Quit-rent paid for last 5 Years.	Total Average Revenue for last 5 Years.
		22	23	24	25	26	27	28	29	30
	Eastern Delta.	RS. A. P.	A. C.	RS. A. P.	A. C.	A. C.	RS. A. P.	A. C.	RS. A. P.	RS. A. P.
1	Bezwada Taluq for Fasli 1283 .. Government .. Zemindari ..	3,956 1 4	40 0	256 1 3	536 63	5,624 03	1,813 5 9	..	..	43,354 5 10
2	Gudivada Taluq for Fasli 1282 .. Government .. Zemindari ..	..	..	..	..	29,301 0	3,693 0 0	..	..	66,465 0 0
3	Bandar Taluq for Fasli not given.. Government .. Zemindari ..	..	14,095 0	18,355 0 0	893 0	1,430 0	451 0 0	2,758 0	652 0 0	1,09,650 0 0
	Total, Kistna District ..	3,956 1 4	14,135 0	18,611 1 3	1,429 63	36,355 03	5,957 5 9	2,758 0	652 0 0	2,19,469 5 10
4	Ellore Taluq for Fasli 1282 .. Government .. Zemindari ..	..	..	..	1,381 93	992 26	61 4 9	14 14	4 8 0	6,561 4 7
	Total, Godavery District ..	..	..	..	1,381 93	992 26	61 4 9	14 14	4 8 0	6,561 4 7
5	Nuzvid Zemindari in Kistna District	..	..	..	..	..	..	..	..	..
	Total, Eastern Delta of Kistna ..	..	..	..	..	..	..	..	..	..

The above statements (totals of which only is given above) were received from the Collectors of Godavery and Kistna with their letters, Nos. 216 and 875, dated 18th October 1873 and 22nd May 1874, respectively.

(Signed) D. McNEIL CAMPBELL, Lieut., R.E.,
Executive Engineer, 7th Range.

(Signed) J. O. HASTED, Major, R.E.,
Superintending Engineer, 1st Division.

TABLE showing the Velocity and Discharge, &c., of all the Principal Channels in the Eastern Delta of Kistna. Formula used $D = A \cdot 916 \times \sqrt{2f} \times \frac{A}{B}$.

Number of Division.	Number of Main Duct.	Number of Branches.	Names of Channels.	Distance from head of Branch Duct.	Bottom width in feet.	Side slopes.	Surface fall of Channel in feet per mile.	Depth of water in feet.	Area of Cross Section in feet.	Hydraulic mean depth.	Surface velocity in feet.	Mean velocity in feet.	Bottom velocity in feet.	Discharge required in cubic feet per second.	Actual discharge in cubic feet per second.	Discharge in cubic yards per hour.	Area under command of Anicut square miles.	Proposed Acreage.	Proposed Acreage per square mile.	Length in miles.	Estimate Amount Rs.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
			Masulipatam or Bundar Main canal at Bezwada.	0 0 900	200	2 to 1	0·5	8·25	1,692·53	7·68	3·137	2·53	1·923	4,050·0	4,268·16	568,945·72	1,295·0	270,000	208·49	900 yds.	
			Do. below Ryves' channel	0 0 900	90	do.	0·5	8·00	848·00	6·74	2·96	2·37	1·78	2,008·11	2,009·76	267,901·00	..	127,500	..		
			Do. to East Bank channel	4 0 0	118	do.	0·5	6·789	893·28	6·02	2·80	2·24	1·68	2,008·11	2,000·94	266,725·3	..	127,500	..		
			Do. below to Kunkipad lock ..	13 0 0	66	do.	0·253	6·0	468·00	5·04	1·82	1·456	1·09	681·408	681·408	90,830·62	..	39,500	..	49·0	First-class navigation line.
			Do. below do. to Veerunky lock ..	24 0 0	25	do.	..	5·0		nel below here is entirely for navigation.					..	..	..	..	..		
			Do. below do. to Neduvole do. ..	37 0 0	25	do.	..	5·0	Chan												
			Do. below do. to Akumarru do. ..	43 0 0	25	do.	..	5·0		6·34	1·15	0·92	0·69	465·00	559·36	74,562·68	140	31,000	221·42		
			Do. below do. to Tidal do. ..	49 1 66	25	do.	..	5·0		5·12	1·35	1·08	0·81	456·00	455·70	60,744·81	..	..	..		
			Ellore Canal Main duct at head ..	0 0 900	60	do.	0·08	8·0	608·0	5·49	1·34	1·07	0·80	453·00	441·80	58,891·94	132·06	30,200	228·60		
			Do. below to Kesarapally branch ..	..	54	do.	0·14	6·33	421·95	5·03	1·275	1·02	0·765	437·25	419·40	55,906·02	121·40	29,150	240·11		
			Do. to Buthumallipad branch 10½ to 15 miles.	..	54	do.	0·125	6·216	412·90	5·02	1·225	0·98	0·735	412·50	401·97	53,582·6	104·66	27,500	262·75		
			Do. to Ponukumad branch 15 to 17½ miles.	..	54	do.	0·125	6·194	411·2	5·01	1·178	0·943	0·708	400·95	386·687	51,545·37	96·97	26,730	275·65	40·0	First-class line of navigation.
			Do. to Cherwada branch 17½ to 20 miles.	..	54	do.	0·115	6·181	401·18	5·03	1·18	0·945	0·71	373·95	388·70	51,812·71	79·02	24,930	315·48		
			Do. to Puttagunta branch 20 to 21½ miles.	..	54	do.	0·1075	6·166	409·00	5·06	1·098	0·879	0·66	361·95	364·69	48,613·17	70·93	24,130	340·20		
			Do. to Kakulapad branch 21½ to 26 miles.	..	54	do.	0·106	6·196	411·36	5·087	1·032	0·826	0·62	201·45	344·60	45,935·18	38·47	13,430	349·10		
			Do. to Gogunta branch 26 to 27¼ miles.	..	54	do.	0·0925	6·241	414·9	5·29	0·34	0·272	0·204	120·00	120·199	16,022·52	24·43	8,000	327·46		
			Do. to Mupparru branch 27¼ to 36½ miles.	..	54	do.	0·08	6·27	417·2	5·33	0·19	0·152	0·114	67·5	67·84	9,043·07	13·31	4,500	338·09		
			Do. to Madepalli branch 36½ to 37 miles.	..	54	do.	0·084	6·58	441·91	..	..	..	..	1,654·008	1,700·53	226,680·64	..	111,500	..		
			Do. to terminus 37 to 40 miles ..	..	50	do.	0·0026	6·634	446·25											22·5	
			Ryves' channel from head to junction with old channel.	0 0 900	90	do.	0·58	Varying from 8 to 6·42	Varying.	5·63	2·94	2·34	1·76	1,654·008	1,700·53	220,464·87	..	111,500	..		
			Do. from do. to Komatigunta..	..	100	do.	0·58	6·42	724·4	5·22	2·81	2·25	1·69	1,140·00	1,147·50	152,916·75	..	76,500	..		
			Below do. to drop in 18½ miles	..	76	do.	0·58	6·00	510·00	5·22	2·81	2·25	1·69	1,140·0	1,147·50	152,916·75	..	76,500	..		
			Do. do. to Marrivada	..	76	do.	0·58	6·00	510·0												
			Falls into Pulleru below Marrivada ..	..				4·0	164·0	3·22	2·82	2·26	1·70	360·0	371·05	49,460·9	96·04	24,000	..	..	
			Gudivada branch duct from head to Mukapad branch to 5th mile drop.	13 5 0	35·0	1½ to 1	0·92	3·5	123·37	2·87	2·73	2·19	1·65	..	270·18	36,014·99	..	..	..	..	
			Do. to 7th mile do. in new line ..	..	30·0	do.	1·00	3·0	139·5	2·64	1·85	1·48	1·11	..	206·46	27,521·18	..	..	..	..	
			Do. below do. do.	..	42·0	do.	0·5	3·0	73·5	2·38	1·76	1·41	1·06	..	103·63	13,813·88	..	..	..	..	
			Do. to end by Moparru channel ..	..	20·0	do.	0·5	3·0	34·5												
			Do. to 1·5' drop in 12th mile	..	7·0	do.	0·6	6·5	617·5	1·93	1·57	1·26	0·95	..	43·47	5,794·55	..	..	..	..	
			Do. 1' 0" drop in 16th mile	..			0·5			5·56	2·69	2·15	1·61	1,320·00	1,327·60	176,971·74	345	88,000	223·00		
			East bank channel itself to head west side channel.	11 0 360	82	2 to 1		6·5	435·5	5·24	2·61	2·09	1·57	900·0	910·19	121,358·8	248	60,000	241·85		
			Do. to Kudera branch	19 2 460	54	do.	0·5	6·5	429·0	5·23	2·61	2·09	1·57	894·0	896·61	11,9548	..	59,600	..		
			Do. to Lankapalli branch	..	53	do.	0·5	6·5	429·0	5·23	2·61	2·09	1·57	886·5	896·61	11,9548	..	59,100	..		
			Do. to Srikakolum do.	23 7 460	53	do.	0·5	6·5	422·5	5·21	2·60	2·08	1·56	874·5	878·80	117,173·33	..	58,300	..		
			Do. to Chittur do.	..	52	do.	0·5	6·5	422·5	5·21	2·60	2·08	1·56	864·0	878·80	117,173·33	..	57,600	..		
			Do. to Vakkalagadda branch ..	28 4 460	52	do.	0·5	6·5	416·0	5·20	2·60	2·08	1·56	855·0	865·28	115,370·88	..	57,000	..		
			Do. to Pagole do.	..	51	do.	0·5	6·5	416·0	5·20	2·60	2·08	1·56	849·0	865·28	115,370·88	..	56,600	..		
			Do. to Pedaprole do.	33 2 460	51	do.	0·5	6·5	409·5	5·18	2·60	2·08	1·56	835·5	851·76	113,539·0	..	55,900	..	52 1 350	Second-class line of navigation.
			Do. to Kistna Branch, north bank channel.	34 0 460	50	do.	0·5	6·5	338·0	4·97	2·55	2·04	1·53	675·0	689·52	919,13·016	..	45,000	..		
			Do. to Puligadda aqueduct and thence to dividing sluices, Avanigadda.	37 5 490	39	do.	0·5	6·5	175·5	4·08	2·31	1·85	1·39	315·00	324·67	43,289·33	..	21,000	..		
			Do. to Bandalayacheruvu branch ..	39 7 350	14	do.	0·5	6·5	162·5	4·04	2·26	1·81	1·36	285·00	294·12	39,216·0	..	19,000	..		
			Do. to Vakanur branch	40 7 350	12	do.	0·5	4·0	140·0	3·12	2·01	1·61	1·21	225·00	225·4	30,053·33	..	15,000	..		
			Do. to Chowdavaram branch ..	43 3 350	27	do.	0·5	4·0	108·0	2·92	1·95	1·56	1·17	165·00	168·48	22,464·00	..	11,000	..		
			Do. to Talagadadtvi do.	46 5 350	19	do.	0·5	4·0	64·0	2·47	1·80	1·44	1·08	90·00	92·16	12,288·0	..	6,000	..		
			Do. to Yetimoga do.	48 4 350	8	do.	0·5	4·0	48·0	2·19	1·69	1·35	1·01	60·00	64·80	8,640·0	..	4,000	..		
			Do. to end	52 1 350	4	do.	0·5	4·0	228·0	4·31	2·34	1·89	1·44	420·00	430·92	57,456·0	96·92	28,000	288·9		
			West side channel to Bunder canal ..	1 2 0	26·0	do.	0·50	6·0	174·0	4·18	3·02	2·42	1·82	420·00	416·24	56,165·33	96·92	28,000	288·9		
			Do. to Volloor branch	2 3 220	20·0	do.	0·83	6·0	174·0	4·18	3·02	2·42	1·82	402·00	416·24	56,165·33	..	26,800	..		
			Do. to Aminpuram drop	..	20·0	do.	0·83	5·5	182·87	4·08	2·49	1·99	1·49	342·00	363·91	48,521·33	..	22,800	..		
			Do. to Bheemanaddy, East side channel.	9 2 250	25·0	do.	0·585	5·5	182·87												
			Do. to regulating bridge	..	25·0	do.	0·585	5·5	182·87	4·08	2·49	1·99	1·49	222·00	363·91	48,521·33	..	14,800	..		
			Do. to Pedasanagalla branch ..	11 3 200	25·0	do.				4·08	2·49	1·99	1·49	222·00	363·91	48,521·33	..	14,800	..		

TABLE showing the Velocity and Discharge, &c., of all the

Number of Division.	Number of Main Duct.	Number of Branches.	Names of Channels.	Distance from head of Branch Duct.	Bottom width in feet.	Side slopes.	Surface fall of Channel in feet per mile.	Depth of water in feet.	Area of Cross Section in feet.
1	2	3	4	5	6	7	8	9	10
			East-side channel to Wurutoor branch.	13 3 200	25·0	2 to 1	0·585	5·0	162·5
			Do. to Pamarru bridge	..	25·0	do.	0·585	5·0	162·5
			Do. to Chinnamuthevi branch ..	15 6 200	18·0	do.	0·585	5·0	127·5
			Do. to Nebhanpudi do. ..	16 7 200	18·0	do.	0·585	5·0	127·5
			Do. to Nedumole lock	..	18·0	do.	0·585	5·0	127·5
			Do. to Rarameapetta branch ..	22 6 200	15·0	do.	0·585	3·0	58·5
			Do. to Polavaram do. ..	24 5 200	15·0	do.	0·585	3·0	58·5
			Do. to Akmarru lock	..	9·0	do.	0·585	3·0	40·5
			Do. to Akmarru branch	27 7 230	4·5	do.	0·66	3·0	31·5
			Do. to Rudravaram do. ..	28 6 230	3·0	do.	0·66	3·0	27·0
			Do. to Gundupallem branch ..	29 6 230	3·0	do.	0·66	3·0	27·0
			Do. to end	30 7 230	3·0	do.	0·66	3·0	27·0
			Pulleru Main duct to Weyoor drop weir.	..	60·0	1½ to 1	0·58	4·0	272·0
			Below do.	..	50·0	do.	0·27	4·0	varying
			At Marrivada	..	50·0	do.	0·27	..	do ..
			Pulleru below junction of Ryves' channel.	12 7 0	105	do.	0·58	6·0	702·0
			Pulleru to Pamarru drop weir ..	..	105	do.	0·42	6·0	684·0
			Do. to head of East side channel ..	19 1 0	90·0	do.	0·33	7·0	700·0
			Do. to head of Butlerkodu	20 0 0	82	2 to 1	0·33	7·0	672·0
			Do. to Palakodu	20 4 0	70	1½ to 1	0·33	7·0	560·0
			Do. to Chittram channel	24 3 0	68	do.	0·29	7·0	549·5
			Do. to Cowtram lock	25 2 0	64	do.	0·29	7·0	521·5
			East side channel of Bander canal from head to Nedumole lock.	26 6 0	16	do.	0·5	4·0	88·0
			Do. to Buddalapalem branch ..	5 2 0	20 to 12	do.	0·33	4·0	104·0
			Do. below do. to Nandamur branch.	17 2 70	12 to 6	do.	0·33	3·0	49·5
			Do. below do. to end	19 6 70	6 to 3	do.	0·33	2·5	24·37
			Polrazkodu and its continuation from head to Chegarkota branch.	23 0 70	5½	do.	0·33	5·0	217·5
			Do. to head of Kykalur channel ..	..	36·0	do.	0·33	5·0	187·5
			Do. to Ramavaram branch	14 0	30·0	do.	0·33	5·0	162·5
			Do. to end or Tadivada lock ..	..	18½	do.	0·33	5·0	162·5
			Chevurkodu to 3rd mile	..	26⅓	do.	0·08	4·0	184·0
			Do. to Rudravaram branch	..	25·0	do.	0·25	3·0	199·5
			Do. to Kaldindi branch	..	3	do.	0·25	3·0	157·5
			Below do.	..	40·0	do.	0·25	3·0	130·5
			Chevurkodu to Kondangi branch ..	..	18½	do.	0·25	3·0	109·5
			Do. to Mattagunta do. ..	..	48	do.	0·25	3·0	82·5
			Below do. to end	..	25	do.	0·25	3·0	29·37
			Buntumally canal throughout ..	..	28½	do.	0·25	3·0	175·0
				..	23·0	do.	0·25	5·0	
				..	8 to 3	do.	0·25		
				..	25·0	2 to 1	0·08		

MASULIPATAM,
September 1874.

Principal Channels in the Eastern Delta of Kistna, &c.—(*Continued*).

Hydraulic mean depth.	Surface velocity in feet.	Mean velocity in feet.	Bottom velocity in feet.	Discharge required in cubic feet per second.	Actual discharge in cubic feet per second.	Discharge in cubic yards per hour.	Area under command of Anicut square miles.	Proposed Acreage.	Proposed Acreage per square mile.	Length in miles.	Estimate. Amount Rs.
11	12	13	14	15	16	17	18	19	20	21	22
3·78	2·40	1·92	1·44	209·25	312·00	41600·0	..	13,950	..		
3·78	2·40	1·92	1·44	194·25	312·00	41,600·0	..	12,950	..		
3·56	2·32	1·86	1·40	173·25	237·15	31,620·0	..	11,550	..		
3·54	2·32	1·86	1·40	147·00	237·15	31,620·0	..	9,800	..		
3·54	2·32	1·86	1·40	129·00	237·15	31,620·0	..	8,600	..		
2·26	1·86	1·49	1·12	91·5	87·16	11,621·33	..	6,100	..	30 7 230	
2·26	1·86	1·49	1·12	69·00	87·16	11,621·33	..	4,600	..		
2·04	1·76	1·41	1·06	45·00	57·10	7,630·33	..	3,000	..		
1·76	1·75	1·40	1·05	45·00	44·10	5,880·0	..	3,000	..		
1·64	1·70	1·36	1·02	31·50	36·72	4,896·0	..	2,100	..		
1·64	1·70	1·36	1·02	16·50	36·72	4,896·0	..	1,100	..		
1·64	1·70	1·36	1·02	3·00	36·72	4,896·0	..	200	..		
3·49	2·3	1·84	1·38	510·0	500·0	66,650·0	26·0	33,500	192·30	..	
..	..	..	..	480·0	..	..	..	30,000	..	..	
..	..	..	..	457·5	..	..	..	..	..	..	
5·32	2·85	2·28	1·71	1597·5	1600·56	213,364·64	487·11	106,500	218·63	..	Ryves' channel joins here.
5·4	2·43	1·95	1·47	1320·0	1333·80	177,795·54	416·84	88,000	211·11	..	
6·07	2·28	1·83	1·38	1237·5	1281·0	170,757·3	401·24	82,500	205·61		
5·93	2·25	1·8	1·35	1102·5	1209·6	161,239·68	347·9	73,500	211·26	26 6 0	Navigable.
5·91	2·11	1·69	1·27	952·0	952·3	126,941·59	312·11	63,500	204·59		
5·89	2·10	1·68	1·26	907·0	923·0	123,035·90	296·34	60,500	..		
5·84	2·10	1·68	1·26	869·5	876·10	116,784·13	239·50	49,000	..		
2·89	1·93	1·55	1·17	135·0	136·4	18,182·12	53·34	9,000	168·74		
3·02	1·62	1·297	0·9758	49·5	134·98	17,992·83	25·12	3,300	131·36	23 0 0	
2·17	2·11	1·69	1·27	34·5	53·95	7,191·53	21·97	2,300	104·68		
1·62	1·175	0·94	0·705	12·0	22·097	2,945·53	14·94	800	53·54		
4·02	1·86	1·49	1·12	300·0	324·07	44,319·85	74·0	20,000	270·27		
3·9	1·28	1·03	0·78	195·0	193·12	25,742·0	..	13,000	..	26½	Second-class navigation line.
3·78	1·27	1·016	0·762	90·0	165·1	22,007·83	..	6,000	..		
3·78	0·62	0·5	0·38	30·0	81·85	10,830·6	..	2,000	..		
3·38	1·49	1·19	0·89	210·0	218·96	29,187·36	67	14,000	..		
2·74	1·33	1·07	0·81	213·0	213·46	28,454·21	..	..	..		
2·68	1·31	1·05	0·79	165·0	165·37	22,043·82	..	11,000	..		
2·62	1·30	1·04	0·78	135·0	135·70	18,088·81	..	9,000	..	30¾	
2·55	1·28	1·03	0·78	112·5	112·78	15,033·57	..	7,500	..		
2·44	1·25	1·0	0·75	84·5	82·5	10,997·25	..	3,500	..		
1·72	1·05	0·84	0·63	25·0	24·67	3,288·31	..	1,100	..		
3·69	0·87	0·696	0·522	45·0	122·49	16,327·92	38·5	3,000	77·92	24·6	Second-class navigation line.

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APPENDIX

Table showing the Area to be drained by, and the Velocity and Discharge, &c., of all the Principal and for Channels

Number of Drains.	——	Junctions into Main Drains.	Area to be drained. Left.	Right.	Total Square Miles.	Rainfall.	Required Discharge per Second.	Bedfall per Mile.
		M. F. FT.						
1	Budemeru Main drain at the crossing of Ellore canal.	..	..	..	..	..	..	..
2	Chendrayakodu at Ryves' channel tunnel.	..	Area above Ryves' channel.		9·0	1·65	399·3	0·58
	Do. at the crossing of Gudivada branch.	11 0 0	..	34·0	43·0	0·98	1,133·9	0·58
	Do. to 16th mile	16 0 0	6·14	5·43	54·57	0·90	1,320·59	0·58
	Do. to Lingavaram branch ..	19 3 0	0·40	0·34	55·31	0·90	1,338·50	0·75
	Do. at Kolleru	23 0 0	..	21·18	76·5	0·81	1,666·17	0·75
3	Polrazkodu at head	..	..	..	1·0	3·44	92·49	0·5
	Do. at Chittram channel ..	4 6 0	5·0	..	6·0	1·89	304·92	0·5
	Do. at Komaravole drain ..	8 0 0	61·0	..	67·0	0·84	1,513·30	0·5
	Do. at Motur branch	12 7 220	11·0	..	78·0	0·80	1,677·86	0·5
	Do. at Kolleru	16 0 440	..	13·00	91·0	0·76	1,859·63	0·5
	Pullava Main Drain.							
4	Pullava Main drain at end	11 1½ 0	..	0·70	18·36	1·30	641·78	0·17
	Do. at junction of Annava affluent.	10 2 0	..	4·55	17·66	1·32	626·81	0·17
	Do. above do.	..	1·68	..	13·11	1·45	511·14	0·17
	Do. above do. with junction of Vedurava affluent.	8 7 0	..	2·64	11·43	1·52	467·15	0·17
	Do. above do. to Atapaka ..	3 4 0	3·31	..	8·79	1·66	392·34	0·17
	Do. above do. to head ..	..	..	3·48	5·48	1·95	287·33	0·17
	Peddakommeleru Main Drain.		2·	..	2·00	2·72	146·27	0·17
5	Peddakommeleru Main drain at end ..	15 3½ 0	..	..	41·25	1·0	1,108·5	0·17
	Do. at junction of Chinnakommeleru affluent.	8 4 0	5·49	3·92	31·84	1·08	924·96	0·17
	Do. above Chinnakommeleru at head.	..	14·62	..	17·22	1·33	615·82	0·17
	Peddalanka Main Drain.							
6	Peddalanka Main drain at head ..	10 0 0	..	..	107·31	0·727	2,097·72	0·17
	Do. at junction of Amudalapally affluent.	6 2 0	..	7·5	99·81	0·744	1,996·73	0·17
	Do. above Amudalapally to Pedda Timmidi affluent.	5 3 0	12·13	..	87·68	0·779	1,836·58	0·17
	Do. to Mattagunta affluent ..	..	15·11	..	72·57	0·837	1,613·54	0·17
	From do. to Kondangi affluent.	2 3 0	..	9·24	53·33	0·848	1,444·03	0·17
	Above Mattagunta to Utukur affluent.	0 7 0	..	16·08	47·25	0·938	1,171·72	0·17
	Do. Utukur to Singaraipalem affluent.	..	18·77	..	28·48	1·17	895·98	0·17
7	Vadlamanad affluent at Dokiparru or head.	..	10·90 Area above Dokiparru.		{ 8·75 9·65	1·58 1·05	409·97 1,002·18	0·62 0·62
	Do. at junction with Lazabunda..	8 0 0	26·75	..	35·5	2·0	276·95	0·5
8	Lazabunda Main drain at Gudur ..	..	5·15	..	5·15	1·4	570·31	0·5
	Do. at junction of Mamellakodu.	3 3 0	10·0	..	15·15	1·2	758·26	0·5
	Do. at Cowtram road ..	6 0 0	8·35	..	23·50	0·89	1,411·94	0·5
	Do. at Vadlamanad affluent ..	7 6 0	35·5	..	59·00	0·82	1,629·41	0·5
	Do. of Isukaparra do. ..	10 7 0	14·9	..	73·90	0·78	1,793·72	0·5
	Do. at Munjulur bridge ..	11 5 0	11·6	..	85·50	0·76	1,871·65	0·5
	Do. at junction of Kansadamkodu.	13 3 0	6·06	..	91·56	0·73	2,093·22	0·5
	Do. at Arthamur branch	14 5 0	15·08	..	106·64	0·69	2,356·27	0·75
	Do. at Gokavaram affluent ..	17 0 0	..	20·36	127·00	1·43	540·62	0·75
9	Gokavaram affluent near Gokavaram.	..	14·06	..	14·06	1·26	689·8	0·7
	Do. at junction with Lazabanda drain.	8 6 0	6·3	..	20·36		430·0	0·10
				Surplus from Bunder canal.			685·36	
10	Escape channel to Agakodu ..	..	..	..	20·069	1·27	1,115·36	0·9

F.

