

(1) Number of pages 124
(2) Date of repair 18.5.44
(3) Initials of the Referencer _____

MADRAS RECORD OFFICE.

Government of Madras.

Public Works DEPARTMENT.

G.O. No. <u>768-69</u>	Press <u> </u>
<u>367-69</u>	Mis. <u> </u>
Dated <u>14</u> <u>3</u>	18 <u>71</u> .

Not to be folded or roughly handled

Western Delta Godavery

Gostanaddi Channel

Abstract Estimate sanctioned in G.O.
N^o 768 dated 14 Mch 1871

Earthworks

R.
3.8

Lock at Penumunta	15,000	
Head Sluice to Eastern Branch	10 20	
Calingulak at Penumunta	3,700	
Aqueduct over Buswarow Rodu	11,270	
Surplus below aqueduct	1,480	
LO pop — do —	1,470	
Head sluice to Viravasaram channel	1,270	
do to Adivi Kodu — do —	1,270	
do to Razi Kodu — do —	1,270	
Surplus weir into Gostanaddi near.		
Razi Kodu —	1,650	39,400

Minor Masonries

Two drops to Bhupiah Channel	700	
" minor Sluices below aqueduct	450	1,150
Compensation for land		5,750
Total for above channel		50,100

channel
Estimate sanctioned for Velpur channel
G.O. N^o 1388 dt. 15 May 75 vide compare
live statement with that G.O. — 90,960
Total for Gostanaddi & Velpur channel in
G.O. N^o 768 dt. 14 Mch 71 — 1,41,060

Keep with original
of G.O. No. 768 dated
11th March 1871.

No. 367 Read the following
22nd No

the Chief Engineer for Irrigation, dated
1870, No. 240:—

In June 1869 Captain Ryves, then Superintending Engineer of the 1st Division, when about to leave India on furlough, transmitted to this Office estimates, amounting to Rupees 9,35,200, for the improvement and completion of the system of irrigation in the western section of the Godavery Delta. These estimates were accompanied by an explanatory memorandum, which will be found in Appendix No. 1. As in the case of the estimates for the eastern section, it was found that certain parts of the project required reconsideration, and the estimates were accordingly returned to the division for revision, and have now been resubmitted in an amended form by the present Superintending Engineer, with the explanatory letters as per margin, which are printed in continuation of this Note.

2. Amount of revised estimates, and general causes of increase.—The revised estimates amount altogether to Rupees 13,12,300, and a brief comparison of the two sets of estimates, with the causes of the differences, are given in the statement, Appendix No. 2. The revised estimates, according to that statement as received from the division, amounted to Rupees 9,90,300, and the difference between this and the sum above named is as follows:—

	RS.
Revised Ellore canal estimates the amount of which was omitted	9,90,300
Restoring navigation with Weyairu...	2,49,500
	72,500*
	13,12,300

* Procs. Madras Govt. No. 2,300, dated 23rd September 1870.

The difference between the two sets of estimates is due:—

1st.—To alterations of arrangements found necessary owing to the incompleteness, or inaccuracy, of the levels on which the former estimates were based.

2nd.—To additional locks on some of the canals, and to the substitution of locks constructed with masonry throughout for locks with revetted chambers, wherever new locks have to be built.

3rd.—To provision for compensation for land required for the works.

In some cases the revised estimates are capable of reduction, while in others some addition is necessary, and these will be noticed in due course.

3. Extent of present and proposed area of irrigation.—The Statement Appendix No. 3 with the Statements forming addenda A. and B., show, the first, the area of irrigation under each canal for the years 1865-66 to 1869-70. The totals are—

	Acres.
Fusly 1275 (1865-66) ...	2,02,438
1276	1,86,643
1277	2,10,727
1278	1,98,136
1279 (1869-70)	2,13,430
	<u>10,11,374</u>
Average...	2,02,275

Statement A. gives the present and ultimate areas of irrigation according to the Executive Engineer and Revenue Officers as follow :—

	Executive Engineer. Acres.	Revenue Officers. Acres.
Now irrigated	1,89,796	2,43,186
Increase expected	60,654	71,021
	<u>2,50,450</u>	<u>3,14,207</u>
Add for Ellore canal present area ...	24,000	
Do. increase	24,200	
	<u>2,98,650</u>	<u>3,14,207</u>

There is a difference of nearly 16,000 acres between the two authorities, which is probably due for the most part to "mamool pullum," or land which pays no water-tax having been included by the Collector in his return. The information afforded, however, is far from being as complete and accurate as it should be, for Statement B., it will be seen, shows—

Area irrigated... Acres 2,43,186... Water-rate Rs. 8,14,891
and the sum collected is the water-rate, at Rupees 4 an acre, on acres 2,03,723 only, and all the difference of acres 39,463 can hardly be due to land paying no tax. Measures have been taken to remove the uncertainty as to the area of irrigated lands in the Godavery Delta, which has for so long rendered impossible any clear perception of the value of the several canals, or any accurate information as to the "duty" performed by the water-supply afforded; when the desired information has once been obtained, a regular annual record of the irrigation under each canal, and of each section of the delta, will be kept up.

The total area, for the irrigation of which the present estimates are intended to provide, is acres 2,96,300, or, say, 94,000 acres in excess of the average area of the last five years. Practically the increase due to the improvements will be somewhat more than this, because these have been already partially carried out, and have led to an increase of cultivation, thus raising the average of past years.

Appendix No. 4 shows the areas under the several canals and their branches.