Drains in the Eastern Delta of Kistna. Formula used $D = 450\sqrt[3]{M^2}$ (for Rainfall inches)

$V = \cdot 916 \times \sqrt{2f \times \frac{A}{B}}$

Surfacefall per Mile.	Depth of Water.	Bottom Width.	Area of Cross Section.	Hydraulic Mean Depth.	Surface Velocity.	Mean Velocity.	Bottom Velocity.	Actual Discharge per Second.	Remarks.
..	..	..	..	..	..	..	..	..	Nothing proposed for this, with the exception of embanking on Gudivada side below Mopara village.
0·58	4·0	47·0	220·0	3·39	2·26	1·81	1·36	398·20	
0·58	4·0	141·0	596·0	3·75	2·35	1·9	1·45	1,132·4	
0·58	4·0	165·0	692·0	3·78	2·38	1·91	1·44	1,321·72	
0·75	4·0	146·00	616·0	3·75	2·71	2·17	1·63	1,336·72	
0·75	4·0	183·0	740·0	3·80	2·72	2·18	1·64	1,665·52	
0·5	1·0	10·0	..	..	..	..	..	..	
0·5	4·0	38·0	184·0	3·29	2·06	1·65	1·24	303·60	
0·5	4·0	203·0	844·0	3·82	2·24	1·79	1·34	1,510·76	
0·5	4·0	226·0	936·0	3·85	2·24	1·79	1·34	1,675·44	
0·5	4·0	252·0	1,040·0	3·85	2·24	1·79	1·34	1,861·60	
0·17	5·0	104·0	570·0	4·51	1·41	1·13	0·85	644·10	
0·17	5·0	102·0	560·0	4·5	1·4	1·12	0·84	629·20	
0·17	5·0	82·0	460·0	4·4	1·39	1·11	0·83	510·60	
0·17	5·0	73·0	415·0	4·34	1·39	1·11	0·83	466·5	
0·17	5·0	62·0	360·0	4·27	1·36	1·09	0·82	392·4	
0·17	5·0	44·0	270·0	4·05	1·34	1·07	0·80	288·9	
0·17	5·0	20·0	150·0	3·38	1·225	0·98	0·735	147·0	
0·17	4·0	265·0	1,092·0	3·86	1·275	1·02	0·765	1,113·84	
0·17	4·0	222·0	920·0	3·83	1·275	1·02	0·765	938·40	
0·17	4·0	143·0	640·0	3·75	1·275	1·02	0·765	616·08	
0·165	4·0	500·0	2,032·0	3·92	1·29	1·03	0·77	2,092·96	
0·165	4·0	477·0	1,940·0	3·92	1·29	1·03	0·77	1,998·2	
0·165	4·0	438·0	1,784·0	3·91	1·29	1·03	0·77	1,839·52	
0·165	4·0	384·0	1,568·0	3·90	1·29	1·03	0·77	1,615·04	
0·165	4·0	343·0	1,404·0	3·89	1·29	1·03	0·77	1,446·12	
0·165	4·0	277·0	1,140·0	3·89	1·29	1·03	0·77	1,174·2	
0·165	4·0	210·0	872·0	3·82	1·28	1·025	0·77	893·8	
0·3009	2·34	20·0	57·75	1·89	1·75	1·4	1·05	80·85	
0·3009	5·0	119·0	660·31	4·65	1·91	1·53	1·15	1,003·67	
0·5	5·0	22·0	160·0	3·6	2·175	1·74	1·305	276·4	
0·5	5·0	52·0	310·0	4·16	2·31	1·85	1·39	573·5	
0·5	5·0	70·0	400·0	4·33	2·35	1·90	1·45	760·00	
0·5	5·0	134·0	720·0	4·60	2·45	1·96	1·47	1,411·20	
0·5	5·0	155·0	825·0	4·70	2·475	1·98	1·485	1,633·5	
0·5	5·0	172·0	910·0	4·68	2·46	1·97	1·48	1,792·7	
0·5	5·0	180·0	950·0	4·7	2·475	1·98	1·485	1,881·00	
0·5	5·0	202·0	1,060·0	4·7	2·475	1·98	1·485	2,098·0	
0·5	5·0	230·0	1,200·0	4·7	2·475	1·98	1·485	2,376·0	
0·5	5·0	76·0	430·0	4·27	1·575	1·26	0·945	541 80	
0·223	5·0	97·0	535·0	4·48	·161	1·29	0·97	690·15	
..	6·0	51·0	378·0	4·85	.375	2·98	2·21	1,126·4	

APPENDIX

Table showing the Area to be drained by, and the Velocity and Discharge, &c.,

Number of Drains.		Junctions into Main Drains			Area to be drained.			Rainfall.	Required Discharge per Second.	Bedfall per Mile.
		M.	F.	FT.	Left.	Right.	Total Square Miles.			
	Peddalanka Main Drain—Contd.									
	Escape channel to Kanikalamadugu.		..		..	..	24·543	1·2	1,221·82	..
	Kanikalamadugu to Kuderu branch..		..		..	..	32·094	1·06	937·72	..
	Do. to Lankapalli branch ..		..		..	..	38·024	1·01	1,032·54	..
	Do. to Bhumanaddy junction ..		..		..	..	59·803	..	..	..
	Do. to Srikakolum branch ..		..		..	..	72·416	..	..	..
	Do. to Chittur do. ..		..		..	..	84·244	..	..	..
	Do. to Vakkalagadda do. ..		..		..	..	90·526	..	..	..
	Do. at junction with Kottapalem road. ..		..		..	..	98·452	..	..	..
	Do. to Pagole branch		..		..	..	100·96	0·74	..	..
	Do. to Peddaprole branch ..		..		..	..	..	..	..	..
	Do. at junction of Bhogireddipalli or C. Majeru drain. ..		..		..	..	122·609	0·69	2,274·82	..
11	Dayapucalva at junction of Inampudi drain.		2	4 0	Dayapucalva and Inampudi drain, total.		219·511	0·57	3,364·35	0·5
	Do. do. land at Dayapucalva ..		3	1 0	..	..	225·177	0·56	3,390·71	..
	Do. do. Mangaleru		5	4 0	..	..	229·809	0·56	3,460·43	..
12	Do. do. Gilkaldindi		9	7 110	..	..	235·207	0·56	3,541·74	..
	Inampudi drain at tunnel		..		From above Bunder Canal.		31·0	1·1	916·9	0·5
	Do. to Wurutur branch..		..		..	3·79	34·79	1·05	982·24	..
	Do. to Agakodu do.		2	3 0	7·45	..	42·24	0·99	1,124·42	..
	Do. to Chinreamuttevi branch ..		5	0 0	..	5·368	47·608	0·95	1,216·27	0·5
	Do. to Nebanpudi branch ..		5	1 0	..	7·263	54·871	0·91	1,342·6	..
	Do. to Krosoornorth do. ..		6	4 0	5·669	..	60·54	0·88	1,432·5	..
	Do. to Nemmakur do. ..		7	7 0	..	4·639	65·179	0·85	1,489·72	..
	Do. to Mallampalli do. ..		..		6·262	..	71·441	0·83	1,594·38	..
	Do. to Ramannapetta do. ..		10	0 0	..	5·686	77·127	0·81	1,679·89	..
	Do. to Poosadam do. ..		11	3 0	..	3·453	80·58	0·80	1,733·36	..
	Do. to West Side channel ..		13	0 0	..	15·04	95·62	0·76	1,954·25	..
	Do. to Lankapalli drain.. ..		13	1 0	..	1·282	96·902	0·75	1,954·25	..
13	Taleru new cut at Massvaram branch. ..		14	2 382	..	..	2·863	2·42	186·1	0·71
	Do. at junction with old channel.) ..		..		..	..	10·183	1·59	435·23	..
	Do. at Kalidindivari branch ..		2	4 0	..	..	15·298	1·39	571·84	..
	Do. at Kodoor do. ..		5	0 0	..	..	22·813	1·22	748·27	..
	Do. at junction with Kistna ..		7	3 0	..	..	33·066	1·08	960·06	..
14	Kanakavulli drain at the village of Kanakavulli. ..		11	7 0	6·06	..	6·06	1·9	309·6	1·0
	Do. at Bheemanaddi below Veranky lock. ..		..		..	..	14·96	1·4	563·16	1·0
	Do. at Inampudi drain (under tunnel.) ..		4	0 0	8·9	..	31·00	1·1	916·9	1·0
15	Gundumotu drain new one at Bandalayscheruvu branch. ..		6	6 0	16·04	..	2·16	2·66	125·84	1·09
	Do. Vakanur do. ..		..		..	..	7·059	1·8	348·7	..
	Do. Chowdavaram do. ..		1	3 330	..	..	20·908	1·25	702·81	1·09
	Do. Talagadadivi do. ..		5	3 0	..	..	33·704	1·07	969·58	1·09
			6	4 0	..	..				

MASULIPATAM,
September 1874.

F.—(*Continued*).

of all the Principal Drains in the Eastern Delta of Kistna, &c.—(*Continued*).

Surfacefall per Mile.	Depth of Water.	Bottom Width.	Area of Cross Section.	Hydraulic Mean Depth.	Surface Velocity.	Mean Velocity.	Bottom Velocity.	Actual Discharge per Second.	Remarks.
..	..	56·0	408·0	4·92	3·76	3·01	2·26	1,228·08	
..	..	..	..	..	..	..	..	..	This part of the drain runs in a natural course of ample capacity.
..	..	..	..	..	..	..	..	..	
..	..	..	..	..	..	..	..	..	
..	..	..	..	..	..	..	..	..	
..	..	..	..	..	..	..	..	..	
..	..	..	..	..	..	..	..	..	
..	6·0	152·0	984·0	5·5	2·68	2·15	1·62	2,115·6	
..	..	165·0	1,062·0	5·53	2·68	2·15	1·62	2,283·3	
0·5	6·0	246·0	1,548·0	5·67	2·725	2·18	1·635	3374·64	
..	..	248·0	1,500·0	5·67	2·725	2·18	1·635	3,400·8	
..	..	253·0	1,560·0	5·67	2·725	2·18	1·635	3,466·2	
..	..	259·0	1,626·0	5·68	2·725	2·18	1·635	3,544·68	
..	..	63·0	450·0	5·0	2·56	2·05	1·54	922·5	
0·5	6·0	68·0	480·0	5·05	2·575	2·06	1·545	988·8	
..	..	79·0	546·0	5·15	2·587	2·07	1·553	1,130·22	
..	..	85·0	582·0	5·19	2·61	2·09	1·57	1,216·38	
0·5	6·0	95·0	642·0	5·26	2·625	2·1	1·575	1,348·2	
..	..	102·0	684·0	5·30	2·625	2·1	1·575	1,436·4	
..	..	106·0	708·0	5·32	2·625	2·1	1·575	1,486·8	
..	..	114·0	756·0	5·36	2·64	2·11	1·58	1,595·16	
..	..	120·0	792·0	5·39	2·65	2·12	1·59	1,679·04	
..	..	..	..	..	..	..	..	..	
..	..	140·0	912·0	5·46	2·67	2·14	1·71	1,951·60	
..	..	140·0	912·0	5·46	2·67	2·14	1·71	1,951·68	
..	..	18·0	104·0	2·88	2·31	1·85	1·39	192·4	
0·71	4·0	47·0	220·0	3·39	2·5	2·0	1·5	440·0	
..	..	62·0	280·0	3·5	2·55	2·04	1·53	571·2	
..	..	82·0	360·0	3·6	2·59	2·07	1·55	745·2	
..	..	108·0	464·0	3·68	2·6	2·08	1·56	965·12	
..	..	26·0	136·0	3·09	2·84	2·27	1·70	308·72	
1·0	4·0	51·0	236·0	3·41	2·98	2·39	1·80	564·04	
1·0	4·0	85·0	372·0	3·61	3·06	2·45	1·84	911·40	
1·09	4·0	7·0	60·0	2·4	2·625	2·1	1·575	126·00	
..	4·0	29·0	148·0	3·5	2·98	2·39	1·80	353·72	
1·09	4·0	62·0	280·0	3·49	3·15	2·52	1·89	705·60	
1·09	4·0	85·0	372·0	3·61	3·2	2·56	1·92	972·8	

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APPENDIX

Statement of Water Distribution

Names of Channels.	Positions.	Area.		Fall or Slope per Mile.		Maximum Depth.	Ordinary full supply.				Discharge in Cubic Yards per Hour.	Discharge in Cubic Feet per Second.
		Commanded.	Supply provided for.	Bed.	Surface.		Depth.	Area of Cross Section.	Mean Velocity in Feet per Second.			
1st Sub-division— Bank Canal	M. F. Y. 4 0 0	SQ. M. 345·00	ACRES. 88,000	FT. 0·5	FT. 0·5	FT. 16·0	FT. 6·5	FT. 617·5	FT. 2·15		176,971·74	1,327·6
West Side Channel, Main Duct.	11 0 0	96·92	28,000	0·5	0·5	7·0	6·0	228·0	1·89		57,456·00	430·92
2nd Sub-division— Ellore Canal	0 4 20	140·0	31,000	0·08	0·08	24·76	8·00	608	0·92		74,562·62	559·36

G.

in the Eastern Delta of Kistna.

Distribution of Water to Branches.							Acreage.	Remarks.
Branch Ducts and Branches.	Distance from Head of Channel.			Quantity. Cubic Yards per Hour.	Quantity. Cubic Feet per Second.			
	M.	F.	Y.					
Kuderu branch	19	2	153	1,824·00	13·68		400	
Lankapalli branch	21	5	153	1,824·00	13·68		500	
Srikakolum do.	23	7	153	1,824·00	13·68		800	Direct under main duct.
Chittur do.	26	7	153	1,824·00	13·68		700	
Vakkalagadda branch ..	28	4	153	1,824·00	13·68		600	
Pagole do. ..	30	6	153	1,824·00	13·68		400	
Pedaprole do. ..	33	2	153	2,560·00	19· 2		700	
Kistna branch North bank channel, Main duct.	34	0	153	23,296·00	174·72		10,900	Direct.
Nelacurru branch	6	2	120	5,921·33	44·41		3,000	Branches.
Chinnayadara branch ..	8	0	60	5,921·33	44·41		3,000	
Suvarnamukley channel, branch duct.	37	5	163	14,234·88	106·76		7,000	Direct.
Mandapakala branch ..	6	0	0	4,353·33	32·65		2,000	
Peddagollapalem branch ..	8	0	0	4,353·33	32·65		1,500	Branches.
Chinnagollapalem do. ..	8	0	0	4,353·33	32·65		1,500	
Kistna branch, south bank channel, branch duct.	37	5	163	38,808·00	291·06		17,000	Direct.
Machavaram branch ..	2	4	0	4,353·33	32·65		2,000	
Kalidindivari do. ..	5	0	0	10,304·00	77·28		5,000	Branches.
Kodur do.	7	0	0	10,304·00	77·28		5,000	
Bandalayacheruva branch ..	39	7	142	4,353·33	32·65		2,000	
Vakanoor do. ..	40	7	142	8,094·88	60·71		4,000	
Chowdavaram do. ..	43	3	56	8,094·88	60·71		4,000	Direct under main duct.
Tolagadadivi do. ..	46	5	56	10,304·00	77·28		5,000	
Yatimoga do. ..	48	4	56	4,353·33	32·65		2,000	
Direct under East bank channel.	..			..	..		4,000	
							60,000*	
Vallur branch	2	3	77	3,780·00	28·35		1,200	Direct.
Medur branch duct	6	0	197	8,293·33	62·20		4,000	
Kistnapuram branch ..	4	6	0	2,053·33	15·40		1,000	
Gudapad do. ..	7	0	0	2,053 33	15·40		1,000	Branches.
Vainulamada do. ..	9	0	0	2,053·33	15·40		1,000	
Bheemaddy East side channel, branch duct.	9	2	77	12,300· 0	92·25		6,000	Direct.
Agakodu branch	4	4	0	2,053·33	15·40		1,000	
Kosoor North branch ..	7	4	0	2,053·33	15·40		900	
Do. South do. ..	8	7	0	3,120·00	23·40		1,400	
Mullampalli do. ..	10	2	0	2,053·33	15·40		1,000	Branches.
Pusadam do. ..	12	2	0	2,053·33	15·40		900	
Yendakuduru do. ..	13	2	0	1,712·00	12·84		600	
Lankapalli do. ..	14	2	0	2,630·88	19·73		250	
Batlapenamarru do. ..	9	2	77	4,229·33	31·72		2,000	
Pedasanagallu do. ..	11	3	77	1,712·00	12·84		850	
Wurutur do. ..	13	3	77	2,053·33	15·40		1,000	
Chinnacuntavi do. ..	15	6	77	3,490;88	26·18		1,750	
Nebhanpudi do. ..	16	7	77	2,689·33	20·17		1,200	
Nemakur do. ..	20	0	77	4,960·00	37· 2		2,500	Direct.
Ramannapetta do. ..	22	6	77	3,120·00	23· 4		1,500	
Polavaram do. ..	24	5	77	3,120·00	23· 4		1,600	
Akumurru do. ..	27	7	77	1,939·33	14·52		900	
Rudravaram do. ..	28	6	77	1,939·33	14·52		1,000	
Goondupalem do. ..	29	6	77	1,939·33	14·52		900	
Direct under West side channel.	..			..	..		1,600	
							28,000	
Direct under Ellore canal ..	..			..	..		300	
Kesarapalli branch	13	0	0	2,099·47	15·75		300	Direct.
Direct under Ellore canal ..	..			..	..		200	
Butremallipad branch ..	15	0	0	3,239·19	24· 3		900	Do.
Direct under Ellore canal ..	..			..	..		150	

* Branches should not be included in the totals.

APPENDIX

Statement of Water Distribution

Names of Channels.	Positions.	Area.		Fall or Slope per Mile.		Maximum Depth.	Ordinary full supply.			Discharge in Cubic Yards per Hour.	Discharge in Cubic Feet per Second.
		Commanded.	Supply provided for.	Bed.	Surface.		Depth.	Area of Cross Section.	Mean Velocity in Feet per Second.		
2nd Sub-division—(*Continued.*) Ellore Canal ..	M. F. Y. ..	SQ. M. ..	ACRES. ..	FT. ..	FT. ..	FT. ..	FT. ..	FT. ..	FT. ..		
3rd Sub-division— Ryves' Canal	0 4 20	146·47	35,000	0·58	0·58	24·76	Varying from 8 to 6·42	..	..		
Pulleru by channels on the north side into Gudivada.	12 1 0	102·10	28,000	0·42	0·42	5·59	6·0	684	1·95		
3rd Division— Masulipatam Canal ..	..	28·43	6,000	0·234	0·253	8·54	6·0	468·0	1·456		
4th Division— Pulleru .. .. .. Polrazcodu branch duct ..	.. Cowtram lock. 26 6 0	.. 74·0 sq. miles ×500= 37,000 acres.	.. 20,000 acres.	.. 0·33	.. 0·33	.. 7·5	.. 5·0	.. 217·5	.. 1·49		
Chevurkodu branch duct ..	Do. ..	67·0 square miles × 500= 33,500 acres.	14,000 acres.	0·25	0·25	8·75	4·0 & 3·0	184·0 & 199·5	1·19 1·07		
Pulleru below Cowtram lock.	..	60·0 Sq. miles —500 30,000	12,000 acres.	0·5	0·5	5·54	4·0	116·0	1·61		

G.—(*Continued*).

in the Eastern Delta of Kistna—(*Continued*).

Distribution of Water to Branches.						Acreage.	Remarks.
Branch Ducts and Branches.	Distance from Head of Channel.	Quantity.					
		Cubic Yards per Hour.	Cubic Feet per Second.				
	M. F. Y.						
Poonukumad branch ..	17 3 0	4,453·55	33·41			1,350	Direct.
Direct under Ellore canal ..	.. ..	..	..			300	
Cherwada branch	19 6 0	3,079·23	23·10			770	
Puttagunta do.	21 4 0	3,385·82	25·40			1,000	
Direct under Ellore canal ..	..	..	..			200	
Direct under tanks near Kamimole.	..	..	..			600	
Kakulpad branch	26 0 0	3,092·56	23·2			800	
Gogunta do.	27 0 0	3,999·00	30·0			1,200	
Direct under tanks	..	..	..			9,500	
Muppurru branch	36 1 0	10,857·28	81·45			5,430	
Madepalli do.	37 1 0	10,093·47	75·72			3,500	
Direct under tanks	..	..	..			4,500	
						31,000	
Velpur branch	..	..	..			200	
Wuppulur branch	..	..	..			200	
Teneru do.	7 4 330	3,459·13	25·95			840	
Vempad branch	7 4 330	4,258·93	31·95			800	
Komatigunta branch ..	7 4 330	4,918·77	36·9			2,000	
Gudivada new branch channel duct.	7 4 330	49,460·9	371·05			24,000	
Mukapad branch	5 0 0	6,207·78	46·57			3,000	Direct.
Tamersa do.	6 3 113	10,250·77	76·90			5,000	
Nandivada do.	6 3 113	4,038·99	30·3			2,000	
Bumelkodu do.	10 5 0	3,080·56	23·11			1,500	
Bingavaram do.	9 6 0	3,448·47	25·87			1,500	
Bushanagolla branch ..	9 6 0	2,239·44	16·80			1,000	
Kunderu branch duct ..	11 2 0	14,277·76	107·11			7,000	
Thundanampad branch ..	3 4 0	1,596·93	11·98			700	Branches.
Zuvanapudy do. ..	7 2 0	8,139·96	61·065			4,000	
						*35,000	
Mudunoor road side channel ..	13 0 0	4,634·84	34·87			2,000	Direct.
Gundikodu branch duct ..	13 0 0	28,408 89	213·12			13,000	
Motur branch	8 2 157	5,206·69	39·06			1,500	Branches.
Lellapudy branch	8 2 66	8,181·95	61·38			3,500	
Golivapally branch	13 0 0	4,918·77	36·90			1,000	
Peddamaddali do. ..	13 0 0	6,286·42	47·16			1,000	Direct.
Pamarru channel branch duct ..	19 1 0	15,472·13	116·07			5,500	
Komaravole branch ..	1 0 0	4,017·66	30·14			1,000	
Penjendra branch	1 0 0	5,158·71	38·70			2,500	Branches.
Angalur do.	3 4 0	3,459·13	25·95			1,000	
Velpur do.	5 0 0	4,017·66	30·14			1,000	
Palakodu do.	21 0 0	8,035·22	60·28			3,000	Direct.
Chitram channel	25 2 0	5,169·37	38·78			2,500	
Direct under Pulleru and Bunder canal.	..	..	..			6,000	
						69,000	
Chigurukota channel ..	5 2 0	9,757·56	73·2			4,000	
Kykalur channel	14 0 0	16,795·8	126·0			7,000	
Other minor branches below 2,000 acres and direct irrigation.	..	..	..			9,000	
Kaldindi branch	18 7 0	8,331·25	62·5			2,000	
Kondongi do.	25 0 0	10,497·57	78·75			4,000	Direct.
Mattagunta branch ..	28 2 0	8,357·9	63·0			2,400	
Other minor branches below 2,000 acres and direct irrigation.	..	..	..			5,600	
Tadicherlakodu	4 4 0	8331·25	62·5			3,000	
Kalidindikodu	7 7 0	8,997·75	67·5			3,000	

Discharge in Cubic Yards per Hour.	Discharge in Cubic Feet per Second.
2,26,680·64	1,700·53
1,77,795·54	1,333·8
90,820·62	681·408
..	..
44,319·85	324·07
29,187·36	218·96
28,454·21	213·46
24,895·1	186·76

APPENDIX

STATEMENT of Water Distribution

Names of Channels.	Positions.	Area.		Fall or Slope per Mile.		Maximum Depth.	Ordinary		
		Commanded.	Supply provided for.	Bed.	Surface.		Depth.	Area of Cross Section.	Mean Velocity in Feet per Second.
	M. F. Y.	SQ. M.	ACRES.	FT.	FT.	FT.	FT.	FT.	
5th Sub-division—Pulleru Masulipatam Canal, East side channel.	20 0 0	53·34	9,000	0·5	0·5	6·58	4·0	88 0	1·55
Pulleru direct at Kankipad ..	0 1 0	26·0	5,000	0·58	0·58	10·05	4·0	272·0	1·84
Do. at Pamarru ..	19 2 0	80·0	..	0·33	0·33	13·90	7·0	672·	1·8
Butlerkodu	20 4 0	35·79	10,000	0·5	0·5	5·26	3·0	..	1·29
Bantumalli canal, side channel.	26 6 0	49·88	9,000	1·0	1·0	7·03	3·0	..	1·98
Bantumalli canal ..	26 6 0	38·50	3,000	0·08	0·08	7·00	5·0	175·0	0·696

MASULIPATAM,
September 1874.

G—(*Continued*).
in the Eastern Delta of Kistna.

full supply.		Distribution of Water to Branches.					Acreage.	Remarks.
				Quantity.				
Discharge in Cubic Yards per Hour.	Discharge in Cubic Feet per Second.	Branch Ducts and Branches.	Distance from Head of Channel.	Cubic Yards per Hour.	Cubic Feet per Second.			
			M. F. Y.					
		Peddatunnoli branch ..	12 4 0	6,398·40	48·0		2,000	Direct.
		Other minor branches below 2,000 acres and direct irrigation.	..	..	..		4,000	
							46,000	
18,182·12	136·4	Chilakalapudi branch ..	16 2 66	4,693·49	35·21		2,000	
		Kottapudi do. ..	2 1 0	3,327·16	24·96		1,500	
		Kappaladoddi do. ..	16 6 66	3,446·25	25·87		1,200	
		Buddallapollem branch ..	17 2 66	3,446·25	25·87		1,000	Direct.
		Kakerlamudy branch ..	19 6 66	3,446·25	25·87		1,000	
		Nandamoor branch.. ..	19 6 66	1,596·93	11·98		500	
		Sardaipetta branch.. ..	10 4 0	2,239·44	16·80		500	
		Direct under Bank canal, East side channel.	..	..	..		1,300	
							9,000	
66,650·0	500	Capileswarapuram branch ..	9 0 0	3,177·87	23·84		1,500	Direct.
		Kurnmadali branch do. ..	13 0 0	3,812·38	28·6		1,500	
161,239·68	1,209·60	Direct under Pulleru and Capileswarapuram tank.	..	..	..		2,000	
							5,000	
6,448·38	48·375	Malapaharekodu	20 4 0	14,377·73	107·86		10,000	Direct.
		Nessenkaraikodu	4 4 0	2,439·39	18·30		1,200	Branches.
		Direct Butlerkodu	..	..	..		200	
18,607·34	139·59	Sairazulankedo	1 5 0	5,328·00	39·97		2,500	
		Konganchcrla branch ..	2 4 100	2,239·44	16·8		500	
		Chevendra channel.. ..	2 4 100	3,448·47	25·87		1,500	
		Old Pulleru continued by Consadumkodu branch.	4 3 0	5,169·37	38·78		2,500	
		Arthamur branch	10 3 0	2,439·39	18·3		1,000	Direct.
		Direct under Bantumalli canal. side channel.	..	..	..		1,000	
			13 6 0	2,848·62	21·37		1,000	
16,327·92	122·49	Mulapurru branch	1 4 0	2,848·62	21·37		1,000	
		Cherukumalli channel ..	..	..	..		1,000	
		Direct under Bantumalli canal.					36,000	

(Signed) D. Mc.NEIL CAMPBELL, Lieut., R.E.,
Executive Engineer, 4th Grade, Kistna.

(Signed) J. O. HASTED, Major, R.E.,
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APPENDIX H.

STATEMENT showing the Outlay incurred and that now proposed on the following works of the Eastern Delta Project.

Names of Works.	Outlay.				Balance of Estimates of Works in progress yet to be worked out.	Total.	Amount of Estimates now framed.	Total proposed Outlay.	Remarks.
	Original Works.	Repairs.	Total to 1873-74.	Probable expenditure in 1874-75, Allotments.					
	RS.	RS.	RS.	RS.	RS.	RS.	RS.	RS.	
1. Anicuts proportionate cost ...	400,866	1,02,997	5,03,863	...	...	5,03,863	91,123	5,94,986	Includes improvements to head and under sluices.
2. Conservancy establishment ...	...	1,91,131	1,91,131	...	...	1,91,131	...	1,91,131	
3. Main canal 900 yards ...	60,562	...	60,562	29,327	20,261	1,10,150	...	1,10,150	
4. Bandar canal from Ryves' channel to Masulipatam tide water	5,78,490	2,92,841	8,71,331	8,000	5,834	8,85,165	2,00,000	10,85,165	
5. Kistna river embankment ...	35,518	70,048	1,05,566	...	...	1,05,566	12,87,000	*14,90,925	Widening the 3¼ miles to Yanamalakudrum and improvements below Kankipad.
6. East bank channel	44,965	...	44,965	...	...	44,965			
7. West side channel, Bandar canal	50,282	2,689	52,971	423	...	53,394			
8. Ellore canal	1,91,007	1,15,740	3,06,747	802	...	3,07,549	2,00,000	5,45,225	
9. Budumeru	24,437	13,239	37,676	...	...	37,676			
10. Ryves' channel	3,10,548	11,154	3,21,702	28,000	1,28,250	5,08,321	2,40,000	10,21,306	
11. Do. branch	20,155	10,214	30,369						
12. Pulleru and its branches in Gudivada taluq from Marrivada to Cowtram lock ...	1,40,721	1,12,781	2,53,502	1,645	17,838	2,72,985			
13. Polrazkodu	23,092	19,978	43,070	...	...	43,070	3,76,522	*4,46,125	
14. Chevur do.	...	...	...	...	...	...			
15. Pulleru below Cowtram lock...	1,512	25,021	26,533	...	...	26,533			
16. Bandar canal branches near Kankipad and weir ...									
17. Pulleru south of Wyur to Cowtram lock	1,007	3,746	4,753	...	...	4,753	3,38,000	4,52,767	
18. East side channel, Bandar canal	28,336	6,298	34,634	...	...	34,634			
19. Buntumalli canal	48,761	15,084	63,845	...	...	63,845			
20. Butlerkodu	375	11,160	11,535	...	...	11,535			
Drainages.									
1st Division	2,708	5,543	8,251	...	...	8,251	5,65,000	5,73,251	
2nd do.	3,388	6,378	9,766	...	...	9,766	2,00,000	2,09,766	
3rd do.	2,708	6,043	8,751	...	...	8,751	4,60,000	4,68,751	
4th do.	2,029	4,210	6,239	3,905	...	10,144	9,73,478	†9,83,622	
5th do.	2,708	5,545	8,253	...	...	8,253	3,47,000	3,55,253	
Total ...	19,74,175	10,31,840	30,06,015	72,102	1,72,183	32,50,300	52,78,123	85,28,423†	

*Represents that detail estimates have been worked out.
†If Maintenance, Conservancy, &c., of new works be included, total cost =1,16,28,423 Rupees.

MASULIPATAM,
September 1874.

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Superintending Engineer, 1st Division.

(Signed) D. Mc.NEIL CAMPBELL, Lieut., R.E.,
Executive Engineer, 4th Grade, Kistna.

APPENDIX I.

STATEMENT showing the Area commanded, the present and the expected increase of Wet Cultivation and the anticipated Cost of Works shown below in the Eastern Delta of Kistna. Figures in Column 4 were taken from a statement of the Collector for 1871-72 of Fasli 1281.

Names of Works.	Area commanded by each Main and Branch Duct.	Proposed Acreage.	Present Area of Irrigation.		Anticipated Increase by proposed works.		Cost of Works proposed.				
			Acreage.	Assessment.	Acreage.	Assessment.	Irrigation.	Navigation.	Drainage.	Total.	
1	2	3	4	5	6	7	8	9	10	11	12
				Rs.		Rs.	Rs.	Rs.	Rs.	Rs.	
1. Main canal from head sluice at Bezwada to Ellore canal.	...	...	...	...	...	...	2,11,123	80,000	...	2,91,123	
2. Bandar canal from head sluice to tide water at Masulipatam.	...	...	...	...	...	...					
3. River embankment and east bank channel.	248·08	60,000	...	...	60,000	...	12,33,870	53,130	5,65,000	18,52,000	1st Division.
4. West side channel, Bandar canal.	96·92	28,000	8,465	32,041	19,535	...					
5. Ellore canal	140· 0	Kistna. 31,000 Godavery. 13,598	5,764	17,580	11,638	...	1,00,000	1,00,000	2,00,000	4,00,000	2nd do.
6. Ryves' channel	65· 0	35,000	26,869	1,53,246	8,131	...	2,08,000	32,000	4,60,000	7,00,000	3rd do.
7. Do. or Gudivada branch duct.	81·47										
8. Pulleru and its branches in Gudivada taluq from Mariwada to Cowtram.	102·10	28,000	17,108	96,616	10,892	...					
9. Polrazkodu	74· 0	20,000	6,735	28,998	13,265	60,084	3.00,187	76,335	9,73,478	13,50,000	4th do.
10. Chevurkodu	67· 0	14,000	...	...	14,000	63,413					
11. Pulleru below Cowtram lock.	60· 0	12,000	5,260	25,927	6,740	30,528					
12. Bandar canal branches near Kankipad and Wyur.	28·43	6,000	6,000	30,130	...	...	System of channels completed.				
13. Pulleru south from Wyur to Cowtram lock direct.	19·49	5,000	...	...	5,000	...	200,000	1,38,000	3,47,000	6,85,000	...
14. East side channel	53·34	9,000	168	842	8,832	...					
15. Bantumalli channel ...	38· 5	3,000	*1,000	5,469	2,000	...					
16. Do. side channel ...	49·88	9,000	408	2,231	8,592	...					
17. Butlerkodu	35·79	10,000	*1,168	5,908	8,832	...					
Total ...	1,160·0	2,70,000	92,543	3,98,988	1,77,457	...†	22,53,180	4,79,465	25,45,478	52,78,123	

* 1. An equal amount is included in the figures of Pulleru below Cowtram lock No. 11.
2. Figures printed in large type denote cost of divisions finished.
3. Figures in column 4 exclude wet land watered free of charge in Kistna = 37,786 Acres.
† The increase deducting land free of charge = 132,277 Acres.

MASULIPATAM,
September 1877.

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APPENDIX J.

Traffic Returns of the Ellore Canal at Bezwada.

Years.	Number of Boats passed through Lock.	Tonnage.	Number of Passengers said to be in Boat.	Salt.		Cotton.		Oil Seeds.		Paddy and other Grains.		Miscellaneous.		Amount.		
				Quantity.	Amount.	Quantity.	Amount.	Quantity.	Amount.	Quantity.	Amount.	Quantity.	Amount.			
Up.				MDS.	RS.	MDS.	RS.	MDS.	RS.	MDS.	RS.	MDS.	RS.	RS.	A.	P.
1862-63 ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...		
1863-64 ...	1,454	...	...	...	32,426	...	6,270	...	...	...	1,19,295	...	4,53,124	6,11,115	0	0
1864-65 ...	1,662	...	...	...	318	...	4,52,600	...	...	...	70,485	...	4,13,572	9,36,975	0	0
1865-66 ...	...	...	...	...	...	...	...	...	...	...	...	...	...	20,26,320	0	0
1866-67 ...	...	...	...	...	...	...	...	...	...	...	...	...	...	1,67,191	0	0
1867-68 ...	...	...	...	...	...	...	...	...	...	...	...	...	...	8,58,954	0	0
1868-69 ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...		
1869-70 ...	2,181	17,408	18,670	...	...	...	...	...	...	...	...	...	...	24,90,667	4	0
1870-71 ...	3,012	15,975	182,622	...	...	...	...	...	...	...	...	...	...	24,62,262	0	0
1871-72 ...	4,289	32,847	211,459	...	...	...	...	...	...	...	...	...	...	29,85,640	0	0
Total ...	12,598	66,230	4,12,751	...	32,744	...	4,58,870	...	...	...	1,89,780	...	8,66,696	1,25,39,124	4	0
Down.																
1862-63 ...	...	...	...	...	...	...	10,51,329	...	...	...	...	...	...	...		
1863-64 ...	1,408	...	...	...	70	...	10,13,125	...	...	...	13,004	...	2,55,550	13,19,953	0	0
1864-65 ...	1,643	...	...	...	420	...	...	...	...	...	17,008	...	2,55,620	12,86,173	0	0
1865-66 ...	...	...	...	...	...	...	...	...	...	...	...	...	...	3,21,078	0	0
1866-67 ...	...	...	...	...	...	...	...	...	...	...	...	...	...	2,29,168	0	0
1867-68 ...	...	...	...	...	...	...	...	...	...	...	...	...	...	5,91,927	0	0
1868-69 ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...		
1869-70 ...	3,352	19,352	16,318	...	...	...	...	...	...	...	...	...	...	17,34,068	8	0
1870-71 ...	3,040	16,486	173,003	...	...	...	...	...	...	...	...	...	...	8,51,528	4	0
1871-72 ...	4,448	35,051½	212,244	...	...	...	...	...	...	...	...	...	...	16,76,899	12	0
Total ...	13,891	70,889½	401,565	...	490	...	20,64,454	...	...	...	30,012	...	5,11,170	80,01,795	8	0
Grand Total.	26,489	137,119½	814,316	...	33,234	...	25,23,324	...	...	...	2,19,792	...	13,77,866	2,05,40,919	12	0

APPENDIX K.

Traffic Returns of the Masulipatam Canal at Bezwada.

Years.	Number of Boats passed through Lock.	Tonnage.	Number of Passengers said to be in Boat.	Salt.		Cotton.		Oil Seeds.		Paddy and Grain.		Miscellaneous.		Total Amount.		
				Quantity.	Amount.	Quantity.	Amount.	Quantity.	Amount.	Quantity.	Amount.	Quantity.	Amount.			
Up.				MDS.	RS.	MDS.	RS.	MDS.	RS.	MDS.	RS.	MDS.	RS.	RS.	A.	P.
1862-63 ...	...	...	...	...	...	...	...	...	...	...	...	...	...	9,53,423	0	0
1863-64 ...	2,326	...	...	...	56,869	...	10,185	...	...	...	1,62,287	...	7,24,082	5,09,720	0	0
1864-65 ...	1,522	...	...	...	50,246	...	18,600	...	...	...	27,500	...	4,13,374	5,76,743	0	0
1865-66 ...	...	...	...	...	...	...	...	...	...	...	...	...	...	8,41,395	0	0
1866-67 ...	...	...	...	...	...	...	...	...	...	...	...	...	...	5,86,980	0	0
1867-68 ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...		
1868-69 ...	...	...	...	...	...	...	...	...	...	...	...	...	...	5,98,779	14	0
1869-70 ...	1,639	8,412	15,229	...	...	...	...	...	...	...	...	...	...	10,45,771	12	0
1870-71 ...	2,365	6,397	1,26,005	...	...	...	...	...	...	...	...	...	...	43,04,354	0	0
1871-72 ...	2,362	7,139	1,22,464	...	...	...	...	...	...	...	...	...	...			
Total ...	10,214	21,948	2,63,698	...	1,07,115	...	28,785	...	...	...	1,89,787	...	11,37,456	94,17,166	10	0
Down.														...		
1862-63 ...	...	...	...	...	...	...	...	...	...	...	...	...	...	13,51,329	0	0
1863-64 ...	2,268	...	...	...	...	...	7,03,941	...	...	...	12,145	...	6,38,243	10,60,639	0	0
1864-65 ...	1,606	...	...	...	509	...	3,92,461	...	...	...	4,376	...	6,63,293	2,29,679	0	0
1865-66 ...	...	...	...	...	...	...	...	...	...	...	...	...	...	6,06,949	0	0
1866-67 ...	...	...	...	...	...	...	...	...	...	...	...	...	...	9,43,913	0	0
1867-68 ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...		
1868-69 ...	...	...	...	...	...	...	...	...	...	...	...	...	...	12,06,874	8	0
1869-70 ...	2,662	8,621	14,204	...	...	...	...	...	...	...	...	...	...	9,64,776	0	0
1870-71 ...	2,357	7,131	1,18,420	...	...	...	...	...	...	...	...	...	...	16,50,388	8	0
1871-72 ...	2,380	7,170	1,22,314	...	...	...	...	...	...	...	...	...	...	...		
Total ...	11,273	22,922	2,54,938	...	509	...	10,96,402	...	...	...	16,521	...	13,01,536	80,14,548	0	0
Grand Total.	21,487	44,870	5,18,636	...	1,07,624	...	11,25,187	...	...	...	2,06,308	...	24,38,992	1,74,31,714	10	0

APPENDIX L.

Statement showing the Cost of Repairs in the Eastern Delta of Kistna from 1852 to 1873-74.

Years.	Total Expenditure on Work.	Total Expenditure on Conservancy Establishment.	Total of Columns 2 and 3.	Proportion of Establishment for the Delta at 30 per cent. on Expenditure.	Total Cost of Maintenance on Project, Columns 4 and 5.	Irrigated Acres.	Cost per acre.	Remarks.
1	2	3	4	5	6	7	8	9
	RS.	RS.	RS.	RS.	RS.			
From 1852 to 1855-56 ...	16,914	...	16,914	5,074	21,988	...	...	
1856-57	63,602	5,823	69,425	20,827	90,252	...	...	
1857-58	21,658	7,956	29,614	8,884	38,498	...	...	
1858-59	42,043	8,050	50,093	15,027	65,120	...	...	
1859-60	39,080	8,520	47,600	14,280	61,880	...	...	
1860-61	39,103	8,520	47,623	14,287	61,910	...	...	
1861-62	44,360	8,772	53,132	15,939	69,071	...	...	
1862-63	39,664	9,792	49,456	14,836	64,292	...	...	
1863-64	52,974	9,854	62,828	18,848	81,676	...	...	
1864-65	97,357	11,206	1,08,563	32,568	1,41,131	...	...	
1865-66	59,623	11,387	71,010	21,303	92,313	...	...	
1866-67	42,833	12,162	54,995	16,498	71,493	...	...	
1867-68	23,336	12,312	35,648	10,694	46,342	...	...	
1868-69	28,153	11,970	40,123	12,037	52,160	...	...	
1869-70	40,711	11,970	52,681	15,804	68,485	...	...	
1870-71	26,549	12,678	39,227	11,768	50,995	119,751	...	
1871-72	34,695	11,910	46,605	13,981	60,586	137,723	...	Figures according to Revenue Account of the present wet shown in the general report of the Delta now sent.
1872-73	46,196	14,322	60,518	18,155	78,673	...	...	
1873-74	81,858	13,927	95,785	28,735	1,24,520	...	...	
Total ...	8,40,709	1,91,131	10,31,840	3,09,552	13,41,385	...	...	
Total for 5 years ...	2,30,009	64,807	2,94,816	88,443	3,83,259	...	...	
Average ...	46,001⅘	12,961⅗	58,963⅕	17,688⅗	76,651⅘	...	...	

MASULIPATAM,
September 1874.

(Signed) J. O. HASTED, Major, R.E.,
Superintending Engineer, 1st Division, Kistna.

(Signed) D. McNEIL CAMPBELL, Lieut., R.E.,
Executive Engineer, 4th Grade, Kistna.

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APPENDIX M.

Statement showing remissions granted by excess and scarcity of water.

Description of Deltas.	Taluqs.	Faslis.	Remission granted by Excess of Water.			Remission granted by the scarcity of Water.			Total Remissions.
			Waste.	Failure of Crops.	Total.	Waste.	Failure of Crops.	Total.	
			RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.
	Gudivada ...	1274	17,756 8 8	16,506 6 10	34,262 15 6	...	4,293 10 3	4,293 10 3	38,556 9 9
		1275	4,493 3 7	1,534 12 6	6,028 0 1	5,640 11 1	1,466 5 2	7,107 0 3	13,135 0 4
		1276	...	...	...	4,666 4 0	17,574 5 0	22,240 9 0	22,240 9 0
		1277	5,931 13 0	1,069 4 0	7,001 1 0	...	...	...	7,001 1 0
		1278	...	...	...	2,303 0 0	1,276 13 0	3,579 13 0	3,579 13 0
		1279	3,283 1 5	1,061 6 5	4,344 7 10	...	...	...	4,344 7 10
		1280	5,871 1 7	553 13 4	6,424 14 11	...	...	...	6,424 14 11
		1281	397 8 11	...	397 8 11	2,951 4 8	938 2 8	3,889 7 4	4,287 0 3
		1282	2,727 8 4	89,240 0 3	91,967 8 7	48 15 8	...	48 15 8	92,016 8 3
		1283	37 2 8	996 14 0	1,034 0 8	2,3041 10 6	1,888 8 5	24,930 2 11	25,964 3 7
			40,498 0 2	1,10,962 9 4	1,51,460 9 6	38,651 13 11	27,437 12 6	66,089 10 5	2,17,550 3 11
	Bandar ...	1274	...	14,000 0 0	14,000 0 0	...	...	...	14,000 0 0
		1275	...	...	...	2,630 11 0	...	2,630 11 0	2,630 11 0
		1276	...	3,045 10 0	3,045 10 0	155 9 0	...	155 9 0	3,201 3 0
		1277	...	1,647 7 0	1,647 7 0	516 2 0	...	516 2 0	2,163 9 0
		1278	...	...	...	1,028 2 0	...	1,028 2 0	1,028 2 0
		1279	...	32 10 0	32 10 0	231 15 0	...	231 15 0	264 9 0
		1280	...	300 0 0	300 0 0	640 2 0	...	640 2 0	940 2 0
		1281	...	912 0 0	912 0 0	36 0 0	...	36 0 0	948 0 0
		1282	...	...	...	252 9 0	...	252 9 0	252 9 0
		1283	...	1,481 7 0	1,481 7 0	2,168 12 0	...	2,168 12 0	3,650 3 0
			...	21,419 2 0	21,419 2 0	7,659 14 0	...	7,659 14 0	29,079 0 0
	Bezwada ...	1274	...	72 6 7	72 6 7	...	...	...	72 6 7
		1278	...	...	...	...	266 7 0	266 7 0	266 7 0
		1280	...	28 10 0	28 10 0	...	...	...	28 10 0

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Statement showing remissions granted by excess and scarcity of water—(*Continued*).

Description of Deltas.	Taluqs.	Fasli.	Remission granted by Excess of Water. Waste.			Remission granted by the scarcity of Water. Failure of Crops.			Total.			Total Remissions.		
			Rs.	A.	F.	Rs.	A.	F.	Rs.	A.	F.	Rs.	A.	F.
			...			...			...			119	9	9
			...			...			...			3,204	2	11
			...			...			...			141	9	8
			...			266	7	0	266	7	0	3,832	13	11
			46,311	11	11	27,704	3	6	74,015	15	5	2,50,462	1	10
			ABSTRACT.											
			8,271	6	1	4,293	10	3	4,293	10	3	52,629	0	4
			1,821	13	0	1,466	5	2	9,737	11	3	15,765	11	4
			516	2	0	17,574	5	0	22,091	2	0	25,441	12	0
			3,331	2	0	...			516	2	0	9,164	10	0
			231	15	0	1,543	4	0	4,874	6	0	4,874	6	0
			640	2	0	...			231	15	0	4,609	0	10
			2,987	4	8	938	2	8	640	2	0	7,393	10	11
			301	8	8	...			3,925	7	4	5,354	10	0
			25,210	6	6	1,888	8	5	301	8	8	95,473	4	2
									27,098	14	11	29,756	0	3
			46,311	11	11	27,704	3	6	74,015	15	5	2,50,462	1	10
			59,231	15	3	46,036	5	11	1,05,268	5	2	4,42,516	4	7
			48,335	6	1	4,293	10	3	52,629	0	4			
			6,028	0	1	9,737	11	3	15,765	11	4			
			3,045	10	0	22,391	2	0	25,441	12	0			
			8,648	8	0	516	2	0	9,164	10	0			
			...			4,874	6	0	4,874	6	0			
			4,377	1	10	231	15	0	4,609	0	10			
			6,753	8	11	640	2	0	7,393	10	11			
			1,429	2	8	3,925	7	4	5,354	10	0			
			95,171	11	6	301	8	8	95,473	4	2			
			2,657	1	4	27,098	14	11	29,756	0	3			
			1,76,446	2	5	74,015	15	5	2,50,462	1	10			
			3,37,247	15	5	1,05,268	5	2	4,42,516	4	7			

(Signed) G. D. LEMAN, Collector.

MASULIPATAM, September 1874.

Average per year on account of excess of water .. .. Rs. 17,644
Do. per year on account of deficiency of water 7,401
Total, Average Remission .. 25,046

(Signed) J. O. HASTED, Major, R.E.,
Suptg. Engr., 1st Division, Kistna.

(Signed) D. McNEIL CAMPBELL, Lieut., R.E.,
Executive Engr., 4th Grade, Kistna.

APPENDIX No. 2.

LIST of papers and plans, &c., of the irrigation and drainage of the 1st Sub-section Eastern Delta, Kistna, submitted to the Chief Engineer for Irrigation with letter No. 86, dated 30th October 1875-76.

Numbers.	Description of papers and plans.	No. of each kind.	No. of half sheets.
1.	Explanatory Report of 1st Sub-section, including the statements of irrigation...	11	56
2.	Bound book of specification reports and estimates of Bank Canal and its branches and rest houses... ...	24	90
3.	Bound book of specification reports and estimates of West Side Channel and its branches	25	66
4.	Bound book of specification reports and estimates of the drainages of 1st Sub-section, including the velocity table	6	28
5.	Bound book of specification reports and estimates of masonry works of Bank Canal and its branches, including the data of the same	80	245
6.	Bound book of specification reports and estimates of masonry works of West Side Channel and its branches, including the data of the same	82	239
7.	Bound book of specification reports and estimates of masonry works of 1st Sub-section drainages, including the data of the same	34	78
8.	Bound book of Survey sheets of Bank Canal rest houses and its branches	26	51
9.	Do. do. of West Side Channel and its branches	25	40
10.	Do. do. of drainages of 1st Division	6	16
11.	Bound book of masonry plans of Bank Canal and its branches	33	42
12.	Do. of masonry plans of West Side Channel and its branches	52	56
13.	Do. of masonry plans of the drainages of 1st Sub-sections	8	8
14.	General plan of irrigation of 1st Sub-section	1	1
15.	Do. of drainage of do.	1	1
16.	Do. of sections of Bank Canal and its branches..	1	1
17.	Do. do. of West Side Channel and its branches	1	1
18.	Do. do. of drainages of 1st Sub-section ...	1	1

MASULIPATAM,
30th October 1875.

(Signed) D. MACN. CAMPBELL, Lieutenant, R.E.,
Executive Engineer in charge Kistna District.

From Lieutenant D. McN. CAMPBELL, R.E., Executive Engineer in charge of the Kistna District, to Lieutenant-Colonel JOHN MULLINS, R.E., Chief Engineer for Irrigation, Madras; dated Masulipatam, 30th October 1875.

In forwarding herewith plans and estimates for the extension and improvements of the irrigation and drainage of the 1st Division of the Eastern Delta of this District, I have the honor to submit the following report:—

1. *Boundaries of 1st Division.*—The 1st Division is that portion of the Delta lying between the Masulipatam Canal and the main branch of the Kistna river, bounded on the South by the sea from the mouth of that river to the fort of Masulipatam. I have already given full information regarding the features of this division, in the general report on the completion project, but as it is necessary that each division should be complete in itself, I will here repeat what I then wrote.

2. *Area to be irrigated.*—The total area of this division under command of the anicut is 345 square miles, out of which 185 square miles are zemindary, and the rest Government land. In this area, it is assumed that 88,000 acres will be cultivated wet, which is at an average rate of 255 acres to a square mile. This may seem a high proportion, but I am sure it is not too great.

3. *Eagerness of Ryots for Water.*—The ryots in Divy are agree after wet cultivation. I have never visited the island without receiving numerous petitions for channels, and I believe

that nearly every inch of land will be taken up for wet crops; in parts of the zemindary portion, the ryots are eager for water, and in many villages, they have presented me with statements skowing the number of acres they will cultivate, if channels be dug to their lands.

4. *Soil.*—The soil throughout the whole of this Division is very rich. It is principally alluvial, though in it, there are sandy portions. In the south-east part of the island of Divy there is an extensive swamp; part of this will be drained by the new scheme, but it is not thought advisable to reclaim all of it, on the score of expense.

5. *Present Cultivation.*—The land in that portion to the north of the road from Masulipatam to Kotapollem is highly cultivated, principally dry; it is subject to occasional floods when the Kistna is in fresh. There is a good deal of wet cultivation in the island of Divy (18,155 acres); the water is supplied from tanks which are filled by cuts from the Kistna river, the supply is very precarious and serious damage is often done by floods; and unless there is a fresh of at least 10 feet over the anicut at Bezwada, most of the tanks receive no water.

6. *General Levels of Country.*—From the cross sections, it has been found that the level of the country near Bezwada is + 55 feet and at the lower part of Divy + 6 feet; the total fall in this distance is, therefore, 49 feet, or about 1 foot a-mile. It will also be noticed that the country falls from the river towards the east; thus, the level at Nadakuduru is + 26 feet and at Masulipatam + 6 feet giving a fall of 8 inches a-mile; again at Ilur it is + 29 feet and at Nedumole + 13 feet, giving a fall of 1 foot a-mile. The country also slopes away on both sides from the branches of the Kistna which separate the island of Divy from the main land. Though the general slopes are as above, it has been noticed that there are two strips of low land, one lying between the Masulipatam canal and the Kistna river from Yanamalakuduru to a short distance beyond the village of Bhaddirazupalem where a natural drainage channel commences called the Kanikalamadugu, and another between the Masulipatam canal and the Bheemanadi from Inampudi to near Yendakuduru, where it joins a natural drainage. It will also be observed that the Kanikalamadugu has several branches, and that these branches do not flow in low ground, but that the general slope of the country is continued across them; thus each branch acts as a catch drain, receiving all the drainage to the west of it, the country falling from it towards the next branch to the east. The general features of the country as mentioned, indicate clearly how the irrigation and drainage of this division can be best carried out. There will be a river bank channel irrigating all the land to the east of it as far as the Kanikalamadugu and also the land in Divy; and a Masulipatam Canal side channel irrigating all the land to the west of it as far as the Kanikalamadugu. A drainage channel will be dug in each of the hollows before mentioned, and the existing drains, viz., the Kanikalamadugu and Dayapu Calva, will be improved.

Bank Channel.

7. *Bank Channel Area commanded, &c.*—This channel will command 248·08 square miles of country, of which it is assumed that 60,000 acres will be cultivated wet. Of this, 45,000 acres is Government land in the island of Divy, and the remainder 15,000 acres Zemindary. In the Zemindary portion to be commanded by this channel, there is at present no wet cultivation, and the amount calculated as likely to be taken up, viz., 15,000 acres in an area of 89·0 square miles, or 168·54 acres per square mile, is, I am sure, perfectly safe. In Divy there are at present 18,155 acres of wet cultivation, yielding an average revenue of Rupees 41,350. There are no less than 49 tanks which occupy a large portion of the island, the total extent of which is 200 square miles: (deducting that part near the sea) when the proposed channels are made, the beds of these tanks can be sold to ryots for cultivation.

8. *Design of Bank Channel.*—The bank channel will take off from the Masulipatam Canal at 3½ miles from its head near the village of Yanamalakuduru and be supplied by a head sluice of five vents of 6 feet span; the level of water in the Masulipatam Canal will be + 44·35 and in this channel + 43·32, the head will therefore be 1·03, which will give a discharge of 975 cubic feet a-second through the sluice as designed, the required discharge being 900 cubic feet a-second, calculated at 2 cubic yards per acre per hour. The channel for the first 10 miles will run in a south-easterly direction following the line of the lowest ground to avoid cutting till it meets the river bank near Royur; from here it will follow the general direction of this bank, advantage being taken of the pits dug when forming the bank, near Bandikallalunka, it will leave the bank and be carried across a small branch of the Kistna which is now almost silted up and can without difficulty be bunded, a little further on it will cross the Puligodda branch of the river into Divy by an aquedact, and from thence it will again follow the river bank for 13 miles to the village of Pedo-Palem; its total length will be 52 miles, 1 furlong and 350 feet.

In your memorandum, No. 706, dated 30th June 1875, paragraph 3, the level of the bed of the bank channel at its head and at the aquedact are laid down, the fall is also given, and it is further stated that there should be a lock with a lock weir at or about the 24th mile; on working this out, it was found that the drop in the lock would only be 8 inches, and as the required level at the aqueduct could be obtained by increasing the fall at 24th mile from 6 inches to 7 inches

per mile (the velocity would not be increased.) I considered that this would be a better arrangement and I trust you will be of the same opinion; should you still consider it advisable to have a lock at the 24th mile, the alterations required will be trifling and the increase to the cost will be very slight. The channel has therefore been designed as follows:—The level of the head sluice floor will be + 36·82, the fall from here to the 24th mile will be 6 inches a-mile width varying from 54 to 35 feet; from 24th mile to the aqueduct (35·34 miles) the fall will be 7 inches a-mile; the level of the floor of the latter being + 18 2; the width of the channel here being 35 feet. The aqueduct itself will be 16·5 feet wide and have a fall of 1·38 in its length of 1,429 feet, which is at the rate of 5 feet a-mile, and will give a velocity of 5·79 feet a-second, which is, I think, as great as should be allowed. After crossing the river, it is of course unnecessary to keep the channel so high. There will, therefore, be a drop of 4 feet at the lower end of the aqueduct, but the surface of water in the channel will still be kept rather high as far as the 37¾th mile in order to give a proper supply to two important channels which take off here, viz., the Hamsaladivi and Suvarnamukhi; at the 37¾th mile there will be dividing sluices,—two to supply the two channels above named and a third to supply the bank channel itself; the latter will have a drop of 1·43. From the aqueduct to the 37¾th mile the fall of channel will be 8 inches a-mile, from the dividing sluice to the terminus the fall of bed will be 6 inches a-mile and in this distance there will be two drops—one at the 41st mile of 2½ feet in surface of water and one at 43½ miles of 1 foot in bed and surface.

The depth of water in the channel from its head to the 41st mile will be 6·5 feet, and below that point 4 feet.

Great care has been taken in arranging the lower part of the channel, and I do not think it could be done any better or cheaper. It has been mentioned that for the first ten miles the course of the channel is through low ground; the drainage water from the country on each side will therefore lie up against its banks, and, to dispose of this, six inlets with swing shutters have been provided, and an escape has been allowed in the east bank near Davarapalli with a surplus channel leading to the Kanikalamadugu drain (to be described further on). Another escape will be provided in the 34⅜th mile just above the aqueduct with a channel leading to the small branch of the river which it is proposed to bund up; when the river is in flood, this escape will of course be useless, but there is no other way of disposing of the surplus at ordinary times cheaply.

When I first designed the channel about three years ago, I was greatly against making it navigable for many reasons which it is unnecessary to mention here; but at the request of Major Hasted, R. E., I allowed locks so that boats could navigate as far as the aqueduct, but as the velocity in the channel would be ·51 feet a-second more than that laid down by you in memorandum No. 1, dated 28th May 1869, you objected to the arrangement, and in memorandum No. 226, dated 24th February 1875, mentioned three other ways in which the canal would be treated; but on my pointing out in letter No. 3, dated 1st April 1875, that it would be very expensive to make the channel a 2nd class line of navigation, you answered in your memorandum No. 706, dated 30th June 1875, that the channel should not be designed as a regular line of navigation but for the purpose of conveying materials, which was the arrangement originally proposed: but by altering the level of the floor of the aqueduct according to your instructions, it was found necessary to revise a number of the plans. A second class lock will be allowed at the head of the channel, but for the reasons before stated it is deemed unnecessary to build another lock; the velocity of water in the channel down to the aqueduct (beyond which it is not proposed to allow for navigation owing to the great cost) will vary from 2·09 feet a-second to 2·17 feet a-second, which in my opinion will not prevent cargo boats from navigating the channel, as, even under these circumstances, the carriage of goods would be much cheaper than by road; however, I believe that even were a first-class line of navigation made here, the traffic along this line would be trifling.

9. *Puligadda Aqueduct.*—The aqueduct will cross the Puligadda branch of the Kistna at a distance of 300 yards from the main river, but as the Puligadda point has been cutting away very considerably in the last few years, it may perhaps be thought advisable to build the work lower down; but this, of course, can best be settled when the work is undertaken with reference to the state of the river at that time. The condition of this Puligadda branch seems to vary considerably: from old records, I find that in the year 1836, it was almost entirely sanded up and only received a supply of fresh water during high floods; and at that time the smaller branch (now to be bunded) appears to have been the larger; some time after, the former channel opened out again and became deep, the other branch becoming proportionately smaller, but as far as I can ascertain for the last ten or twelve years, both branches have been very gradually sanding up again. It is probably this circumstance which led Major Ryves to propose to bund up the branch altogether and carry the irrigation channel on this bund; this is of course possible, but it is difficult to foresee what might be the effect of damming up this important branch. The drawings forwarded with this letter show the present state of the river, but it is advisable that the changes in the bed should be recorded for several years, and as it will doubtless be some time before the aqueduct is built, this can easily be done. The aqueduct will consist of thirty-one vents of 40′ span and three abutment piers will be allowed, arches are provided in the spandril spaces to increase the discharge and save waste of material, the flooring and foundations have been designed in accordance with instructions contained in paragraph 5 of your memorandum, No. 226, dated 24th February 1875. All the details concerning the work will be seen in the plan and specifi-

cation report, so it is unnecessary to repeat them here. The work, I believe, will be amply strong, though I am sorry that you should have ordered that the bridge I originally designed in connection with the work should be omitted, as it would have added greatly to its strength I have addressed the Local Fund Board to ascertain if they are willing to pay for the cost of this latter work; but I have not yet received an answer, and I do not think it is at all likely that they will be able to provide funds. The mean velocity of water in the branch calculated by the surface fall and hydraulic mean depth is 4·82ft. a-second, the quantity of water to be discharged through the bridge during the highest known fresh is 152,257 cubic ft. a-second, which will give a velocity of 7·64 cubic ft. a-second through it, and it may be assumed that in some places the velocity will be as much as 10ft. a-second; and the flooring could stand a much greater velocity than that.

The principal damage to which the work will be exposed is having the wings turned by the river cutting in behind them, but this I believe can be prevented by planting large quantities of grass above and below as was done in the case of Gunnavaram aqueduct; the wings, returns and revetments are so designed that in my opinion it would be impossible for the river to do any damage of consequence in one season. Considerable difficulty will be experienced in carrying out this work, and preparations for it should be made some time before it is proposed actually to commence work. With all materials ready, I think the foundations and flooring might be put in one season, and the work completed in the following one, though without forced labor this will be a difficult matter.

10. *Proposed Culvert.*—The alternative design of a culvert under the river will be sent in shortly; but as the level of the bed of the channel at the crossing may be made much lower than if an aqueduct were allowed, the whole of the upper portion of the channel has to be revised, which will take a little time. That a syphon culvert would be cheaper than an aqueduct, may be the case; but I am positively convinced that it would not answer its purpose; there are several syphon tunnels in this district, and there is not one that does not silt up more or less every season and some get blocked up entirely. The head might be calculated so as to give a velocity of 15 feet a-second through the culvert, and then of course no silt would be deposited; but if there were any neglect in regulating the supply and the head were reduced for even one or two days, the work would get choked up, and this might be caused by circumstances that could not be helped; a breach in the channel below might reduce the head through the culvert to nothing. I would here mention that in your memorandum No. 226, dated 24th February 1875, you proposed for the dimensions of the culvert two spans of 12 feet with 3 feet height to springing and 2 feet rise; how to clear out a tunnel ¼ mile long with this height would be a matter of extreme difficulty, if it would not be quite impossible; by increasing the height (though the width may be diminished) the expense will be greatly increased, as the excavation has to be deeper and the floor would have to be at least—9½ or 5½ feet below L. W. M. Another difficulty in the construction which will add to the cost is that owing to the great drop there will be a head of about 18 feet of water tending to blow up the arches when the river is dry (which is often the case in November and December.) Consequently they must be weighted considerably; about 6 feet of stone would be required, and unless this was heaped up so as to form a dam across the channel, which I think would be objectionable, the work would have to be still deeper by 6 feet or the floor be—15½ feet. I thought of another arrangement, which is, to have the vents covered with flat stones bolted down through piers and abutments, but the Bezwada stone would certainly not be strong enough for this purpose, and if the Kondapally black granite stone has sufficient strength—which I doubt—the cost of carrying it to the work spot and cutting it would be enormous. I hope that, under these circumstances, you will reconsider your proposal for a syphon culvert.

11. *Branches of Bank Channel.*—The branches of the bank channel will be as follow:—

			Acres.
1st.	Kuderu	branch	400
2nd.	Lankapalli	do.	500
3rd.	Srikakolam	do.	800
4th.	Chittur	do.	700
5th.	Vakkalagadda	do.	600
6th.	Pagole	do.	400
6th.	Peda Prole	do.	700
8th.	Wadapalum	do.	10,900
9th.	Hamsaladivi	do.	17,000
10th.	Suvarnamuki	do.	7,000
11th.	Bandalaicheru	do.	2,000
12th.	Vakamur	do.	4,000
13th.	Chowdaram	do.	4,000
14th.	Talagadadivi	do.	5,000
15th.	Yetimoga	do.	2,000
	Direct in Devi	... ...	4,000
		Total ...	60,000

The most important of these are the Wadapalem Channel (called in the general report the Kistna branch, north bank channel), the Hamsuladivi Channel (called in general report the Kistna branch south bank channel) and the Suvarnamuki Channel.

12. *Wadapalem Channel.*—The first mentioned will leave the bank channel in the 34th mile, at the village of Bandikollalanka; and will follow the general direction of the Puligadda branch of the Kistna to beyond the village of Wadapalem; its length will be twelve miles and six furlongs. The head sluice will consist of two vents of three feet span with a drop in the floor of 8·16, and near the end of the first mile where an accommodation bridge is required for the Mopidevi road, there will be another drop of two feet, the fall of the channel throughout will be six inches a-mile and the depth four feet. It has not been thought advisable to make this channel navigable; but this can easily be done if necessary.

13. *Hamsaladevi and Sivarnamuki Channels.*—The second and third branches will take off from the bank channel in the 38th mile near the village of Avanigadda; the former will be supplied by a sluice of two vents of five feet span, and will have a fall of seven inches per mile throughout, with a drop of one foot six inches in surface of water in the third mile; the water above this being kept high to supply the Machavaram branch. It will follow the general direction of the south bank of the Puligadda branch to near the village of Hamsaladivi; its total length will be fifteen miles and one furlong. The latter will be supplied by a head sluice of one vent of five feet span and will have a fall seven inches a-mile throughout, with a drop of three feet in the second mile and another in the surface of water of one foot in the sixth mile and a third one of one foot in both bed and water at the 8th mile; these drops are necessary to avoid banking; it will run in a south-easterly direction nearly through the centre of Divi; all the other branches of bank channel are small and the details concerning them are given in Appendix B.

14. *Rest Houses.*—I have provided three rest-houses in the estimate for the channel—two first class, one at Ilur and one at Avanigadda, one second class at Kodur.

15. *Cattle Crossings, &c.*—Cattle crossings and accommodation bridges have been provided where necessary.

16. *Several Remarks on the Estimates.*—The estimates have been prepared with great care and the rates allowed are believed to be ample, so that under proper superintendence there is no chance of these being exceeded, and if the work is commenced soon, there will doubtless be a considerable saving. I may here mention that the levels were all taken between three and four years ago, and owing to the high freshes in late years which have breached the river bank, it may be found that the levels are slightly altered; but this will cause a very slight difference, as in some places the existing pits have been deepened and enlarged to repair the bank, while in others they have got somewhat silted up, so that there will be no increase or decrease to speak of in the estimate. It may likely be found also in carrying out the work that in parts where the river has cut in, it will be safer to take the line of the channel a little further inland; I did not think it necessary on account of these circumstances to have the whole channel surveyed and levelled again.

17. *Cost and Returns.*—I cannot give with accuracy the revenue to be derived by the construction of the Bank Channel, as I am unable to get the necessary information regarding that portion of the land to be irrigated which is Zemindary; but I think I can show satisfactorily that the work will prove remunerative. The total cost is as follows, *vide* Appendix C:—

	Rs.
Navigation	26,853
Irrigation	10,56,757
Drainage	2,27,705
Total Rupees ...	13,11,315
Say	13,11,000
Tools and plant at eight per cent	1,04,880
Say	1,05,000
Total Cost	14,16,000

If 2 lakhs are spent yearly, which I think can easily be done, the project will take 7 years to complete.

Taking repairs, maintenance and conservancy during execution at 3 per cent on outlay (about the present rate):—

	Rs.
For the 1st year cost will be	6,000
„ 2nd „	12,000
and so on.	
And for the 7 years	1,68,000
The simple interest on the money borrowed at 4 per cent will amount to	2,24,000
Take hutting money at	10,000

The dry land to be occupied by the channels will be acres 2,800, assessed at Rupees 2, and if one-seventh of this be taken up yearly, the loss of assessment will be Rupees 22,400.

The required expenditure before the project is completed will therefore be as follows:—

	Rs.
Actual cost of work	13,11,000
Tools and plant	1,05,000
Repairs, &c., during construction	1,68,000
Simple interest	2,24,000
Hutting money	10,000
Loss of assessment on land	22,000
Contingencies and unforeseen expenses	20,000
Total	18,60,000

No extra establishment is allowed to carry out the works, as it will not be required. Excluding all Zemindary and Inam lands, the revenue to be derived from Divy alone,—*vide* Appendix E—is Rupees 1,89,013, say Rupees 1,90,000.

From this has to be deducted cost of repairs, maintenance and conservancy at Annas 10 per acre on Acres 45,000 = Rupees 28,125, say Rupees 28,000. Loss of assessment on land occupied = Rupees 5,600 say Rupees 6,000. Net Revenue = Rupees 1,56,000 or 8·38 per cent on total expenditure. Deduct interest at 4 per cent, profit to Government = 4½ per cent nearly.

If the 15,000 acres of Zemindary land were included at Rupees 4 per acre water-tax, the return would be about 8 per cent In the foregoing calculations, it has been assumed that not an acre of land will be taken up till all the works are completed, which is most improbable. No allowance has been made for the value of the land in the beds of the tanks in Divy, which may be sold, and returns from navigation and canal produce have been omitted; in fact, I have taken the worst possible view of the case merely to show that the channel will pay under any circumstances; at the same time, I am convinced that the channel will eventually give at least 10 per cent clear profit, and if this is thought too little, and a complete scheme for irrigation and drainage is required, the only way a larger return can be obtained is by increasing the water-tax.

18. *General Remarks.*—That all the land in Divy will [illegible] cannot be doubted by any one who has seen it; the island is peculiarly adapted for rice cultivation and nothing else could well be grown there, except in the north-west corner; that it may be some years before the whole 45,000 acres are taken up is possible owing to the small population; but at the same time, it must be remembered that the system of irrigation now proposed will not be completed for some years, and the mere fact of executing large works in the island, by which the people who are now very poor will be able to earn money, whereby they may buy good food and clothes and house themselves comfortably, will tend to increase the population. I would most strongly urge the necessity for commencing this channel immediately instead of waiting till the whole of the Eastern Delta Project is completed and the returns laid down in such detail as seem to be required by the Government of India, to do which latter will, I am convinced, take considerable time. The total cost of the Eastern Delta Project can be seen nearly enough from the general report, and this division, viz. the 1st, is quite independent of any other division, so there is no reason why the works in it should not be carried out immediately. The circumstances of Divy are becoming worse and worse every year; the tanks are getting so silted that in one or even two freshes, they do not receive a sufficient supply of water to last for the season. The tank banks are falling into a state of decay, and require large sums of money yearly to keep them in repair. The open cuts from the river cause great destruction to the river bank; in fact, the whole island is in a most miserable state and it is not improbable that if something is not done soon, there will be no cultivation at all except a little dry on the high ground near Avanigadda, and all this may be prevented in about four years from this time; if the proposed works were commenced at once, instead of waiting to get figures shown on paper, which may really be useless as the whole success of the work depends on whether the ryots take up the land or not; and I think the Local Officers ought to know that best. I have not travelled about constantly in this district for six years without knowing what land will be taken up and what will not, and I am convinced (I do not know how to put it strong enough) that the channel will repay Government well; there is no other new channel in the district that is so certain of proving remunerative. I would therefore advise that the Government of India be requested to grant sanction to commence this work at once. Every year of delay is so much loss of revenue, and as the price of labor and materials is increasing every year will add to the cost of the work.

19. *Masulipatam West-side Channel.*—The area commanded by the west side channel is 96·92 square miles, out of which 96 square miles are Zemindary, and out of this whole area it is assumed that 28,000 acres will be cultivated wet, which is in the proportion of 288·89 acres to the square mile.

20. *Present state of Irrigation.*—In the area commanded by this channel there were in the year 1873-74 (the latest year for which account returns have been received), Acres 6,838 of wet cultivation; this is supplied principally by the Aga Kodu, an old channel excavated from

the Bheemanady drainage, which latter now receives a supply from the Masulipatam Canal by a sluice above Viranki lock, the Aga Kodu joins the existing Inampudi drain near the village of Peda Muttevi, and from thence, they flow in one channel to the village of Kotlapudi where the channel bifurcates, one branch going into the Mallavole swamp under which there is a considerable amount of irrigation, and the other ending in the Dayapu Calava drainage. As the Aga Kodu acts both as an irrigation and drainage channel, it gives rise to constant disputes between the ryots, some of whom want it bunded to supply the Kaza tank and some minor channels while others want it left unobstructed to allow the surplus water to run from their fields. The other sources of supply are the Bhatlapenumarru, the Kosur North and the Kosur South channels, all branches of the Bheemanadi, and the Bodlunka, Daggemalli, Nimakur and Mallavole channels, all of which take off direct from the Masulipatam Canal; there are also several palmyra sluices in the west bank of the Masulipatam Canal which water a few acres.

21. *Original Estimates.*—It will be seen by the above brief sketch that the irrigation and drainage of this part of the delta is very defective. An estimate for the Masulipatam west side channel amounting to Rupees 49,860 was sanctioned in the year 1866—*vide* G.O., No. 3,342, dated 19th October 1866—but the work was stopped in 1871, and a revised estimate called for, the whole of the excavation as far as Aukumarru has been done in a sort of way, but such a number of years having elapsed since the work was executed, the channel has silted up and got choked up with grass and weeds so as to be hardly discernible in parts and a great deal of earthwork has yet to be done. The original estimate did not allow for any branch channels and only Rupees 1,200 for sluices; but in the year 1869, three vents of the weir at Kunkipaud were converted into a head sluice at a cost of Rupees 8,726-11-9, and materials were collected for a drop and tunnel at Bodlapaud and a tunnel at Kommamur at a cost of Rupees 1,429-0-5. These works appear to have been executed from the money allowed for earthwork.

	Rs.	A.	P.
Bodlapaud Drop	183	3	6
Bodlapaud Tunnel	774	2	9
Kommamur do.	471	10	2
	1,429	0	5

The original design allowed for the existing lock weir of the Masulipatam Canal being used as drops on the side channel, as they would not be required for the former channel, which would be converted into a still water one: this I consider a bad arrangement, and you expressed yourself of the same opinion when you visited the district in 1873, it would cause very little saving in the cost of the side channel, and I think it advisable to maintain the weirs on the Masulipatam Canal in case of emergency, as it may sometimes be found impossible to keep still water in it.

Paragraph 30 of Memorandum No. 309-A, dated 7th May 1874.

In the plan now sent in, nearly the same falls as originally proposed are maintained; but instead of the channel ending near Aukumarru lock in a cross bund, it will be continued in a westerly direction to the Aga Kodu drain, and in place of using the existing weirs, drops have been provided where necessary.

22. *Head Sluice.*—At two cubic yards per acre per hour, the discharge required through the head sluice is 420 cubic feet a-second; this sluice at present consists of nine vents of 2 feet 9 inches span by 2 feet 9 inches height; the level of the floor is + 35 feet 0 inch and of the top of the covering stones + 38·5 inches. The level of the water in the Masulipatam Canal will be + 41·5—*vide* paragraph 2 of the report of that canal—the level of water in side channel will be + 41·0; consequently, the head will be 0·5 and the discharge would be insufficient; moreover, the water in Masulipatam Canal would go over the top of the vents. It is therefore, proposed to convert two more arches of the weir bridge into a sluice by dividing them each into two vents of 5 feet 12 inches span and 2 feet 9 inches height; to raise all the piers; to add a platform throughout at a level of + 43 feet and to fix screw gearing to the shutters. Steps will be allowed at one end from the level of the platform to that of the roadway. The discharge through the sluice will then be 435·53 cubic feet a-second, which is ample.

23. *Position of Head.*—I may here mention that I had intended to take the west side channel from the bank channel instead of from the Masulipatam Canal; and I proved in my letter No. 3, dated 1st April 1875, that the former plan would be cheaper and more advantageous than the latter; but in your memorandum, No. 226, dated 24th February 1875, you did not allude to this, but only remarked that the side channel was to take off from the Masulipatam Canal at Kaukipaud lock.

24. *Design of Channel.*—I have therefore obeyed those instructions, though I am still of opinion that the other arrangement is better, no argument having been advanced against it. From the head sluice for a distance of 2¼ miles the fall of bed will be 7 inches a-mile, depth of water 6 feet, at this point there will be a drop of 3 feet; from thence to the 10th mile the fall will be 10 inches a-mile, depth of water 5 feet 6 inches; at 10th mile, there will be a drop of 2 feet 1 inch with an accommodation bridge over it; from this point for a distance

of thirteen miles, the fall will be 7 inches, depth 5 feet 6 inches; here there will be a regulating bridge, the depth of water below being only 5 feet, the fall of 7 inches will be continued as far as thirty-one miles and two furlongs from head, and in the 25th mile a drop of 3·78 with a bridge will be provided, and below this point the depth of water will be 3 feet: from thirty-one miles and two furlongs, the fall will be 8 inches a-mile to its termination in the Aga Kodu, where there will be a tail escape. These falls have been designed with reference to the channel as already excavated. Full information regarding velocity, discharge, &c., will be found in Appendix G accompanying this report.

25. *Bridges, &c.*—Several accommodation bridges have been allowed at important points in the channel to allow of the produce of the country to the west of the Masulipatam Canal being carted to boats on that canal without having to break bulk to cross the side channel. Cattle crossings have also been allowed where necessary.

26. *Principal Branches.*—The principal branches of the side channel will be the Medur channel and the Bheemanadi east side channel.

27. *Medur Branch.*—The former will leave the side channel; 10th mile and after following the course of the existing Bodlunka channel for a distance of two miles five furlongs will be continued along the east side of the Kanikalamadugu tailing into it near the village of Chilkalapudi; it will command all the land between the Bheemanadi and the Kanikalamadugu, in all 24·03 square miles, and will irrigate 4,000 acres.

28. *Bheemanadi Cut with Channel.*—The latter will leave the west side channel in the 13th mile and follow the general direction of the Bheemanadi drainage (avoiding bends) for a distance of fifteen miles three furlongs, where it will tail into the Kanikalamadugu. It will command all the land between the Bheemanadi and the existing and proposed Inampudi drain, in all 22·95 square miles and will irrigate 6,000 acres.

29. *Bhatlapenumarru Channel and Aga Kodu.*—The Bhatlapenumarru channel and the first part of the Aga Kodu will be used (being improved) as branches of this channel; but all that part of the Aga Kodu to the east of the Inampudi drain will be abandoned as an irrigation channel, and the latter portion of it from the end of the proposed Polaveram channel to the Dayapu Calava will be used entirely as a drainage. The remaining branches of the side channels are minor ones, and all details concerning them can be found in the Appendix G; they need no be described here.

30. *General Design of Branch Channels.*—The falls of most of these branches were settled by Captain Smalley, R.E., before I took over charge of the project, and they are all seven inches a-mile, and as the fall of the country is rapid, numerous drops have to be provided on the Medur Channel and Bheemanadi east side channel; if the falls of the channels were increased, it is probable that temporary cross bunds would have to be raised, as the transverse fall of the country is slight, but still I am of opinion that a fall of 9 inches a-mile with fewer drops would be better; however, this is a matter of opinion, and as increasing the fall will reduce the cost, I think that if the alteration be approved, it may be done while the works are being carried out without all the plans and estimates being revised at present.

Drainage.

31. *General Principles of Drainage.*—The principles and data on which drainage channels are to be designed are laid down in memorandum No. 491-F, dated 8th August 1873, paragraphs 2 to 9, and these have been rigidly adhered to in designing the channels. As the drainage areas, discharge, falls and all detail of the channels are given on the plans and in Appendix K, it will not be necessary to give this information here, so I will confine my remarks to describing the present state of the drainage and the proposed improvements.

32. *Inampudi Drain.*—The principal drainage is the Inampudi channel which will drain 31 square miles of country to the north of Masulipatam Canal and nearly the whole of the country between the Bheemanadi and the Masulipatam Canal as far south as the road from Masulipatam to Sallapally. The drainage water from the 31 square miles north of the Masulipatam Canal used to pass under that canal and the west side channel by an under tunnel of one vent of 6 feet span, but this year a tunnel of five vents of 8 feet span each has been added which gives ample discharge; from the under tunnel there is a small channel for a distance of five miles where it joins the Aga Kodu as mentioned in paragraph 20; this channel is to be considerably enlarged and continued in nearly a straight line from its present junction with the Agakodu to the Dayapu Calava; as the channel will drain very important lands on either side, it was thought advisable to keep the water surface low, hence there is considerable cutting. The Dayapu Calava is simply a large and deep swamp into which the drainage of a large portion of the country (it is now proposed to drain by the Inampudi drain) slowly finds its way, and there being no proper outlet, it floods a large tract of country both above the Sallapalli road and also as far down as the villages of Kotta Majeru and Chinnapuram.

33. *Dayapu Calava.*—The Inampudi drain is continued in the lowest part of the swamp for about half-a-mile, when it is joined by the proposed drainage from the Kanikalamadugu; these two united are carried in one channel called in this project the Dayapu Calava drain; it will be carried along the lowest part of the swamp to the terminus of the latter, and will then be taken in a straight line to a small creek near Garaladibba, from whence it is discharged into the Masulipatam creek near Gilakaladindy.

The drainage will be carried the whole distance between banks, as the expense of cutting the channel to its full width and depth would be very great. The creek from Garaladibba to Gilakaladindy, not being nearly large enough to discharge all the drainage, will also be embanked to prevent the water from spreading and induce scouring. The water being carried above the level of the country will of course impede the discharge of the local drainage at times; but this cannot be prevented except at enormous expense, and as the land for some distance on each side of the channel is waste, it will not signify much. By this and the Inampudi drain, it is anticipated that a large tract of country now periodically flooded will be rendered fit for cultivation.

34. *Lankapally and Sivagunga Drains.*—There is a piece of country, north of the Sallapalli road as far as the villages of Mallavole and Aukumarru, which cannot drain into the Inampudi channel; the drainage from this portion will be received into the existing Lankapally drain (amply large) by which it will be discharged through the Sivagunga self-acting sluice into the Sivagunga drainage channel, which is now being enlarged and will be completed this year. Part of the land to the east of the Dayapu Calava will also drain into the Sivagunga channel.

35. *Kanikalamadugu.*—The Kanikalamadugu is a natural drain commencing about midway between the Masulipatam canal and the Kistna river a little above the village of Penamakur, it flows in a south-easterly direction for 11 miles, where it divides into two branches; the west branch will be banked cross by two of the proposed irrigation channels and will not be required for drainage (in the portion crossed with red in the plan) as the water will be led into the west branch by the catch drains on the upper sides of the irrigation channels; the east branch will be joined near Chilkalapudi by the Bheemanadi; these unite in one channel (known only by the name of the former) which flows in an easterly direction, crossing the Sallapally road near Lankapally; from thence it used to flow in an easterly direction into the Puligadda branch of the Kistna, but the latter part of the channel being now silted up, it takes a sudden turn again and joins the Dayapu Calava; this latter having no outlet, the water from the Kanikalamadugu is not discharged freely; it consequently overflows its banks and finds its way across country into the Kistna branch, where the water in the latter is low. The Kanikalamadugu and the Bheemanadi both before and after they unite are sufficiently large to carry all the drainage they are required to discharge as may be seen from the cross sections, consequently no alterations are proposed to them. A straight cut about a mile in length will, however, be made to connect the Kanikalamadugu and the Dayapu Calava drain.

36. *Drain near Bank Channel.*—37. *Bodlapad Channel.*—I have stated in paragraph 6 of this report that there are two strips of low land in this division; the first mentioned will be traversed by the Inampudi drain and the last partly by the bank channel; this latter will therefore be provided with inlets and the surplus will be discharged by a weir near Davarapalli and a channel to the Kanikalamadugu; the other part of the low strip will be drained by the Bodlapad channel which will discharge into the Kanikalamadugu.

38. *Viranki Drain.*—There will also be a small channel called the Viranki drain which will carry off the water from about 2 square miles of country which was formerly drained by the Bheemanadi but is now intercepted by the Masulipatam Canal.

39. *Taleru Drain.*—It can be seen from the map that there is an extensive swamp in the south-east portion of the island of Divy near Kodur; this is excellent soil and the ryots are very anxious to cultivate it; it is proposed to drain this by a channel called the Taleru drain running along the lowest part of this swamp and discharging into the Kistna branch.

40. *Gudumotu Drain.*—As the ground falls both from the river and from its branch, it is evident that some drainage water will lie up against the banks of the Suvarnamukhi channel which runs nearly through the centre of the island; it is therefore proposed to dig a catch drain on each side of that channel, that on the north side will discharge into the Taleru drain, that on the south side will be called the Gudumotu drain and will be excavated as far as a small salt creek. Many of the branch irrigation channels will have catch drains on their upper side.

41. *Cost.*—The total cost of the drains of this Division is Rupees 4,42,940 and by this expenditure it is anticipated that 401·97 square miles of country will be thoroughly drained; in this area, the wet cultivation benefited will be 88,000 acres while the dry will amount to about 1,42,800 acres, so that it seems hardly fair that the whole amount should be charged to irrigation; however, this must be settled by higher authorities.

42. *General Remark.*—I would here state that I consider the drainage channels a great deal larger than necessary, and I believe they would answer the purpose quite well enough if they were reduced to one-third the size now estimated for,—at any rate as regards draining wet cultivation.

43. *General Remarks on Plans and Estimates.*—Most of the works in this division were designed three years ago, so some of the late instructions regarding masonry works generally have not been attended to, but the alterations necessary are so trifling that I did not think it necessary to re-draw the plans, and if the alterations required make any difference in the estimate, it will be to reduce the amount. The length of time the plans and estimates have been kept in this office also accounts for their somewhat untidy appearance, most of the plans were drawn by men who were new to the work and who had consequently to be taught; this is why they are not so neat as those done lately. I hope these defects will be excused.

44. *General Principles observed in the Designs for Masonry Works.*—The springing line of all arches over drainage channels has been made three feet above full supply level and rough stone aprons have been allowed in front of the piers; puddle has been allowed behind all walls exposed to pressure from water; screw gearing has been provided for all sluices where the head of water is greater than three feet or the size of the vent more than three feet. The screw gearing is of that pattern found to answer best in the Godavery District. Rough stone aprons and revetments in rear of sluices, &c., have been allowed, the length being as follows:—

Head.	Length.
6 inches	10 feet.
1 foot 6 inches	15 ,,
3 feet	20 ,,
More than that	25 ,,

These being the distances to which I have observed the banks to cut away with various heads. The foundations of all works are on concrete. An external batter of $\frac{1}{12}$ has been given to all wing walls.

The upper wings of sluices, &c., have all an outward curve, and the lower wings are curved in to the width of channel below. In the Godavery works, the width between the ends of the lower wings is considerably more than that of the channel below, and the revetments are thrown still further apart; this gives rise to a considerable back current, which does much to injure the banks. The foregoing are the points most worthy of note in the masonry works.

Numerous bridges and ramps have been allowed, and whether part of the cost of this should be paid from Local Funds or not must be settled.

45.—*Cost of all Works in 1st Division.*—The total cost of works in this Division are:—

Bank channel and branches	10,83,610
Masulipatam west side channel	2,03,100
Drainage	4,42,940
	17,29,650
Or	26,853
Navigation	12,59,857
Irrigation	4,42,940
Drainage	

46. *General Observations on Returns.*—I think I have shown clearly in paragraph 17 that the bank channel will pay, but I will not attempt to go into the revenue to be derived by all the proposed works in the division, and I must confess my inability to obtain any accurate revenue accounts; but even if the class, &c., of each particular field to be is irrigated ascertained, which I believe is what is wanted, even then it would be impossible to get accurate results for the following reason:—The channels do not irrigate all the land they command; for instance, the bank channel commands 1,58,720 acres but is only to irrigate 60,000 acres, consequently, it cannot be ascertained what fields will be irrigated till the land is actually taken up. Some may be Inam, some mamool wet, and it will be impossible to tell this before hand. The difficulty of calculating the returns to be derived from increasing the irrigation and drainage of this division is increased by the fact that it is nearly all Zemindary. Now, the manner in which water-tax is levied on Zemindary is a mystery to me, and though I have puzzled over the revenue returns, I am unable to understand them. From the last return received from the Collector for 1873-74, it appears that in the Eastern Delta alone, there are 20,323 acres of land watered free of charge, while, as far as I can make out from old records, the total wet cultivation in Zemindary before the construction of the anicut was only Acres 8,000, so how there can now be more Acres 20,000 of mamool wet, I cannot make out. The average water tax now received from all the Zemindary land watered, omitting that free of charge, is only Rupees 1-9-0 an acre; and it is evident that at this rate it will not pay to make any new channels to irrigate Zemindary land, and I think it is absolutely necessary that strict enquiries should be made into the area and class of Zemindary land now irrigated, and as this

will be a troublesome and difficult matter, I do not think it can be satisfactorily done unless a Public Works and a Revenue Officer are appointed especially for the work. During the time that I have been travelling about the district, I have become convinced that the anicut does not get its full dues on account of Zemindary land irrigated.

47. *Indirect Returns.*—In conclusion, I would observe that besides the direct returns to Government from the estimated works, the advantages to the country will be enormous and the prosperity of the district greatly increased thereby, for, the communication will be improved; the country will no longer be impassable during the monsoon; by the discharge of a large quantity of drainage into the Masulipatam creek, the bar will be greatly improved and the port may become as important as it was in former days; and lastly, the mere fact of spending a large sum of money by which many persons will be maintained and earn money will add greatly to the wealth of the people and enable them to buy and cultivate land, which otherwise they could not do, and this in time will yield money to Government. There is no better way of increasing the prosperity of a country than by giving the people lots of work, by which they can earn money and thereby increase the circulation of coin.

A.

Statement showing the distribution of Water of Bank Canal

Names of Channels.	Positions.	Area.		Fall or Slope per Mile.		Maximum Depth.	Ordinary full		
		Commanded.	Supply provided per.	Bed.	Surface.		Depth.	Area of Cross Section.	Mean Velocity in Feet per Second.
1st Sub-division—	M. F. Y.	SQ. M.	ACRES.	FT. IN.	FT. IN.				
Bank Canal	4 0 0	248·0	60,000	0 6 0 7 0 8 0 6	0 6 0 7 0 8 0 6	..	6·5	435·5	2·09

Masulipatam,
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in the 1st Sub-section of Eastern Delta, Kistna District.

supply.		Distribution of Water to Branches.						
Discharge in Cubic Yards per Hour.	Discharge in Cubic Feet per Second.	Branch Ducts and Branches.	Distance from head of Channel.	Quantity.		Acreage.	Remarks.
				Cubic Yards per Hour.	Cubic Feet per Second.		
			M. F. Y.				
121,358·8	910·19	Kuderu branch	19 2 153	1,824·00	13·68	400	Direct under main duct.
		Lankapalli do.	21 5 153	1,824·00	13·68	500	
		Sricakolam do.	23 7 153	1,824·00	13·68	800	
		Chittore do.	26 7 153	1,824·00	13·68	700	
		Vakkalagadd do.	28 4 153	1,824·00	13·68	600	
		Pogole do.	30 6 153	1,824·00	13·68	400	
		Pedaprole do.	33 2 153	2,560·00	19·20	700	
		Wadapalem channel, branch duct..	34 0 153	23,296·0	174·72	10,900	Direct.
		Nelakurru branch	6 2 120	5,921·33	44·41	3,000	Branches.
		Chinnayadra do.	8 0 60	5,921·33	44·41	3,000	
		Suvarnamuki channel duct ..	37 5 163	14,234·88	106·76	7,000	Direct.
		Mandapakala branch	6 0 0	4,353·33	32·65	2,000	Branches.
		Pedagollapalem branch	8 0 0	4,353·33	32·65	1,500	
		Chinnapalem do.	8 0 0	4,353·33	32·65	1,500	
		Hamsaldivi channel, branch duct..	37 5 163	38,808·00	291·06	17,000	Direct.
		Machavaran branch	2 4 0	4,353·33	32·65	2,000	Branches.
		Kaldindivari do.	5 0 0	10,304·00	77·28	5,000	
		Kodur do.	7 0 0	10,304·00	77·28	5,000	
		Bandalayacheruvu branch ..	39 7 142	4,353·33	32·65	2,000	Direct under main duct.
		Vakanur do. ..	40 7 142	8,094·88	60·71	4,000	
		Chowdaveruvu do. ..	43 3 56	8,094·88	60·71	4,000	
		Talagadadivi do. ..	46 5 56	10,304·00	77·28	5,000	
		Yetimoga do. ..	48 4 56	4,353·33	32·65	2,000	
		Direct under bank canal in Divi ..	..	..	..	4,000	
						60,000	

(Signed) D. McNEIL CAMPBELL, Lieut., R.E.,
Executive Engineer, Kistna District.

Table showing the Velocity and Discharge, &c., of the different Channels estimated

Formula used is $D = A \times \cdot 916 \sqrt{2f \times H.M.D.}$

Number of Divisions.	Number of Main Ducts.	Number of Branches.	Names of Channels.	Distance from head.	Side Slopes.	Bottom Width.	Fall of Channel.
1	2	3	4	5	6	7	8
D. I.	C.	..	Bank Canal, head at Yanamalakuduru	..	2 to 1	54	0·5
			Do. to Kuderru branch	19 2 460	2 to 1	54	0·5
			Do. to Lankapalli do.	..	2 to 1	53	0·5
			Do. to Srikakulum do.	23 7 460	2 to 1	53	0·5
			Do. to Chittoor do.	24 0 0	2 to 1	48	0·58
			Do. to Vakkalagedda do.	28 4 460	2 to 1	47	0·58
			Do. to Pogole do.	..	2 to 1	46	0·58
			Do. to Pedaprole do.	33 2 460	2 to 1	46	0·58
			Do. to Wadapalem branch channel ..	34 0 46	2 to 1	45	0·58
			Do. to Aqueduct at Poligedda	35 3 0	2 to 1	35	0·58
			Do. to Dividing sluice at Avinigudru ..	37 5 490	2 to 1	32	67
..	C	..	Do. to Bundalaya Cheruvu branch ..	39 7 350	2 to 1	14·0	0·5
			Do. to Vakanur do.	40 7 350	2 to 1	12·0	0·5
			Do. to Chowdavarum do.	43 3 350	2 to 1	27	0·5
			Do. to Talagadadivi do.	46 5 350	2 to 1	19	0·5
			Do. to Yetimoga do.	48 4 350	2 to 1	8·0	0·5
			Do. to end	52 1 350	2 to 1	4·0	0·5
		6	Kuduru branch	19 2 460	1½ to 1	3·0	0·66
		8	Lunkapalli do.	..	1½ to 1	3·0	0·66
		9	Srikakalam do.	23 7 460	1½ to 1	3·0	0·66
		11	Chittoor do.	..	1½ to 1	3·0	0·66
		12	Vakkalagadda branch	28 4 460	1½ to 1	3·0	0·66
		13	Pogole do.	..	1½ to 1	3·0	0·66
		15	Pedaprole do.	33 2 460	1½ to 1	5·0	0·66
		16	Wadapalem channel, branch duct	34 0 460	..	..	..
			Vadapalem branch channel and Nelakurru branch.	6 2 360	2 to 1	20·0	0·5
			Wadapalem China Yedra branch	8 0 180	2 to 1	10·0	0·5
			Do. to end	12 6 0	2 to 1	4·0	0·5
..	C	51	Nelacurru branch	6 2 360	1½ to 1	6·0	0·66
	16						
		53	China Yadra do.	8 0 180	1½ to 1	6·0	0·66
			Direct irrigation under the main duct near Pedakullapalli.	..	..	..	..
			Do. do. Vadapalem	..	..	..	..
..	C	20	Savernamukhy channel branch duct ..	37 5 490	..	..	..
			Do. do. to Mandapakala branch,	6 0 0	2 to 1	9·0	0·583
			Do. do. Pedagollapalem branch ..	8 0 0	2 to 1	12·0	0·585
			Do. to end	10 4 0	2 to 1	3·0	0·585
..	C	68	Mandapakala branch	6 0 0	1½ to 1	6·0	0·66
	20						
		70	Pedagollapallum branch	8 0 0	1½ to 1	6·0	0·66
		71	Chinna Gollapallem do.	8 0 0	1½ to 1	6·0	0·66
			Direct Irrigation under the main duct ..	..	..	..	..
..	C	21	Kamsaldivi branch channel	37 5 490	..	..	..
			Do. to Matsavaram branch ..	2 4 0	2 to 1	17·00	0·585
			Do. to Kalidindivari do. ..	5 0 0	2 to 1	24·00	0·585
			Do. to Kodur do. ..	7 0 0	2 to 1	16·00	0·585
			Do. to end	15 1 0	2 to 1	6·00	0·585
..	C	56	Matsavaram branch	2 4 0	1½ to 1	6·00	0·66
	21						
		60	Kalidivari do.	15 0 0	1½ to 1	17·00	0·66
		62	Kodur do.	7 0 0	1½ to 1	17·00	0·66
			Direct irrigation under the main duct ..	..	..	..	..
..	C	22	Bandalayachervoo branch	39 7 350	1½ to 1	6·00	0·66
	22						
		23	Vakanur do.	40 7 350	1½ to 1	13·00	0·66
		25	Chowdavaram do.	43 3 350	1½ to 1	13·00	0·66
		27	Talagadadivi do.	46 5 350	1½ to 1	17·00	0·66
		29	Yetimoga do.	48 4 350	1½ to 1	6·00	0·66
			Irrigation under main duct in Divi Island ..	..	..	..	..

Masulipatam,
30th October 1875.

B.

in connection with the Bank Canal in 1st Sub-section, Eastern Delta, Kistna.

Depth of Water.	Area of Cross Section.	Hydraulic Mean Depth.	Surface Velocity.	Mean Velocity.	Bottom Velocity.	Discharge required in Cubic feet per second.	Actual Discharge in cubic feet per second.	Discharge in cubic yards per hour.	Area in Square Miles under command of Anicut Water.	Proposed Acreage.	Proposed Acreage per Square Mile.
9	10	11	12	13	14	15	16	17	18	19	20
6·5	435·5	5·24	2·61	2·09	1·57	900·0	910·19	121,358·88	248·08	60,000	..
6·5	435·5	5·24	2·61	2·09	1,57	900·0	910·19	121,358·88	248·08	60,000	241·85
6·5	429·0	5·23	2·61	2·09	1·57	894·0	896·61	119,548·0	..	59,600	..
6·5	429	5·23	2·61	2·09	1·57	886·5	896·61	119,548·0	..	59,100	..
6·5	396·5	5·14	2·79	2·23	1·67	874·5	884·19	117,892·0	..	58,300	..
6·5	390·0	5·12	2·77	2·22	1·67	864·0	865·80	115,440·0	..	57,600	..
6·5	383·5	5·11	2·77	2·22	1·67	855·0	851·37	113,516·0	..	57,000	..
6·5	383·5	5·11	2·77	2·22	1·67	849·0	851·37	113,516 0	..	56,600	..
6·5	377·0	5·09	2·77	2·22	1·67	835·5	836·04	111,592·0	..	55,900	..
6·5	312·0	4·87	2·71	2·17	1·63	675·0	677·04	90,272·0	..	45,000	..
6·5	292·5	4·79	2·89	2·31	1·73	675	675·67	90,089·33	..	45,000	..
6·5	175·5	4·08	2·31	1·85	1·39	315	324·67	43,289·33	..	21,000	..
6·5	162·5	4·04	2·26	1·81	1·36	285	294·12	39,216·0	..	19,000	..
4·0	140·0	3·12	2·01	1·01	1·27	225	225·4	30,053·33	..	15,000	..
4·0	108·2	2·92	1·95	1·56	1·17	165	168·43	22,464	..	11,000	..
4·0	64·0	2·47	1·80	1·44	1·08	90·0	92·16	12,228	..	6,000	..
4·0	48·0	2·19	1·69	1·35	1·01	60·0	64·8	8,640	..	4,000	..
2·0	12·0	1·17	1·42	1·14	0·86	6·0	13·68	1,824·0	4·047	400	98·84
2·0	12·0	1·17	1·42	1·14	0·86	7·5	13·68	1,824·0	5·394	500	92·70
2·0	12·0	1·17	1·42	1·14	0·86	12·0	13·68	1,824·6	9·806	800	83·60
2·0	12·0	1·17	1·42	1·14	0·86	10·5	13·68	1,824·0	7·96	700	87·96
2·0	12·0	1·17	1·42	1·14	0·86	9·0	13·68	1,824·0	7·828	600	76·65
2·0	12·0	1·17	1·42	1·14	0·86	6·0	13·68	1,824·0	4·56	400	89·77
2·0	16·0	1·31	1·50	1·20	0·90	10·5	19·20	2,560·0	7·612	700	91·96
..	..	..	..	..	..	..	..	..	..	..	..
4·0	112·0	2·95	1·95	1·56	1·17	163·5	174·72	23,296·00	49·234	10,900	221·39
4·0	72·0	2·58	1·82	1·46	1·1	105·0	105·12	14,016·00	..	7,000	..
4·0	48·0	2·19	1·69	1·35	1·01	45·0	64·80	8,640·00	..	3,000	..
3·0	31·5	1·87	1·76	1·41	1·16	45·0	44·41	5,921·33	14·742	3,000	203·50
3·0	31·5	1·87	1·76	1·41	1,16	45·0	44·41	5,921·33	13·904	3,000	215·76
..	..	..	..	..	..	..	..	..	6·51	1,900	291·86
..	..	..	..	..	..	..	..	..	14·078	3,000	213·09
..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..
4·00	68·0	2·53	1·96	1·57	1,18	105·0	106·76	14,234·88	28·669	7,000	244·16
3 00	54·0	2·12	1·79	1·43	1·04	75·0	77·22	10,296·00	..	5,000	..
3·00	27·0	1·64	1·57	1·26	0·95	30·00	34·02	4,536·00	..	2,000	..
2·5	24·37	1·62	1·67	1·34	1·01	30·00	32·65	4,353·33	8·637	2,000	231·56
2·5	24·37	1·62	1·67	1·34	1·01	22·50	32·65	4,353·33	6·03	1,500	248·75
2·5	24·37	1·62	1·67	1·34	1·01	22·50	32·65	4,353·33	6·28	1,500	238·85
2·5	24·37	1·62	1·67	1·34	1·01	22·50	..	..	7·722	2,000	259·00
..	..	..	..	..	..	..	..	..	..	..	..
..	..	..	..	..	..	..	..	..	..	..	..
5·5	154·0	3·7	2·36	1·89	1·42	255·00	291·06	38,808·00	35·23	17,000	482 54
4·0	128·0	3·05	2·16	1·73	1·30	225·00	221·44	29,525·33	..	15,000	..
4·0	96·0	2·83	2·07	1·66	1·25	150·00	36	21,248·00	..	10,000	..
4·0	56·0	2·34	1·89	1·51	1·13	75·00	84·56	11,274·88	..	5,000	..
2·5	24·37	1·62	1·67	1·34	1·01	30·00	32·65	4,353·33	5·642	2,000	354·48
2·5	51·87	1·99	1·86	1·49	1·12	75·00	77·28	10,304·00	9·644	5,000	518·45
2·5	51·87	1·99	1·86	1·49	1·12	75·00	77·28	10,304·00	9·341	5,000	535·27
..	..	..	..	..	..	..	..	..	10·623	5,000	470·67
2·5	24·37	1·62	1·67	1·34	1·01	30·00	32·65	4,353·33	5·629	2,000	355·30
2·5	41·87	1·90	1·81	1·45	1·09	60·00	60·71	8,094·88	11·783	4,000	339·39
2·5	41·87	1·90	1·81	1·45	1·09	60·00	60·71	8,094·88	10·714	4,000	373·34
2·5	51·87	1·99	1·86	1·49	1·12	75·00	77·28	10,304·00	11·625	5,000	430·10
2·5	24·37	1·62	1·67	1·34	1·01	30·00	32·65	4,353·33	6·95	2,000	302·16
..	..	..	..	..	..	..	..	..	10·467	4,000	382·15

(Signed) D. McNEIL CAMPBELL, Lieut., R.E.,
Executive Engineer in Charge, Kistna District.

C.

STATEMENT showing the Area commanded, the present and the expected increase of Wet Cultivation and the anticipated Cost of Works shown below in the 1st Sub-section of the Eastern Delta, Kistna.

Names of Works.	Area commanded, Swamps, &c.	Acreage proposed.	Present Area of Irrigation.		Expected increase by proposed works.		Cost of proposed Works.			
			Acreage.	Assessment.	Acreage.	Assessment.	Irrigation.	Navigation.	Drainage.	Total.
	SQ. MILES.	ACRES.								
Bank canal ..	248·08	60,000	*18,155	41,350	41,845	2,49,013	10,56,757	26,853	†2,27,705	13,11,315

* Divi supplied from tanks which are fed by open cuts from the river.
† Includes all charges except Inampudi and Viranki channels which drains are to be watered by West Side channel.

MASULIPATAM,
30th October 1875.

(Signed) D. McNEIL CAMPBELL, Lieut., R.E.,
Executive Engineer in Charge, Kistna.

D.

STATEMENT showing the Outlay incurred and that now proposed on the following works of the 1st Sub-section in the Eastern Delta of Kistna.

Names of Works.	Outlay.				Balance of Estimate of Works in progress yet to be worked out.	Total.	Amount of Estimate now framed.	Total proposed Outlay.	Remarks.
	Original Works.	Repairs.	Total to 1874-75.	Probable Expenditure in 1875-76.					
	RS.	RS.	RS.	Allotment.	RS.	RS.	RS.	RS.	
Bank canal	44,965	..	44,965	..	..	44,965	10,21,350	10,66,315	
Kistna river embankment	35,932	80,269	1,16,201	12,000	4,000	1,32,201	62,260	1,94,461	
Total ..	80,897	80,269	1,61,166	12,000	4,000	1,77,166	10,83,610	12,60,776	

MASULIPATAM,
30th October 1875.

(Signed) D. McNEIL CAMPBELL, Lieut., R.E.,
Executive Engineer in Charge, Kistna.

E.

Irrigation Statement of Divi Division in Bunder Taluq, Kistna District, prepared by figures taken from Tahsildar's Statement of 27th April 1874, which was received in this Office agreeably to the Collector's Tahsildar No. 1,855, dated 29th July 1873.

Names of Villages.	Total Area.	Total Area of deduction, Land reserved for Public purposes and unfit Swamps.	Government.						Inam.				Total.		Remarks.
			Waste Land fit for Cultivation.	Cultivated Dry.	Average Revenue of last five years.	Wet Land not supplied by anicut water.	Average Revenue of last five years.	Waste Land fit for Cultivation.	Dry.	Total Average quitrent received during last five Years.	Wet Land not supplied by Anicut water.	Total Average quitrent received during last five Years.	Area.	Average Revenue of last five Years.	
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Vakanur	4,029	1,503	200	957	3,007	1,205	4,181	..	33	6	131	68	2,526	7,262	It would appear from the above statement that the arable land, viz., 67,084 acres, fetches 67,174 Rupees or Rupee 1 per acre; that the existing wet area is 18,155 acres, and the revenue derived therefrom is Rupees 41,350. Total available area is 67,084, of which it is expected to irrigate 45,000 acres by this project. From this deducting the present wet there will be left 26,845 acres to be taken up from the available waste of 36,105 acres, and the revenue derivable will be Rupees 1,34,225 at Rupees 6 per acre, including 1 Rupee only for land revenue. Besides this present wet land fetches Rupees 2·5 per acre as will be seen from the revenue of 40,876 Rupees for 15,944 acres. When Kistna water is supplied there is no reason why this area should not fetch Rupees 95,564 at Rupees 6 an acre as
2. Nangagadda	2,233	338	48	890	2,182	792	3,054	..	77	71	88	37	6,344	2,523	
3. Nagayalanka	2,904	2,069	100	470	1,634	198	861	..	41	8	26	20	835	8,121	
4. Marripalem	37,000	21,053	11,750	2,244	5,144	1,073	2,917	..	189	36	91	24	15,347	3,050	
5. Talagadadivi	15,664	8,606	4,339	1,053	1,239	1,304	2,694	..	59	1	203	16	7,058	2,710	
6. Chodaveram	1,679	56	271	468	773	749	1,894	..	53	27	82	16	1,623	6,131	
7. Bhavadavarapalli ..	15,619	1,892	8,458	1,098	1,256	3,831	3,820	..	70	21	(270	34	13,727	1,422	
8. Mandapakala	6,643	2,362	2,823	849	717	530	675	..	72	29	7	1	4,281	5,313	
9. Kodur	21,923	18,193	2,000	300	300	1,071	4,980	..	60	13	309	20	3,730	3,628	
10. Machavaram	2,065	360	663	332	1,525	698	1,998	..	14	1	58	4	1,705	7,500	
11. Modumudi	3,455	1,032	826	489	2,569	975	4,883	..	18	1	115	47	2,423	7,951	
12. Avinigadda	6,132	1,711	1,255	1,796	4,289	1,011	3,651	..	152	47	207	64	4,421	988	
13. Pittalanka	1,731	926	431	54	148	248	809	..	14	4	58	27	805	4,708	
14. Veswanadhapalli ..	9,957	5,684	1,000	855	652	1,941	3,969	..	..	..	477	87	4,273	383	
15. Karkaka	544	161	168	..	..	171	250	..	12	1	32	1	383	2,052	
16. Hamasaladivi	33,889	31,837	1,673	100	120	207	340	..	15	3	57	8	2,032	471	
Total ..	1,65,467	98,383	36,105	11,955	25,555	15,944	40,876	..	869	269	2,211	474	67,084	67,174	

Remarks.—The Inams to be taken up and the other Delta lands do. The total expected returns may thus be taken at Rupees 1,34,225 for waste to be taken up and
Rupees 94,788 increase for Government existing wet land which now fetches only about half its proper value, being imperfectly supplied.

Rupees 1,89,013 total expected return in Divi.

The Inams to be watered are not taken into account at all.

F.

Statement of Water Distribution of the West Side Channel of Masuli

Names of Channels.	Positions.	Area.		Fall or Slope per Mile.		Maximum Depth.	Ordinary		
		Commanded.	Supply provided for Acres.	Bed.	Surface.		Depth.	Area of Cross Section.	Mean Velocity in Feet per Second.
	M. F. Y.	SQ. MS.							
West Side Channel main duct.	...	96·92	28,000	0·58	0·58	7·0	6·0	204·0	2·06

MASULIPATAM,
30th October 1875.

patam Canal in the 1st Sub-Section, Eastern Delta, Kistna District.

Full Supply.		Distribution of Water to Branches.						
				Quantity.				
Discharge in Cubic Yards per Hour.	Discharge in Cubic Feet per Second.	Branch Ducts and Branches.	Distance from Head of Channel.	Cubic Yards per Hour.	Cubic Feet per Second.	Acreage.	Remarks.
			M. F. Y.				
56017·99	420·24	Vallur branch	2 3 77	3780	28·35	1,200	Direct.
		Medur do. duct ...	6 0 197	8293·33	62·2	4,000	
		Kristnapurum do. ...	4 6 0	2053·33	15·4	1,000	Branches.
		Gudapaud do. ...	7 0 0	2053·33	15·4	1,000	
		Vemulamoda do. ..	9 0 0	2053·33	15·4	1,000	
		Bhemanari East Side Channel branch duct.	9 2 77	12300	92·25	6,000	Direct.
		Agakodu branch ...	4 4 0	2053·33	15·4	1,000	Branches.
		Kosur north do. ...	7 4 0	2053·33	15·4	900	
		Do. south do. ...	8 7 0	3120·00	23·4	1,400	
		Mallumpalli do. ...	10 2 0	2053·33	15·4	1,000	
		Pusadum do. ...	12 2 0	2053·33	15·4	900	
		Yendakuduru do. ...	13 2 0	1712·0	12·84	600	
		Lunkapalli do. ...	14 2 0	2630·88	19·73	250	
		Bhatlapenumaru channel.	9 2 77	4229·33	31·72	2,000	Direct.
		Pedasanagallu do. ...	11 3 77	1712·0	12·84	850	
		Wurutur branch ...	13 3 77	2053·33	15·4	1,000	
		Chinamuthoi do. ...	15 6 77	3490·88	26·18	1,750	
		Nebhanipuri do. ...	16 7 77	2689·33	20·17	1,200	
		Nemmakur do. ...	20 0 77	4960·0	37.20	2,500	
		Ramanuapeta do. ...	22 6 77	3120·0	23·4	1,500	
		Polaverum do. ...	24 5 77	3120·0	23·4	1,600	
		Aukumarru do. ...	27 7 77	1939·33	14·52	900	
		Rudraverum do. ...	28 6 77	1939·33	14·52	1,000	
		Gundupalem do. ...	29 6 77	1939·33	14·52	900	
		Direct under West Side Channel.	...	...	...	1,600	
						28,000	

(Signed) D. McNEIL CAMPBELL, Lieut., R.E.,
Executive Engineer in charge of Kistna District.

G.

TABLE showing the Velocity and Discharge, &c., of the West Side Channel of Masulipatam Canal and its Branches in the 1st Sub-Section of Eastern Delta Kistna. Formula used is $D = A \times \cdot 916 \sqrt{2f \times \frac{A}{B}}$.

Number of Divisions.	Number of Main Ducts.	Number of Branches.	Names of Channels.	Distance from Head of each Channel.	Side Slopes.	Bottom Widths.	Fall of Channel.	Depth of Water.	Area of Cross Sections.	Hydraulic Mean Depth.	Surface Velocity.	Mean Velocity.	Bottom Velocity.	Discharge required in Cubic Feet per Second.	Actual Discharge in Cubic Feet per Second.	Discharge in Cubic Yards per Hour.	Area in Square Miles under Command of Anicut Water.	Proposed Acreage.	Proposed Acreage per Square Mile.	Remarks.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
I.	D.	..	West Side Channel of Masulipatam Canal from head at Kunkipad Lock to Bodlapad drop	2 2 300	1½ to 1	25·0	0·58	6·0	204·0	4·38	2·57	2·06	1·55	420·0	420·24	56017·99	96·92	28,000	288·89	The widths are as the channel was originally dug.
			Do. to Vallur branch	5 6 300	..	20·00	0·83	6·00	174·00	4·18	3·02	2·42	1·82	420·00	416·24	56165·33	..	28,000	..	
			Do. to Athenpuram drop..	9 7 520	..	20·00	0·83	6·00	174·00	4·18	3·02	2·42	1·82	402·00	416·24	56165·33	..	26,800	..	
			Do. to Bhcemanady East Side Channel branch duct.	12 5 300	..	25·00	0·585	5·5	182·87	4·08	2·49	1·99	1·49	342·00	363·91	48521·33	..	22,800	..	
			Do. to the regulating bridge	13 0 300	..	25·00	0·585	5·5	182·87	4·08	2·49	1·99	1·49	222·00	363·91	48521·33	..	14,800	..	
			Do. to Pedasanagallu branch	14 6 30	..	25·00	0·585	5·0	162·5	3·77	2·4	1·92	1·44	222·00	312·00	41600·00	..	14,800	..	
			Do. to Wurtur do.	16 6 300	..	25·00	0·585	5·0	162·5	3·78	2·4	1·92	1·44	209·25	312·00	41600·00	..	13,950	..	
			Do. to Pamarru bridge	18 2 300	..	25·00	0·585	5·0	162·5	3·78	2·4	1·92	1·44	194·25	312·00	41600·00	..	12,950	..	
			Do. to Chimamutteni branch	19 1 300	..	18·00	0·585	5·0	127·5	3·54	2·32	1·86	1·4	173·25	237·15	31620·00	..	11,550	..	
			Do. to Nebhanpudi do.	20 2 300	..	18·00	0·585	5·0	127·5	3·54	2·32	1·86	1·4	147·00	237·15	31620·00	..	9,800	..	
			Do. to Nedumole Lock	24 3 300	..	18·00	0·585	5·0	127·5	3·54	2·32	1·86	1·4	129·00	237·15	31620·00	..	8,600	..	
			Do. to Ramannapetta branch	26 1 300	..	15·00	0·585	3·0	127·5	3·54	2·32	1·86	1·4	129·00	237·15	31620·00	..	8,600	..	
			Do. to Polaveram branch and to Gudur cattle crossing.	29 5 630	..	15·00	0·585	3·0	58·5	2·26	1·86	1·49	1·12	91·5	87·16	11621·33	..	6,100	..	
			Do. to Aukumarru Lock	30 3 300	..	9·00	0·585	3·0	58·5	2·26	1·86	1·49	1·12	69·00	87·16	11621·33	..	4,600	..	
			Do. to Ankumarru branch	31 2 300	2 to 1	4·5	0·66	3·0	40·5	2·04	1·76	1·41	1·06	45·00	57·1	7613·33	..	3,000	..	
			Do. to Rudravaram do.	32 1 300	..	3·00	0·66	3·0	31·5	1·76	1·75	1·4	1·05	45·00	44·1	5880·00	..	3,000	..	
			Do. to Gundupollem do.	33 1 300	..	3·00	0·66	3·0	27·00	1·64	1·7	1·36	1·02	31·50	36·72	4896·00	..	2,100	..	
			Do. to end	34 2 300	..	3·00	0·66	3·0	27·00	1·64	1·7	1·36	1·02	16·5	36·72	4896·00	..	1,100	..	
			Medur branch duct to terminus	12 1 340	1½ to 1	3·00	0·585	3·00	27·00	1·64	1·7	1·36	1·02	3·00	36·72	4896·00	..	200	..	
			Branches of do.						22·5	1·63	1·57	1·26	0·95	18·00	28·35	3780·00	3·313	1,200	362·21	
..	D/4	31	Kistnapuram branch	2 1 330	1½ to 1	4·00	0·585	2·00	22·5	1·63	1·57	1·26	0·95	15·00	28·35	3780·00	..	1,000	..	
		32	Gudapadu branch	3 6 0	..	4·00	0·585	2·00	43·5	2·09	1·79	1·43	1·07	60·00	62·22	8293·33	24·03	4,000	166·44	
		33	Vemulamada do.	2 6 150	..	4·00	0·585	2·00	34·5	1·94	1·71	6·37	1·03	45·00	47·26	6301·33	..	2,000	..	
..	D	7	Bhemanady East Side Channel to Agakodu ..	4 4 0	1½ to 1	16·00	0·585	3·00	25·5	1·72	1·62	1·3	0·98	30·00	33·15	4420·00	..	2,000	..	
			Do. to Krosur north branch	7 4 0	..	12·5	0·585	3·00	22·5	1·63	1·57	1·26	0·95	15·00	28·35	3780·00	..	1,000	..	
I.	D	7	Do. to Krosur south do.	8 7 0	1½ to 1	10·00	0·585	3·00	14·00	1·25	1·37	1·1	0·83	15·00	15·4	2053·33	7·765	1,000	128·78	
			Do. to Mallampalli do.	10 2 0	..	6·00	0·585	3·00	14·00	1·25	1·37	1·1	0·83	15·00	15·4	2053·33	5·512	1,000	181·44	
			Do. to Pusadam do.	12 2 0	..	3·00	0·585	3·00	14·00	1·25	1·37	1·1	0·83	15·00	15·4	2053·33	3·36	1,000	297·63	
			Do. to Yendakuduru do.	13 2 0	..	3·00	0·585	3·00	61·5	2·29	1·87	1·5	1·13	90·00	92·25	12300·00	22·95	6,000	260·88	
			Do. to Lankapalli do.	14 2 0	..	3·00	0·585	3·00	57·00	2·19	1·82	1·46	1·1	75·00	74·46	9928·00	..	5,000	..	
			Do. to terminus	15 3 0	..	3·00	0·585	3·00	43·5	2·09	1·79	1·43	1·07	61·5	62·2	8293·33	..	4,100	..	
			Branches of do.						43·5	2·09	1·79	1·43	1·07	40·5	42·52	5669·33	..	2,700	..	
..	D/7	41	Agakodu branch	3 0 0	1½ to 1	4·0	0·585	2·0	31·5	1·87	1·66	1·35	1·00	25·5	28·35	3780·00	..	1,700	..	
		43	Krosur north branch	3 0 0	..	4·0	0·585	2·0	22·5	1·63	1·57	1·26	0·95	12·00	28·35	3780·00	..	800	..	
		44	Do. south do.	3 5 0	..	7·0	0·585	2·0	22·5	1·63	1·57	1·26	0·95	6·00	28·35	3780·00	..	400	..	
		46	Mallampalli do.	4 3 0	..	4·0	0·585	2·0	22·5	1·63	1·57	1·26	0·95	2·25	28·35	3780·00	..	150	..	
		47	Pusadam do.	4 1 0	..	4·0	0·585	2·0	14·00	1·25	1·37	1·1	0·83	15·00	15·4	2053·33	4·66	1,000	214·6	
		48	Yendakuduru do.	3 5 390	..	3·0	0·585	2·0	14·00	1·25	1·37	1·1	0·83	13·5	15·4	2053·33	2·983	900	304·77	
		49	Lankapalli do	1 3 0	..	3·0	0·585	2·5	20·00	1·4	1·46	1·17	0·88	21·00	23·4	3120·00	4·187	1,400	334 4	
..	D	⅛ 9	Bhatlapemmarru Channel	5 7 0	1½ to 1	10·0	0·585	2·0	14·00	1·25	1·37	1·1	0·83	15·00	15·4	2053·33	3·101	1,000	322·47	
		9	Pedasanagallu branch	1 6 0	..	3·0	0·585	2·0	14·00	1·25	1·37	1·1	0·83	13·5	15·4	2053·33	3·019	900	298·11	
		10	Wurutur do.	2 3 0	1½ to 1	4·0	0·585	2·0	12·00	1·17	1·34	1·07	0·8	9·00	12·84	1712·00	1·494	600	267·74	
		12	Chinamutteni do.	4 5 0	..	8·0	0·585	2·0	16·87	1·4	1·46	1·17	0·88	3·75	19·73	2630·88	1·105	250	226·29	
		13	Nebhanupudi do.	5 3 0	..	6·0	0·585	2·0	26·00	1·51	1·52	1·22	0·92	30·00	31·72	4229·33	4·909	2,000	407·41	
I.	D	15	Nemmakur do.	4 4 0	1½ to 1	12·0	0·585	2·0	12·00	1·17	1·34	1·07	0·8	12·75	12·84	1712·00	2·274	850	373·79	
		17	Ramannapetta do.	5 1 0	..	7·0	0·585	2·0	14·00	1·25	1·37	1·1	0·83	15·00	15·4	2053·33	5·00	1,600	200·00	
		19	Polaveram do.	2 4 0	..	7·0	0 585	2·0	22·00	1·45	1·49	1·19	0·89	26·25	26·18	3490·88	7·387	1,750	236·9	
		20	Aukumarru do.	2 0 0	..	3·0	0·75	2·0	18·00	1·36	1·44	1·15	0·86	18·00	20·17	2689·33	4·541	1,200	264·25	
		21	Rudravaram do.	2 1 0	..	3·0	0·75	2·0	30·00	1·56	1·55	1·24	0·93	37·5	37·2	4960·00	5·566	2,500	449·15	
		22	Gundupallem do.	2 0 0	..	3·0	0·75	2·0	20·00	1·41	1·46	1·17	0·88	22·5	23·4	3120·00	4·717	1,500	328·00	
									20·00	1·41	1·46	1·17	0·88	24·0	23·4	3120·00	4·5	1,600	333·33	
									12·00	1·17	1·51	1·21	0·91	13·5	14·52	1939·33	1·85	900	486·48	
									12·00	1·17	1·51	1·21	0·91	15·00	14·52	1939·33	2·112	1,000	473·48	
									12·00	1·17	1·51	1·21	0·91	13·5	14·52	1939·33	2·25	900	400·00	

MASULIPATAM,
30th October 1875.

(Signed) D. McNEIL CAMPBELL, Lieut., R.E.,
Executive Engineer in charge of Kistna District.

H.

Statement showing the Area commanded, the present and the expected Increase of Wet Cultivation and the anticipated Cost of Masulipatam Canal, West Side Channel, and its Branches in the Eastern Delta of Kistna District. The figures in columns 4 and 5 have been taken from the Collector's Statement for 1873-74 (fasli 1283).

Name of Work.	Area commanded.	Present Area of Irrigation.		Expected Increase by proposed Works.		Cost of proposed Works.				
	Proposed Acreage.	Acreage.	Assessment.	Acreage.	Assessment.	Irrigation.	Navigation.	Drainage.	Total.	
1	2	3	4	5	6	7	8	9	10	11
MASULIPATAM CANAL.	SQ. MILES.		RS.		RS.	RS.	RS.	RS.	RS.	RS.
West side channel.	96·92	28,000	5,185	2,830	22,815	91,260*	2,03,100	..	2,15,225	4,18,325

* Taken at Rupees 4 an acre. This is only a rough estimate, as the land is all zemindari, and the rules which regulate the water-tax charged to Zemindars not understood.

MASULIPATAM,
30th October 1875.

(Signed) D. McNEIL CAMPBELL, Lieut., R.E.,
Executive Engr. in charge, Kistna.

I.

Statement showing the outlay incurred and that now proposed on the West Side Channel of Masulipatam Canal in the 1st Sub-section of Eastern Delta, Kistna.

Name of Work.	Outlay.			Balance of Estimate of Work in progress yet to be worked out.	Total.	Amount of Estimate now framed.	Total proposed Outlay.
	Original Works.	Repairs.	Total to 1874-75.	Probable Expenditure in 1875-76, Allotment.			
	RS.	RS.	RS.	RS.	RS.	RS.	RS.
West side channel of Masulipatam canal including distributaries ..	59,656	5,245	64,901	New repairs. 2,600 Approximate.	67,501	2,27,800 24,700	2,95,301
Deduct value of work executed on estimate sanctioned.—*Vide* G.O. No. 3,342, dated 19th October 1866.				.. ..	..	2,03,100	† 24,700
							2,70,601

† Total expenditure Rupees 49,437-9-7 half the cost deducted, owing to channel being choked up and the materials collected turned useless.

Given as per G.O. No. 1,868 of 3rd July 1875.

MASULIPATAM,
30th October 1875.

(Signed) D. McNEIL CAMPBELL, Lieut., R.E.,
Executive Engr. in charge, Kistna.

J.

Comparative Statement showing the Increase and Decrease between the Original and Revised Estimates of the West Side Channel of Masulipatam Canal and its Branches in the 1st Sub-section of Eastern Delta, Kistna.

Names of Channels.	Sub-heads.	Original Estimate.		Expenditure.	Revised Estimate.		Increase.	Decrease.	Remarks.
		Quantity.	Amount.		Quantity.	Amount.			
1	2	3	4	5	6	7	8	9	10
			RS. A. P.	RS. A. P.		RS. A. P.	RS. A. P.		
West Side Channel.	Earthwork	703,525	47,634 8 1	36,420 3 10	706,920	61,945 7 6	14,310 15 5	...	
	Sundries	...	1,025 7 11	1,783 5 4	...	3,094 8 6	2,069 0 7	...	
	Irrigation sluices	No. 12	1,200 0 0	...	...	...	...	1,200	
	Compensation	...	...	342 6 2	452·38	9,050 0 0	9,050 0 0	...	
	Materials at site of irrigation sluice.	...	...	735 14 1	...	...	...	...	
	Ramps	...	...	...	10	3,790 0 0	3,790 0 0	...	
	Half a mile bench mark stones.	...	...	...	...	173 0 0	173 0 0	...	
	Head sluice near Kankipad lock.	...	...	8,726 11 9	...	3,580 0 0	3,580 0 0	...	
	Rough stone drop at Boolapad.	...	...	183 3 6	...	330 0 0	330 0 0	...	
	Tunnel at do.	...	...	774 2 9	...	...	...	...	
	Accommodation bridge on Vallur district road.	...	...	...	...	2,410 0 0	2,410 0 0	...	
	Tunnel at Commamore ...	...	...	471 10 2	...	...	...	...	
	Drop near Aminpur ...	...	...	...	...	2,800 0 0	2,800 0 0	...	
	Accommodation bridge near Veranki lock.	...	...	...	...	3,555 0 0	3,555 0 0	...	
	Regulating bridge at 10th mile.	...	...	...	...	2,320 0 0	2,320 0 0	...	
	Accommodation bridge at Pamarru.	...	...	...	...	2,410 0 0	2,410 0 0	...	
	Do. do. at Zughavarm.	...	...	...	...	2,400 0 0	2,400 0 0	...	
	Do. do. near Nedumole lock.	...	...	...	...	2,045 0 0	2,045 0 0	...	

Comparative Statement showing the Increase and Decrease between the Original and Revised Estimates, &c.— (*Continued*).

Names of Channels.	Sub-heads.	Original Estimate.		Expenditure.	Revised Estimate.		Increase.	Decrease.	Remarks.
		Quantity.	Amount.		Quantity.	Amount.			
1	2	3	4	5	6	7	8	9	10
			Rs. A. P.	Rs. A. P.		Rs. A. P.	Rs. A. P.		
	Accommodation bridge at Turkatur.	...	...	...	...	1,800 0 0	1,800 0 0	...	
	Tail escape weir into Agakodu.	...	...	...	...	565 0 0	565 0 0	...	
Vallur branch of West side channel.	Earthwork	...	...	...	3,201½	210 0 0	210 0 0	...	
	Compensation	...	...	...	7·51	150 0 0	150 0 0	...	
	Head sluice	...	...	...	...	365 0 0	365 0 0	...	
	Tail escape weir	...	...	...	...	550 0 0	550 0 0	...	
Medur branch duct channel.	Earthwork	...	...	...	175,083	11,490 0 0	11,490 0 0	...	
	Compensation	...	...	...	85·19	1,700 0 0	1,700 0 0	...	
	Head sluice	...	...	...	...	575 0 0	575 0 0	...	
	Drop at 1½ mile	...	...	...	...	460 0 0	460 0 0	...	
	Do. at 3rd „	...	...	...	...	495 0 0	495 0 0	...	
	Accommodation bridge at the crossing of Ilur road.	...	...	...	...	1,570 0 0	1,570 0 0	...	
	Drop at 5th mile ...	...	...	...	...	450 0 0	450 0 0	...	
	Do. at 6th „ ...	...	...	...	...	465 0 0	465 0 0	...	
	Do. at 8th „ ...	...	...	...	...	445 0 0	445 0 0	...	
	Do. at 11th „ ...	...	...	...	...	430 0 0	430 0 0	...	
	Tail escape weir	...	...	...	22,874	640 0 0	640 0 0	...	
Kistnapuram branch of the Medur branch duct.	Earthwork	...	...	...	16·7	1,500 0 0	1,500 0 0	...	
	Compensation	...	...	...	...	330 0 0	330 0 0	...	
	Head sluice	...	...	...	...	450 0 0	450 0 0	...	
	Tail escape weir	...	...	...	28,225	370 0 0	370 0 0	...	
Gudapaud branch do.	Earthwork	...	...	...	28·63	1,850 0 0	1,850 0 0	...	
	Compensation	...	...	...	...	570 0 0	570 0 0	...	
	Head sluice	...	...	...	...	495 0 0	495 0 0	...	
	Tail escape wier	...	...	...	28,484	390 0 0	390 0 0	...	
Vemalamada do. do.	Earthwork	...	...	...	...	1,870 0 0	1,870 0 0	...	
	Compensation	...	...	...	21·02	420 0 0	420 0 0	...	
	Head sluice	...	...	...	...	530 0 0	530 0 0	...	
	Tail escape weir	...	...	...	...	550 0 0	550 0 0	...	
Bhemanady East side channel branch duct of West side channel.	Earthwork	...	...	...	211,250	13,870 0 0	13,870 0 0	...	
	Compensation	...	...	...	148·21	2,960 0 0	2,960 0 0	...	
	Head sluice	...	...	...	...	1,120 0 0	1,120 0 0	...	
	Drop in 2nd mile	...	...	...	...	570 0 0	570 0 0	...	
	Accommodation bridge at the crossing of Ilur road.	...	...	...	...	1,950 0 0	1,950 0 0	...	
	Drop in 6th mile	...	...	...	...	595 0 0	595 0 0	...	
	Do. in 8th „	...	...	...	...	570 0 0	570 0 0	...	
	Tail escape weir	...	...	...	...	530 0 0	530 0 0	...	
Agakodu branch of of Bhemanady East side channel branch duct of West side channel.	Earthwork	...	...	...	18,684	1,226 0 0	1,226 0 0	...	
	Compensation	...	...	...	...	...	...	...	
	Head sluice	...	...	...	...	520 0 0	520 0 0	...	
	Drop in 1st mile	...	...	...	...	380 0 0	380 0 0	...	
	Tail escape weir	...	...	...	...	650 0 0	650 0 0	...	
Kosur north branch of Bhemanady East side channel.	Earthwork	...	...	...	12,166	800 0 0	800 0 0	...	
	Compensation	...	...	...	7·63	150 0 0	150 0 0	...	
	Head sluice	...	...	...	...	515 0 0	515 0 0	...	
	Drop in 2nd mile	...	...	...	...	395 0 0	395 0 0	...	
	Tail escape weir	...	...	...	...	520 0 0	520 0 0	...	
Kosur south branch of do.	Earthwork	...	...	...	38,344	2,510 0 0	2,510 0 0	...	
	Compensation	...	...	...	35·7	710 0 0	710 0 0	...	
	Head sluice	...	...	...	...	520 0 0	520 0 0	...	
	Drop in 1st mile	...	...	...	...	485 0 0	485 0 0	...	
	Tail escape weir	...	...	...	...	515 0 0	515 0 0	...	
Mallampalli branch of do.	Earthwork	...	...	...	51,251	3,360 0 6	3,360 0 0	...	
	Compensation	...	...	...	35·53	710 0 0	710 0 0	...	
	Head sluice	...	...	...	...	505 0 0	505 0 0	..	
	Drop in 2nd mile	...	...	...	...	465 0 0	465 0 0	...	
	Tail escape weir	...	...	...	...	460 0 0	460 0 0	...	
Pusadam branch of do.	Earthwork	...	...	...	46,621	3,060 0 0	3,060 0 0	...	
	Compensation	...	...	...	33·5	670 0 0	670 0 0	...	
	Head sluice	...	...	...	...	540 0 0	540 0 0	...	
	Tail escape	...	...	...	...	600 0 0	600 0 0	...	
Yendakuduru branch of do.	Earthwork	...	...	...	49,972	3,280 0 0	3,280 0 0	...	
	Compensation	...	...	...	28·63	570 0 0	570 0 0	...	
	Head sluice	...	...	...	...	450 0 0	450 0 0	...	
	Tail escape weir	...	...	...	...	420 0 0	420 0 0	...	

Comparative Statement showing the Increase and Decrease between the Original and Revised Estimates, &c.—(*Continued*).

Names of Channel.	Sub-heads.	Original Estimate. Quantity.	Original Estimate. Amount.	Expenditure.	Revised Estimate. Quantity.	Revised Estimate. Amount.	Increase.	Decrease.	Remarks.
1	2	3	4	5	6	7	8	9	10
			RS. A. P.	RS. A. P.		RS. A. P.	RS. A. P.		
Lankapalli branch of do.	Earthwork	...	...	...	8,610	565 0 0	565 0 0	...	
	Compensation	...	...	...	8·5	170 0 0	170 0 0	...	
	Head sluice	...	...	...	...	470 0 0	470 0 0	...	
	Tail escape weir	...	...	...	...	450 0 0	450 0 0	...	
Bhatlapenamarru branch of West side channel.	Earthwork	...	...	...	58,785	3,860 0 0	3.860 0 0	...	
	Compensation	...	...	...	...	...	...	...	
	Head-sluice	...	...	...	...	...	...	...	
	Drop in 1st mile	...	...	...	...	410 0 0	410 0 0	...	
	Drop in 3rd ,, ...	...	...	...	...	365 0 0	365 0 0	...	
	Drop in 4th ,, ...	...	...	...	...	405 0 0	405 0 0	...	
	Tail escape weir	...	...	...	...	370 0 0	370 0 0	...	
Pedasanagallu branch of do.	Earthwork	...	...	...	18,208	1,195 0 0	1,195 0 0	...	
	Compensation	...	...	...	13·15	260 0 0	260 0 0	...	
	Head sluice	...	...	...	...	475 0 0	475 0 0	...	
	Drop in 1st mile	...	...	...	...	340 0 0	340 0 0	...	
	Tail escape weir	...	...	...	...	330 0 0	330 0 0	...	
Wutur branch of do.	Earthwork	...	...	...	27,362	1,795 0 0	1,795 0 0	...	
	Compensation	...	...	...	15·27	305 0 0	305 0 0	...	
	Head sluice	...	...	...	...	475 0 0	475 0 0	...	
	Drop in 1st mile	...	...	...	...	360 0 0	360 0 0	...	
	Tail escape weir	...	...	...	...	625 0 0	625 0 0	...	
Chinamutivi branch of do.	Earthwork	...	...	...	53,819	3,530 0 0	3,530 0 0	...	
	Compensation	...	...	...	38·68	770 0 0	770 0 0	...	
	Head sluice	...	...	...	...	580 0 0	580 0 0	...	
	Drop in 1st mile	...	...	...	...	385 0 0	385 0 0	...	
	Drop in 3rd ,, ...	...	...	...	...	375 0 0	375 0 0	...	
	Tail escape weir	...	...	...	...	645 0 0	645 0 0	...	
Nebhanpudi branch of do.	Earthwork	...	...	...	56,906	3,730 0 0	3,730 0 0	...	
	Compensation	...	...	...	41·04	820 0 0	820 0 0	...	
	Head sluice	...	...	...	...	545 0 0	545 0 0	...	
	Drop in 1st mile	...	...	...	..	360 0 0	360 0 0	...	
	Do. in 3rd ,, ...	...	...	...	...	350 0 0	350 0 0	...	
	Tail escape weir	...	...	...	...	490 0 0	490 0 0	...	
Nemmakur branch of do.	Earthwork	...	...	...	58,418	3,830 0 0	3,830 0 0	...	
	Compensation	...	...	...	13·36	260 0 0	260 0 0	...	
	Head sluice	...	...	...	...	530 0 0	530 0 0	...	
	Drop in in 2nd mile ...	...	...	...	...	465 0 0	465 0 0	...	
	Tail escape weir	...	...	...	...	540 0 0	540 0 0	...	
Ramannapetta branch of do.	Earthwork	...	...	...	64,698	4,246 0 0	4,246 0 0	...	
	Compensation	...	...	...	39·13	780 0 0	780 0 0	...	
Ramannapetta branch of West side channel	Head sluice	...	...	...	...	375 0 0	375 0 0	...	
	Drop in 4th mile	...	...	...	...	360 0 0	360 0 0	...	
	Tail escape weir	...	...	...	...	600 0 0	600 0 0	...	
Polaveram branch of do.	Earthwork	...	...	...	33,588	2,200 0 0	2,200 0 0	...	
	Compensation	...	...	...	19·09	380 0 0	380 0 0	...	
	Head sluice	...	...	...	...	355 0 0	355 0 0	...	
Ankumarru branch of do.	Earthwork	...	...	...	28,955	1,900 0 0	1,900 0 0	...	
	Compensation	...	...	...	13·9	280 0 0	280 0 0	...	
	Head sluice	...	...	...	...	460 0 0	460 0 0	...	
Rudravaram branch of do.	Earthwork	...	...	...	30,979	2,030 0 0	2,030 0 0	...	
	Compensation	...	...	...	13·9	280 0 0	280 0 0	...	
	Head sluice	...	...	...	...	485 0 0	485 0 0	...	
	Tail escape weir	...	...	...	...	490 0 0	490 0 0	...	
Gundupollum branch of do.	Earthwork	...	...	...	19,504	1,280 0 0	1,280 0 0	...	
	Compensation	...	...	...	13·09	260 0 0	260 0 0	...	
	Head sluice	...	...	...	...	435 0 0	435 0 0	...	
	Tail escape weir	...	...	...	...	435 0 0	435 0 0	...	
	Total ...	...	49,860 0 0	49,437 9 7	...	2,27,800 0 0	1,79,140 0 0	1,200	

MASULIPATAM,
30th October 1875.

(Signed) D. McNEIL CAMPBELL, Lieut., R.E.,
Executive Engineer in charge, Kistna District.

APPENDIX No. 3.

No. 226.

MEMORANDUM.

Eastern Delta, Bank Canal.—The undersigned has the honor in continuation of the memorandum, No. 66, dated 16th January 1875, on the Ellore Canal arrangements, and with reference to the letter, No. 100, of the 4th November 1874, from the Superintending Engineer, Kistna, to make the following observations on the remarks of Lieutenant Campbell in paragraphs 7 to 18 of his report on the Eastern Delta completion estimates.

2. If the bank canal (this is to be its designation) is to be a 2nd-class line of navigation and if the expense of locks is to be incurred and a considerable outlay on other items then the prescribed conditions of a 2nd-class navigable canal must be attended to. One of these conditions is that 2,000 yards an hour shall be the maximum velocity; it is higher than is altogether desirable, and it is a maximum. Whether navigation should or should not be included in this section of the scheme is another matter. Possibly if it be clearly shown what its provision will cost it may be negatived, seeing that the greater part of the country to be benefitted and the whole if the navigation were to stop short of Divi is Zemindari, and not only so, but Zemindari which has hitherto contributed but very little to a return on the outlay already incurred for the Masulipatam Canal. Lieutenant Campbell is quite mistaken in supposing that there is any desire to make irrigation other than of the first importance, but in recent years the value of cheap and easy communications have been more fully recognized than they were ten or eleven years ago, and as in the Godavery it has been considered right to remodel canals which were originally constructed with a heavy surface fall in order to make the navigation more convenient, it would hardly be good policy in the Kistna to introduce on new canals arrangements which have been condemned elsewhere.

3. In the present case there are three ways of dealing with this sub-section of the delta.

1*st*.—An irrigation channel only might be constructed, and in that case an aqueduct could be altogether dispensed with, as it would certainly be much cheaper to carry the water across the Puligadda branch by a culvert. It is thought that 2½ feet a second is as great a velocity as is generally desirable in delta channels. The fall available in the first 35 miles appears to be about 36·91—12·00* = 24·91. For the first eleven miles to the head of the west side channel a canal with 70 feet bottom width, 6½ feet depth, and a fall of 8 inches a mile would give very nearly the proper discharge of 1,327 cubic feet with a velocity slightly under 2½ feet a second, and, supposing the bed level at 35 miles to have been correctly assumed, a fall of 8¾ inches a mile from the 11th to the 35th mile with a bed fall of 2 feet and a surface fall besides of about the same in the next mile would be available. Possibly, however, the one fall of 8 inches in the 35 miles would be better, thus giving 9 inches more head at the culvert. The culvert would require about 94 square feet of waterway, or say 2 spans of 12 feet with 3 feet to springing and 2 feet rise. Its floor would be about 6½ feet below the bed of the river, and as it would offer no obstruction the protective aprons would be inexpensive, and the foundations of moderate depth, say 8 feet† below the floor. This arrangement would undoubtedly reduce the expense of supplying Divi with irrigation so materially as to make this part of the project highly profitable.

9 It is not clear exactly what the level here must be with reference to the north bank channel.

That is a change of depth from 6 or 6½ to 4 or 4½.

* Two feet of masonry and concrete on 6 feet wells.

2*ndly*.—Irrigation and navigation may be combined, and if so the requirements of both must be duly considered. Those of irrigation are well understood, and the only one above the aqueduct rendering to be taken into account here is the maximum velocity which must not exceed 2,000 yards an hour (1·66 feet a second), while it would be better that the surface velocity should not exceed this which would reduce the mean velocity to about 1,600 yards an hour, or 1·33 feet a second. It would apparently be of no advantage under the particular circumstances of this canal to form a side channel in connection with a navigable line.

3*rdly*.—The irrigation water may be carried by a separate channel and the irrigation by a distinct canal throughout, and the two may run side by side or not as may be most convenient; probably the irrigation channel would cost less if carried apart from the canal, but taking the left bank of the latter and the flood bank of the river into account it may possibly be economical to combine the earthworks of the two. It is moreover open to consideration whether in this arrangement it will be desirable to extend navigation into Divi, and, if so, whether the irrigation water should be carried

by the navigation aqueduct or by a culvert. As far as can be judged the latter would be the cheaper. The navigation canal would be still water throughout. It must now be noticed that Lieutenant Campbell's ideas of a navigable canal in Divi would not apparently do. In the longitudinal section the full supply depth of water is shown to be only 4 feet from the 41st to 52nd mile, and in Appendix E the bottom widths are noted as 8 and 4 feet respectively in the lower miles. It would manifestly be very unwise to build an aqueduct for any such navigation as this would be.

4. The requirements of the aqueduct across the Kistna branch would be very different apparently to those supposed by Lieutenant Campbell. It may first be noticed that were a bed and surface fall of 6 inches a mile in the bank canal admissible it would not be necessary or desirable to insert two locks to obtain the bed level at the 35th mile. There is apparently (from the section) no sufficient reason for placing a lock at the 19th mile instead of carrying the first reach into about the 28th mile and making one drop there. Lieutenant Campbell says that the floor of his aqueduct would be at 15·09 maximum flood level in the river being 19. It is first a question whether the latter was not exceeded at the end of September last, and at any rate it may be assumed that the maximum should be taken to be about 21. Then looking at the section it appears that the average floor level of the canal at the aqueduct is for the principal channel of the Puligadda branch 14·40, and probably the soffit of the arch would be at about 12, so the water might rise to 9 feet above the soffit. Next supposing the spans of the arches to be 36 to 40 the rise would be 7 or 8 feet and the tops of the piers 16 or 17 feet below maximum flood level. That a work can be built to stand under such circumstances may readily be allowed; the conditions are such as are of common occurrence at head sluices, and they can be effectually dealt with, but this officer's supposition that the maximum velocity through such a work would not exceed 6·10 feet a second is erroneous. Most probably at present the maximum velocity in particular parts of the cross section of the river greatly exceeds this already, for there are always wide departures in river channels from the mean velocity needed to pass a given discharge per second. At a guess with the river prevented from scouring perhaps 12 feet a second might be taken as the maximum velocity with a low level aqueduct.

5. The following are some of the details considered necessary for a low level aqueduct, such as Lieutenant Campbell has proposed, supposing the floor level to be at — 2·66 as shown in the section:—

Foundations.—Four feet of masonry on 9 feet wells—bottom of wells at	15·66
Floorings.—Under arches to extend 3 feet beyond the salients of the cut waters and to consist of 1 foot of cut stone on 2 feet of concrete with retaining walls at both edges 4 feet deep on 9 feet wells, the bottom of which at	15·66
Do.—Above or first upper apron 12 feet wide of masonry (rubble) with a surface slope of one in eight making upper ridge ...	4·16
Retaining wall and wells below do. with bottom of wells at ...	15·66
Do. do.—Outer apron, rough stone 3 feet deep 15 feet wide and horizontal	4·16
1*st*.—Lower apron horizontal surface at	3·66
Width 24 feet of 1 foot of cut stone on 2 feet of concrete, retaining wall 4 feet on 8 feet wells	15·66
2*nd*.—Lower apron horizontal surface at	4·66
Width 30 feet and depth 3 feet, rough stone.	

6. If navigation and irrigation be combined, the bed and surface wall in the 35 miles will be approximately 0·30 feet a mile (this is using Lieutenant Campbell's formula) and a lock with 8 feet drop would then be required at the 24th mile. Bed level at the 35th mile would then be 36·91 — (10·5 + 8·0) = 18·41, which is certainly as low at this point as would be admissible for an aqueduct. With this increase of level the aqueduct floor might be placed at—1·00, and the width of the protective aprons reduced by one-fourth or one-fifth, but no other alteration would be admissible. The above arrangement is a compromise. It is admitted that the objections to raising the level some 4·6 feet more as detailed in paragraphs 11 and 12 of Lieutenant Campbell's report are serious, and it is in connection with these that a lower level is now considered to be admissible.

7. The general conclusion at which the undersigned has arrived is that the difficulty and cost of providing a good navigation for the 52 miles are so considerable that it is probable that taking the fact that for 35 miles the canal would afford transport to country on one side only, and that all Zemindari, it is improbable that any navigation will be provided, beyond possibly at some future period building a head lock to a channel designed for irrigation only. It is with reluctance that this deduction has been arrived at, but if Lieutenant Campbell can satisfy the conditions at a moderate cost the under-

signed will be most glad to support a scheme which will provide for navigation as well as irrigation, otherwise this tract of country must depend upon the Masulipatam Canal for water communication, and its connection therewith by roads will become of importance.

8. *First reach of Masulipatam Canal.*—In close connection with the bank canal is the subject of the arrangement of the first reach of the Masulipatam Canal. It was mentioned in paragraph 42 of the Inspection Memorandum of the 7th May 1874 that the first 12 miles of this canal should carry as much water as possible, and the Superintending Engineer in paragraph 9 says that either this canal must be widened considerably (beyond it is supposed the width intended in Lieutenant Campbell's arrangements), or a new head from the bank canal must be given to this side channel, and he adds that the latter arrangement will be cheaper and more desirable. The undersigned thinks that this opinion is hardly borne out by the facts or supported by the circumstances. It appears from the longitudinal section that if instead of giving a surface fall of 6 inches a mile in the first 3½ miles to the intended head of the bank canal with a diminution of depth from 8 feet to 6·789 feet the canal be laid out with a surface and bed fall of 0·25 feet a mile throughout the 12 miles to Kunkipad, the only alteration needed will be an addition of 15 feet to the width in the 3½ miles to carry the 2,008 cubic feet a second needed and below this point the required capacity being for Pulleru ... ... 681 cubic feet a second.

for West Side Channel ...	420	„ „
Total ...	1,101	

With the 66 feet bottom width shown in the section given the discharge will be 1,081 cubic feet or twenty less than required. This modification of arrangements will make the bed of the canal at Kunkipad 1 foot lower and the water surface 1 foot higher, and neither variation is objectionable. In the first 3½ miles the mean velocity will be 1·73 feet instead of 2·55, in the rest of the reach 1·65 instead of 1·43, a considerable improvement on the whole.

9. Looking moreover to the circumstances little or no water is at present needed for this western side channel, and until all that can now be supplied or nearly all has been utilized no further expenditure for the irrigation of the lands under the channel will be recommended, consequently until some indefinite future the first 11 miles of the bank canal would, were the west side channel supplied from that source, be kept at a reduced section, but the head sluice would have to be made of its ultimate dimensions at once. The other way the Masulipatam Canal will be widened only down to 3½ miles, or at least the rest will be altered only so much as may be needed for the proper supply of the Pulleru. The undersigned therefore can see nothing that has been yet advanced in favor of the connection of the west side channel with the bank canal which would induce him to adopt this radical change from the formerly intended arrangements.

10. There will be no objection to the conversion of the Masulipatam Canal below Kunkipad into a practically still-water navigation. It will be used, however, for some years to come to carry such small quantity of water for irrigation as may be convenient or requisite so that means of passing irrigation water from reach to reach should be retained.

(Signed) JOHN MULLINS,
Chief Engineer for Irrigation.

24*th February* 1875.

From Lieutenant D. McN. CAMPBELL, R.E., Executive Engineer, 7th Range, to Major J. O. HASTED, R.E., Superintending Engineer, 1st Division, Kistna District, dated Masulipatam, 1st April 1875, No. 3.

With reference to Chief Engineer's memorandum, No. 226, dated 24th February 1875, I have the honor to make the following remarks.

The bank channel being entirely dependent on the Bander Canal, it is necessary to discuss the proposed arrangements of the latter first, though it is referred to last by the Chief Engineer.

1. The Chief Engineer objects to the plan of taking the west side channel off from the bank channel, and wishes it to be supplied from Bander Canal immediately above Kunkipad Lock, and to enable the Bander Canal to carry sufficient water for this purpose he proposes to let it run deeper and lower the Kunkipad Lock upper sill 1 foot; thus he proposes to give a uniform bed and surface fall of 0·25 a mile to the Bander Canal to Kunkipad, the depth of 8 feet at head of channel being continued throughout; he states that if this were done the extra widening required down to where bank channel takes off would be only 15 feet. I do not know if he means an extra widening of 15 feet to present width of channel 45 feet, or to the width proposed in general report, but in either case he is apparently mistaken, for to give the required discharge of 2,008 cubic feet a second, with fall 0·25 feet depth 8 feet, the bed width must be 130 feet; the

widths allowed in the general report are 90 feet at Ryves' channel and 118 feet at 3½ mile or head of bank channel, average width 105 feet, so the average extra widening would be 25 feet, and it will be noticed that at the head, where the cutting is heaviest, the widening would be 40 feet.

2. As regards the Bander Canal below the 3½ miles, according to the proposals of the Chief Engineer it would have to be widened from 66 feet to 67½ feet to Kunkipad; this is of course only a trifling alteration, but a more serious one is the lowering of Kunkipad Lock sill by 1 foot; this could be done, and probably without damage to the work, but in my opinion it would be quite useless to lower this without also lowering the floors of the head sluices of Pullair and west-side channel, and I do not think, judging from the plan, that the former could be lowered with safety, consequently the work would have to be rebuilt.

I do not think it can be doubted that these works would have to be lowered; for the lock culverts would only effect the bed of the canal for a very short distance above, and there being a head sluice on each side of the channel drawing off water at a level of 1 foot above bed would certainly cause a bar of silt 1 foot high to form across the channel, and the fall of bed would really be from the head of the channel to top of this bar, and not from head of channel to lock upper sill.

3. I will now show the difference in the cost of the two arrangements.

As proposed by Colonel Mullins.

	Rs.
Widening Bander Canal from 45 feet to 130 feet width; from head to 3½ mile	1,93,700
Do. from 66 feet to 67½ feet; from 3½ mile to Kunkipad ...	55,250
Total ...	2,48,950

To this should be added cost of lowering Kunkipad upper sill, Pullair and west side channel head sluices.

As proposed in General Report.

	Rs.
Widening Bander Canal from 45 feet to 90 feet at head and 118 at bank channel	1,23,180
Extra cost of making East Bank Channel of sufficient capacity to carry water for west side channel	65,260
Cost of enlarging Aga Kodu to form a channel from bank channel to existing west side channel	2,737
Head sluice to west-side channel	2,855
Total ...	1,94,032

To this must be added the trifling cost of extra size required for head sluice at 3½ miles.

It will be seen from this that the arrangements proposed in general report cost Rs. 54,918 less than those proposed by the Chief Engineer. Colonel Mullins also states that by his arrangement "In the first 3½ miles the mean velocity will be 1·73 instead of 2·55, in the rest of the reach 1·65 instead of 1·43—a considerable improvement on the whole." In my opinion this is a very doubtful question, and it is open to argument whether it is better to have a less velocity for a distance of 3½ miles and a higher one for 8½ miles or *vice versa*.

I may here mention that not only the arrangement proposed by the Chief Engineer but many other ways of treating the Bander Canal were fully considered and discussed before it was decided that the one entered in the general report was the best, and I think I have clearly shown that the facts and circumstances prove that it will be cheaper and more desirable to take off the west side channel from the bank channel than from the Bander Canal.

4. As regards the bank channel, the Chief Engineer mentions three different ways in which this channel may be treated—

1*st*.—To make it entirely for navigation, a separate channel being excavated to carry water for irrigation.

2*nd*.—To combine navigation and irrigation.

3*rd*.—To make the channel for irrigation only.

Now without working out in detail any of these three methods, it is obvious that the first will be much the most expensive and the last the cheapest, so that it rests entirely with the Chief Engineer to decide which method is to be adopted. Colonel Mullins states afterwards, in paragraph 7, that the general conclusion that he has arrived at is that it is improbable that any navigation will be provided beyond possibly at some future period building a head lock to a channel designed for irrigation only.

5. Now this is exactly what was intended in the arrangement proposed in the general report; the channel was designed for irrigation and locks were allowed in case it was found that

any navigation was required, locks were allowed at the 19th and 24th miles, because this was found to cheapen the cost of earthwork, by diminishing banking; thus if the bed were continued to 28th mile as proposed by Chief Engineer without a drop the earthwork would cost Rs. 99,880, and the cost of the lock and weir at that mile Rupees 25,000, total cost Rupees 1,24,880. While with the two locks and weirs proposed the earthwork would cost Rupees 40,060, two locks Rupees 41,260,* total Rupees 81,320.

	Rs.
* Two locks	27,390
Two weirs	13,870
Total ...	41,260

The first of these two locks may not be exactly in the position which would render cost of earthwork the least, but as an accommodation bridge is necessary at the place it is cheaper to build the lock there.

6. It was not intended to carry the navigation into Divi, owing to the extra cost of the aqueduct, so a bridge was allowed in connection with that work which would not only connect Divi with the mainland, but would also add greatly to the strength of the aqueduct by acting as a buttress along its entire length. A culvert as proposed by Colonel Mullins would certainly be cheaper than an aqueduct as regards materials; but the difficulty of its construction (the floor of the work being so much below low water) would be very great and the cost of labor would be heavy; it would also in my opinion take longer to construct, which in a case of this kind, when there are only four months in the year available for the work, is a matter of great importance. There is also the objection that if it silted up, which is very probable, the cost and difficulty of clearing would be great.

Another consideration is that after the culvert had been constructed Divi would be as badly off as ever in the way of communication with the mainland.

7. In paragraph 6 the Chief Engineer states that 18·41 is a low a level as is desirable for the bed of the aqueduct, but in paragraph 5 he describes some of the details necessary for a low level aqueduct. Now even with the bed of aqueduct at 18·41, which is 4½ feet lower than formerly proposed by Chief Engineer, the bed of the channel would be above the country for 7 miles and the water surface would average 7 feet above country, and the cost of banking would be considerable; it must also be remembered that a breach occurring in this part of the canal would be most serious. Colonel Mullins states that if the canal be designed entirely for irrigation the bed and the surface fall might be 8½ inches a mile. Now from the experience I have had of large channels in this delta, for example the Ryves' Channel, Pullairu, and others, I consider this fall too great (and I think you will agree with me), especially as the slope of the country does not admit of the branch channels having a fall sufficient to generate a velocity anything approaching that which the main canal would have fall 8½ inches a mile; moreover with this fall the water will not come to the surface of country till 19 miles from head of channel.

8. The average velocity in the bank channel as proposed in general report would be about 2·08 feet a second, but it must be remembered that it will only be necessary to keep this velocity when a full supply of water is required, and at other times, by reducing depth of water at head to 5 feet and holding up 1 foot or 1½ feet water at first lock, the velocity could be considerably reduced, though it would still slightly exceed what has been laid down in the circular; but it must be admitted there are circumstances under which it is better not to adhere closely to fixed rules; if the rule about a velocity of 2,000 cubic yards an hour is to be strictly adhered to, of course the first 12 miles of the Bander Canal must be entirely altered.

9. With reference to the latter part of paragraph 3, regarding my idea of a navigable canal, Colonel Mullins might have seen by paragraph 15 of general report that it was proposed to make the Suvarnamuky Channel or centre line in Divi navigable, and not the bank channel below the aqueduct.

10. The arrangements proposed in the general report were settled after a considerable deal of thought; the levels of the country, the requirements of navigation and irrigation, the nature of the soil were carefully considered, and I am still thoroughly convinced that these arrangements are the best, but I shall be glad to estimate for the channel in any way the Chief Engineer may decide upon; but as I have mentioned before the comparative cost of the (3) methods he has proposed can easily be seen; hence I have not thought it necessary (with the exception of those parts the cost of which I have entered in figures) to work them out in detail as it would certainly occupy three or four months.

No. 706.

MEMORANDUM.

With reference to the letter, No. 3, of the 1st April last, from Lieutenant McN. Campbell, to the Superintending Engineer, Kistna, the undersigned has the honor to subjoin for guidance

in preparing the completion estimates for the Masulipatam and bank canal, Eastern Delta, the following observations.

2. *Masulipatam Canal from head at Ryves' Head Sluice to Kunkipad.*—The west side channel is to be supplied from this canal by the head sluice just above Kunkipad Lock. For many years to come in all probability the demand for water will be inconsiderable. The estimate will provide for the supposed ultimate area, but the widening of the Masulipatam Canal will be carried out only to such extent as the demand for water may show to be requisite.

The off-take of the bank canal will be as proposed in the 4th mile of the Masulipatam Canal.

The surface and bed fall from the head to the bank canal off-take to be 0·33 feet a mile with a depth of 8 feet throughout.

Looking to the present circumstances of the canal the bottom width at the head will be limited to 100 feet and for the required discharge the velocity will be 2·23 feet a second. This reduced width will be maintained only so far as the depth of cutting and the nearness of old spoil banks may show to be advisable, and the normal width and that required at the off-take of the bank canal will be 115 feet with a mean velocity of 1·98 feet a second.

Side slopes 1½ to 1.
Discharge required 2,000 cubic feet a second.

From the above point to the Kunkipad Lock, the surface fall will be continued at 0·33 feet a mile, and a bottom width of about 58 feet will then be necessary immediately below the bank canal head. The bed may either be parallel to the surface which would make it 2 feet below the upper sill of the lock at Kunkipad or the depth of water may be decreased to 7 feet there and the width proportionately increased to say 68 feet; the few sections given on the ground sheet, dated 5th September 1874, do not allow of the best arrangement being determined. It is immaterial whether the canal bed be below the sill of the lock or not, and it is of little consequence its being below the sill of the sluices supplying the Pulleru. With a given velocity a certain amount of silt will be deposited annually whatever the level of the bed may be, and if the sluices will draw off the full supply carried this will be conveyed practically equally well whether the bed be at or below the sluice sills. The only condition which would necessitate the lowering of the lock upper sill would be the lowering of the water surface so much as to leave an insufficient depth of water for convenient navigation. The Pulleru sluices need not be altered unless their capacity be insufficient, or their condition unsafe. What the sill levels are is not clear from the canal section.

Side slopes 1½ to 1.
Discharge required 1,100 cubic feet a second.

3. *Bank Canal.*—The canal will not be designed as a regular line of navigation, but for the purpose of conveying materials, and in order to afford water communication of a practicable but inexpensive kind, a head lock will be allowed for, as also a second lock at or about the 24th mile with a lock weir. The bed and surface falls may then be 6 inches a mile as proposed. The navigable part of the canal will terminate at the 35th mile.

As regards the crossing of the Puligadda branch of the Kistna into Divi, the undersigned is at present of opinion that a culvert for the conveyance of a supply to Divi will be the best arrangement, but both an aqueduct and a culvert should be designed and estimated for as alternative arrangements. The level of canal bed at the 35th mile should not be lower than 18·41, *vide* paragraph 6 of memorandum, No. 226, 24th February 1875; as it may be considered settled that no navigation will be provided for in Divi the channels there should be designed for irrigation only and as economically as may be convenient.

The bank canal is to carry water only for—

1*st*, the sub-section of country between the Kistna and the Kanikalamadagu and Dayapacalwa with that commanded by the Puligadda N.B. Channel; 2*ndly*, for Divi.

4. Whatever mode of crossing the Puligadda branch be finally adopted it will be needful to regulate the admission of water to Divi and to provide for passing surplus into the branch river at some point between the head of the N.B. Channel and the crossing.

5. It is hoped that with these instructions there will be no difficulty in completing the estimates for the canals and channels referred to at an early date.

6. One or two points remain to be noticed. The culvert for the Puligadda branch would certainly require means to prevent choking and to facilitate periodical clearing. The regulating work above it should therefore have a grating to stop any floating materials, while for inspection and repair it would have to be emptied, and the best means of doing this would be by a pump at the lower end worked by coolies. Or as ample baling power will be required during the construction a small engine and centrifugal pump might be retained permanently for use on the culvert subsequently. There will with hydraulic cement made of lime and burnt clay be no difficulty in making the culvert watertight, and as it would be founded on wells and a bed of concrete its construction would present no difficulty of moment. The centering used should allow of water being drawn off under it from the completed but still

centred portion. The undersigned differs from Lieutenant Campbell as to time required for construction. Probably the whole culvert could be built in the time which it would take to complete the foundations and aprons of an aqueduct, and all the risk attending the erection of the superstructure of the latter in the event of untimely freshes would be avoided.

7. If a bridge be designed in connection with the aqueduct the additional cost due to the former should be distinctly shown, and the Local Fund Board should be asked to state whether the amount required for the bridge will be provided from local funds.

8. All branch channels should have their heads located so as to command with a good and sufficient fall the lands they are to irrigate. In the Western Delta inattention to this essential has made the Nizampatam Side Channels far less efficient than they would otherwise have been, and has indeed interfered materially with the object with which these channels were constructed, viz., the securing of a much greater fall and velocity than was attainable in the canal.

(Signed) JOHN MULLINS,
Chief Engineer for Irrigation.

30th June 1875.

APPENDIX No. 4.

From Lieutenant D. McN. CAMPBELL, R.E., Executive Engineer, in charge of Kistna District, to the Chief Engineer for Irrigation, dated Masulipatam, 7th September 1875, No. 65.

I HAVE the honor to submit the following report on the proposed improvements to the Masulipatam Canal from Ryves' Channel Head Sluice to Tidal Lock, forming part of the Eastern Delta Completion Project.

2. 1*st reach*.—The plans and estimates for this reach have been prepared in accordance with the instructions contained in paragraph 2 of your memorandum, No. 706, dated 30th June 1875. The surface and bed fall as far as the off-take of the bank channel will be 0·33 feet per mile, depth 8 feet, width from 100 to 115 feet, which will give a discharge of 2,001·52 cubic feet a second, the required discharge being 2,000·00 cubic feet a second; from the bank channel to Kunkipad Lock the same surface fall will be continued, the bed fall will be 215 feet per mile, the level at the end being 1 foot lower than the upper sill of Kunkipad Lock (+ 34·5) the depth of water at head will be 8 feet, width 61 feet, at end depth 7 feet, width 76 feet, which will give a discharge of 1,095·95 cubic feet a second against the required discharge of 1,100·00 cubic feet a second. The present widths of Masulipatam Canal are 45 feet from head to 4th mile and 66 feet from thence to Kunkipad, so that what is shown as widening in the latter portion is really mostly clearing. As decided by you the west side channel will be taken off just above Kunkipad Lock, and no alterations will be necessary to any of the masonry works in this reach.

The total cost of the improvements in this reach is Rupees 1,74,660.

3. *Masulipatam Canal from Kunkipad to Tidal Lock*.—It is proposed to reserve this portion of the canal entirely for navigation and to make it still-water with a depth of water of 5 feet on the lower sills of all the locks, which necessitates some alterations to most of the existing masonry works. The land to the west of the canal will be irrigated by the west side channel, and that to the east by branches from the Pulleru as at present. Taking 5 feet of water on Kunkipad Lock lower sill (level +28 feet) the surface of the water will be at +33 feet, which is 1 foot below the upper sill walls and 0· foot 8 inches above the lower ones of Veranky Lock, the estimate allows for raising these walls by ½ and 2½ feet respectively. The level of the lower sill being +16 feet, depth of water 5 feet, there will be a drop of 12 feet which is somewhat heavy, and it was proposed in the general report to build a new lock immediately above the existing one, but I have since decided that this will not be necessary, as the drop is at present often greater than this, and no harm results, and the lock will probably stand for many years to come. At the 31st mile there is a channel which connects the Masulipatam Canal with the Pulleru and a lock into the latter at Pamarru village. The necessary alterations to this lock have already been done this year. The next lock is that at Nedumole; the surface level here will be the same as that at lower sill of Veranky Lock or +21 feet, which is 1 foot below the level of the top of the upper sill walls of Nedumole Lock and equal to the height of the lower sill wall; it will therefore be necessary to raise the former by 6 inches and the latter by 1 foot 6 inches; the drop will be 10·5 feet. The lock being in very bad repair and the chamber walls cracked, it would not stand such a large drop. I think it would therefore be advisable to demolish the work and build a new one. The banks above will have to be raised.

4. The level of the lower sill of Nedumole Lock being + 5·5 feet the surface of water in lower reach will be + 10·5 feet. The heights of the chamber walls of the next or Ankumarru Lock on upper sill wall + 12·43 feet, lower sill wall +11·43 feet, the latter only will herefore have to be raised to + 12·43 feet.

5. The level of the low sill of Ankumarru Lock being — ·82 feet the surface level in the lower reach will be + 4·18 feet, and this will necessitate no alterations to the next or tidal lock, the chamber walls of which are + 5·18, but the banks in this reach will have to be raised places.

6. The headway under all the bridges is sufficient excepting the iron girder bridge at Chintaguntapollum, which will have to be raised 1 foot, and the bridge over the channel connecting the Pulleru with Masulipatam Canal will have to be raised 3 feet. The canal being a still-water one no escape weirs will be necessary; the existing ones will therefore be left as they are at present. The banks will have to be raised in parts to allow the proper depth of water being maintained. The total cost of the improvements to the Masulipatam Canal will be first reach Rupees 1,74,660 (Irrigation), remainder Rupees 38,640 (Navigation); total Rupees 2,13,300.

APPENDIX No. 5.

From Major J. O. HASTED, R.E., Superintending Engineer, Kistna, to the Chief Engineer for Irrigation, dated Masulipatam, 3rd June 1876, No. 29.

I HAVE the honor to forward, herewith, plans and estimates for completing the irrigation and drainage works in the second sub-section of the Ellore Canal, with a report by Lieutenant D. McN. Campbell, R.E., and statements as shown in subjoined lists.

1 Book containing plans, &c.
1 Do. do. Lieutenant Campbell's report, estimates, specification, &c.
—
2 (Sent by banghy in a separate packet.)
—

2. These plans and estimates were completed during my absence from the district, and it was intended that they should be submitted direct by Lieutenant Campbell; various circumstances, however, have delayed their submission, and they have now come into my hands bound and ready for submission. A brief description of the proposed works is therefore all that it will be necessary for me to give.

3. This section comprises the Ellore high level canal from Bezwarah to Ellore and the country lying between it, the Budameir, and the Colair lake; also improvements to the Budameir.

4. The total area of land commanded by the Ellore Canal is 140 square miles, of which only 40 miles is Government land, the rest being Zemindari; the extent of cultivation provided for is at the rate of 221·43 acres per square mile, and this will probably be sufficient for the present, as it will be impossible to confine the flood water below the canal; but I have every reason to believe that as much land as can be supplied with water will be taken up in Zemindari.

5. The soil is peculiar, as the Ellore Canal passes through considerable plains which have hitherto been "soudu." All this soudu land is, however, fit for irrigation, as has been proved, after it has been flooded with river water for two or three seasons; and parts of these plains are already beginning to be cultivated. Nearer the Budameir, which is the natural drainage of the country from the low hills towards Nuzvid, the soil is black cotton of the best description for irrigation.

6. The canal runs for the last 13 miles of its course in the Godavery District, and now supplies a number of old tanks, under which irrigation to the extent of about 13,000 acres is carried on. So long as the tanks are serviceable they will be maintained, and will be of considerable service in storing water at a point where it may be difficult, when the river is low, to maintain a full supply for irrigation. After their beds silt up they may be given up and cultivated.

7. As the canal crosses the entire drainage of the country, the chief difficulty has hitherto been to pass the drainage water without damaging the canal and stopping navigation. As a connecting link between the Godavery and Kistna the traffic is now considerable, and will doubtless increase (see traffic statement attached), and warrants a considerable expenditure. The estimates now forwarded provide for drainage works at a cost of Rupees 1,70,000 (after a deduction, I propose, of Rupees 9,000 from cost of outlet in 27th mile), works for the benefit of navigation only at a cost of Rupees 57,395, and irrigation works Rupees 67,775.

8. The bed level at head of Ellore Canal, half a mile below the head sluices at Bezwarah, will be 37·50, and the upper sill of Ellore lock, distant 40 miles, is 31·95; the water surface at head being 40·50, and at Ellore Lock, with a depth of 6 feet, 37·95. The proposed arrangement of the canal is as follows:—From head to 10½ miles, bed and surface fall 0·08 feet per mile depth of water 8 feet; from 10½ to 19¼ miles, bed horizontal and surface fall 228 feet per mile, depth decreasing from 8 to 6 feet; from 19¼ miles to Ellore Lock 40 miles, bed and surface fall ·228 feet per mile, depth 6 feet. The bottom width from head to Kasarapally branch in 12th mile is 36 feet, thence to Ellore 42 feet; this width is in excess of that required for irrigation in

the lower part of the canal, but it has been considered necessary to keep a width of 60 feet at water surface for navigation.

9. The irrigation channels are taken off between each two consecutive drainages, and have been laid down on the plan. I think it possible that some modification of the alignment of some of these channels may have to be made when carrying out the work. Only two of them, which irrigate more than 2,000 acres each, has been estimated in detail—the Muparu and the Medapalli distributaries—but all the necessary masonry works have been estimated, and Lieutenant Campbell has allowed for rapids in place of vertical falls on the distributaries, as they are the cheaper; I am, however, in favor of the falls myself.

10. The arrangements for passing the drainage will be as follows:—

	SQ. M.
In 7th to 16th mile, the Budameir drainage area ...	525
And the Anadapilly drain, area	96
Total ...	621

have to be passed; maximum discharge allowed for is 48,397 feet per second. There are the following works existing:—

	FEET.	
Ryves' channel old head sluice discharging	630	per second.
Budameir aqueduct, ,,	6,536	,,
Nakkalur under tunnel, ,,	420	,,
Kasarapally do., ,,	420	,,
Do. sluices, ,,	...	To be given up.
Budhaveram escape ,,	828	per second.
Antipally tunnel ... ,,	400	,,
	9,234	,,

And it is proposed to add an aqueduct of
12 arches 10 feet span discharge 8,313 feet.

And in addition to leave one mile of canal without banks, so as to allow the flood water to pass freely across the canal, the water level being a little below the ground level; this can be done safely.

In the 17th to 20th miles the Atkur drainage, area 5½ square miles, flood discharge 1,743 feet per second, has to be passed.

The existing works are—

	FEET.	
Atkur under tunnel discharging	140	per second.
,, escape weir ,, ...	648	,,
,, sluices ,, ...	140	,,
Pottipad escape weir ,, ...	864	,,
,, sluices ,, ...	360	,,
	2,152	

No new works are therefore required. In the 21st mile the Ampapoor drainage, area 7 square miles, flood discharge 2,059 feet per second, is passed. The existing works are—

Ampapoor under tunnel discharging 280 feet per second.
Do. inlet } ,, 475 ,,
Do. outlet }

The inlet and outlet will be lengthened by 115 and 140 feet so as to give the full discharge of 2,059 feet per second.

In the 22nd to 26th mile is the Viravally drainage, area 50 square miles, flood discharge 7,633 feet per second; the existing works are—

	FEET.	
Outlet in 22⅝ miles discharging	712	per second.
Inlet } 23rd mile ... ... Outlet }	1,425	,,
Viravally under tunnel	850	,,
Escape and sluice	2,448	,,
Narasamapolem tunnel	280	,,
Inlet } 26th mile ... ... Outlet }	2,280	,,
	7,995	

Improvements to these works only are allowed for.

At the 27th the Ramelairu, drainage area 110 square miles, flood discharge 12,910 cubic feet per second, is passed. The existing works are—

	FEET.	
Perikeed under tunnel discharging	860	per second.
Outlet ,, ...	2,261	,,
Totagudium under tunnel ,, ...	640	,,
	3,761	

The proposed work is an outlet of 960 feet in length, discharging 19,060 cubic feet per second.

In the 32nd and 33rd mile is the Pedapad drainage, area 25 square miles, flood discharge 4,809 feet per second, is passed. Existing works are inlet and outlet in 32nd mile, Pedapad under tunnel, dischargeing 600 feet per second.

The outlet has self-acting shutters which do not answer; it is proposed to build up the body wall, when the outlet will discharge only 456 cubic feet per second, and to construct another outlet 395 feet in length, which will discharge 3,753 cubic feet per second.

The last drainage crossed is the Tumilair, draining 457 square miles, flood discharge 33,520 cubic feet a second. The river divides in two branches a little above the town of Ellore. The western branch is crossed by an aqueduct which has not answered, as the bed of the river has risen to the top of the side walls of the aqueduct, and spill water is carried off by the Wuttur tunnel. It is now proposed to cut down the aqueduct and construct sluices along its whole length on the lower side with their floors on the level of the bed of canal. This work will discharge 10,584 cubic feet per second; just above the aqueduct an outlet will be constructed at the old bed of the Tumilair, 360 feet long, discharging 3,420 cubic feet a second; and the Wuttur tunnel will be removed entirely, and in its place an outlet of 700 feet, discharging 6,690 cubic feet per second, will be constructed. The east branch of the Tumilair is passed at present by two escape weirs, one of which has sluices in the body wall. These works will be converted into sluices with their floors on the level of the bed of canal, and will discharge 9,622 feet per second.

11. The existing under tunnels that are made use of are on such a level that they do not interfere with the bed of the canal. The estimate provides for minor improvements to these and other masonry works. The escape channels have been estimated, with a fall of 1 foot per mile, till they run out at the surface of ground generally within half a mile of the canal; the water is then allowed to spread, as is that discharged by the outlets, and find its way to the Budameir.

12. Provision has been made for embanking the Budameir on the south side, a most necessary work, as the water now spreads into Gudewada Taluq in floods and does much damage. The embankment will join the embankment to the Collair Lake, which is proposed to be carried round to the Upputeru.

13. Lieutenant Campbell has made no attempt to estimate the returns that may be expected from the proposed outlay; and as the subject of the expected returns from the completion of the Delta works is now in the hands of a special officer, it is doubtful if any figures that might be given by the district officers would be accepted. Assuming, however, that we may take credit for the full water-rate, Rupees 4 per acre, and accepting Lieutenant Campbell's figures, the return from additional cultivation of 12,807·63 acres would be Rupees 51,230, or 16·8 per cent. on the total of the estimates Rupees 3,04,170. In addition to this the cost of repairing damages done to the canal by floods would be saved; it appears that since 1859 a sum of Rupees 12,970 has been expended on these repairs, or 820 Rupees per annum. Some return from improved navigation may also be expected, but this it is difficult to estimate. Looking, therefore, to direct returns alone, it is beyond question that this part of completion project will be amply remunerative.

List

No. 601 I 133 P. W. D. 1222

Proceedings of the Madras Government

Under date the 24th July 78

Read the following:-

Order to Appendices to Note by Chief Engineer for Irrigation No. 294 M, dated 6th Nov. 1876, with index

Communicated to the Officers concerned in continuation of G. O. No. 3528, dated 22nd December 1876.

M
22/7/78

To,

The Dr. Rajv. Kistna and Godavery

" Collectors of do- do

" Chief Engr for Irrigation

" Exec. P. W. Accts

" Rev: Depart.

Desp. 20-8-78 with Copies of Appendices to Note by the Chief Engr.

To Circ 23-7-71

Govt. of {1878} Madras.

PUBLIC WORKS.

To

Dated N. Rishant

Issued

Read. Encl. Jo Parvain

G. O., 24 July 1878. No. 601

Nos. 90 to 91.

Appendices to the Note by the Chief Engineer for Irrigation, recorded in G.O. No. 3528 of 22nd Decr 1876 regarding the scheme for the construction of the work in ——

Communicated to the Revenue Officers concerned.

The G.O. will do not refer to the Appendices requires revision. There are some mistakes in the headings of Appendix F.

1877. Dec 25

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

24th July 1878, No. 601 I.

Irrigation.

Read the following paper:—

No. 90. Appendices to Note by the Chief Engineer for Irrigation, dated 6th November 1876, No. 294 W, with Index.

No. 91. ORDER THEREO 24th July 1878, No. 601 I.

COMMUNICATED to the offic ncerned, in continuation of G.O., No. 3,528, dated 22nd December 1876.

ue Extract.)

gned) JOHN MULLINS, Lt.-Col., R.E.,
Joint Secy. to Govt., P.W.D.,
Irrigation Branch.

To the District Engineers, Kistna and Godavery.
" Collectors of do. do.
" Chief Engineer for Irrigation.
" Examiner of Public Works Accounts.
" Revenue Department.

Exd. T. D. Ryan.
Spare Copies

Govt. of [1878] Madras.

PUBLIC WORKS.

THE DISTRICT ENGINEERS,
KISTNA AND GODAVERY,
&c., &c., &c.

Encl.

G. O., 24th July 1878, *No.* 601 I.

JULY.

Nos. 90-91.

Eastern Delta, Kistna.—Appendices to the Note by the Chief Engineer for Irrigation recorded in G.O., No. 3,528, of 22nd December 1876, regarding the scheme for the completion of the work in —, communicated to officers concerned.

GOVERNMENT

PUBLIC WORKS

24th July 1878, No. 601 I.

Irrigation.

Read the following paper:—

No. 90. Appendices to Note by the Chief Engi
November 1876, No. 294 W, wi

No. 91. ORDER THEREON, 24

COMMUNICATED to the officers conce
dated 22nd December 1876.

(True

(Sign

(True

To the District Engineers, Kistna and Godavery
" Collectors of do. do.
" Chief Engineer for Irrigation.
" Examiner of Public Works Accounts.
" Revenue Department.

Exd. T. D. Ryan.
Spare Copies

Original.

IRRIGATION.

Govt. of [1878] Madras.

PUBLIC WORKS.

To

The DISTRICT ENGINEERS,
KISTNA AND GODAVERY,
&c., &c., &c.

20.
Submit
25/35
Letter for Pt
29/6/36

Dated July 24th.

Issued

Read. Encl.

G. O., 24th July 1878, No. 601 I.

JULY.

Nos. 90-91.

Eastern Delta, Kistna.—Appendices to the Note by the Chief Engineer for Irrigation recorded in G.O., No. 8,528, of 22nd December 1876, regarding the scheme for the completion of the work in —, communicated to the officers concerned.