4. *Area commanded.*—The area commanded by the canals of this section of the delta is 960 square-miles, or 6,14,400 acres, so that the proportion to be irrigated will be raised from a little under one-third of the total area to a little less than one-half. In Appendix 4 the area, in acres, of the ground commanded is taken at 500 acres to the square-mile, but it appears to be more correct to take the full area, as the fall of the country is so much in excess of that required to lead the water, that every acre might be irrigated, if necessary, from one or other of the canals.

5. *Water-supply.*—The supply intended to be carried by the main canal is 526,000 cubic yards an hour (3,945 cubic feet a second), or 1.775 cubic yards per acre per hour. This is rather less than the usual gross allowance of 2 cubic yards which was given in the Eastern Delta, and generally in this part of the Presidency. The reason for the difference is given in paragraph 4 of the Superintending Engineer's letter, namely, that a large part of the delta lies low, and does not need as much water as higher lands, while it is not advisable to render the drainage more difficult by adding to the surplus discharged from the several canals. Moreover it is

* Executive Engineer's letter, paragraph 19. stated* that under the Bank canal one-third of the area is cultivated with crops

which do not need water when the rices require a maximum supply. A cubic yard of water will undoubtedly do more duty when the contemplated improvements have been carried out than is the case at present, and I am of opinion that the quantity allowed will suffice, while it must be remembered that the acreage under the main canal is large, and that the average supply necessary will, therefore, be less than under smaller canals. Again, the distribution to the primary branches shows an allowance has been made to—

The Karkarapurru canal of 1.8 cubic yards per acre per hour.

„ Venkia and Weyairu 1.6 „ „ „
„ Ellore canal 1.9 „ „ „

The Bank canal is under the Karkarapurru branch, and therefore this can bear some diminution; the Venkia and Weyairu receive much drainage water in addition to the supply from the river; the Ellore canal gets some land drainage, but this has properly been left out of the account, and this high level canal has relatively the largest proportion of Godavery water.

6. *Capacity of Head Sluice about sufficient.*—It is not intended, at least for the present, to increase the capacity of the head sluice. It has 15 vents $7\frac{1}{2}$ feet high, and varying in width from $5\frac{1}{2}$ to 6 feet, the differences apparently having been accidental. The sill is at + 28, and, to afford a full supply to the main canal, the Godavery must be at between 37 and 37.50, according to the co-efficient used.

† Appendix 1, paragraph 12.

From the Abstract Register† it will be seen that on the average the river stands

between 37 and 38 for 85 days, and for 55 days more between 36 and 37, and I think, therefore, that the sluice will be found to be large enough. I have retained in the estimates a provision of Rupees 19,500 for altering the sluice, so as to enable a double set of shutters to be used. The present Superintending Engineer is averse to this alteration, and it will not be carried out, if at all, until after further

discussion on the return of Captain Ryves from furlough. The amount will probably suffice for any alterations of capacity, as well as of arrangement, which may in the future be deemed advisable, and for several years at any rate the sluice, as it is, will pass an ample supply.

7. *Main Canal, Rupees 49,000.*—The items of the estimate for the main canal are—

	RS.
Earthworks	42,030
Baling	1,750
Compensation for land	2,500
Sundries	2,720

The arrangements have been carefully worked out and are clearly shown in the book of sections, which contains also surveys of the channels which together form, what is termed, the main canal. The general specification says that the embankments of main channels are to be everywhere $2\frac{1}{2}$ feet above highest water surface. This is, I think, not a sufficient margin, and it will be better to place the top of the banks at 4 feet above ordinary full supply level in this canal, which it may be remarked receives land drainage.

8. *Heights of canal banks generally.*—Perhaps it will be as well to lay down a general rule for the levels of embankments of the Delta Canals, as I observe that the practice varies in different executive ranges. The following appear to be suitable:—

Branch canals carrying 100,000 cubic yards an hour and upwards	3 feet margin.
Canals do. less than the above	$2\frac{1}{2}$ " "

The Executive Engineer should of course use his discretion in making the banks higher, if special circumstances make this advisable, and, wherever it would save taking up land were the height increased, this should be done; the towing paths being kept however on a uniform level.

9. *Karkarapurru Canal, Estimate Rupees 33,000.*—The items of the estimate are—

	RS.
Earthworks	28,845
Compensation for land	2,000
Sundries	2,155

Captain Ryves' estimate was Rupees 47,000. The difference is due to alterations of arrangements, which are approved for the reasons given in paragraph 7 of the Superintending Engineer's letter, and in paragraph 13 of that from the Executive Engineer. These alterations are—

1st.—The discharge has been reduced by 10,000 cubic yards an hour.

2ndly.—60,000 instead of 45,000 cubic yards will be dropped into the Gostanaddi.

The discharge allowed is 220,000 cubic yards an hour (1,650 cubic feet a second). I find however that, with the bottom width of 71 feet shown, the discharge would, were the actual and normal beds the same, be about 255,000 cubic yards an hour, while as the bed is much of it below the proper level, the actual discharge would be somewhat more. I think, therefore, that the bottom width may

be reduced with advantage by 6 feet, when the capacity will still be more than sufficient for the first $1\frac{1}{4}$ miles. On the other hand, below this point, the depth being reduced to 8 feet, the bottom width requires to be increased from 62 to 65 feet.

10. *Nursapore Canal, Estimate Rupees 2,09,600.*—This is the principal branch of the Kakarapurru canal. Besides irrigating ultimately 54,000 acres, it is an important line of communication, Nursapore being a large town with a considerable trade, and Mogultur also is a place of importance.

The items of the estimate are—

	RS.
Peravelly Lock	21,390
Do. Weir	6,640
Itempudi Lock	21,640
Do. Weir	5,070
Martair Lock	21,400
Do. Weir	1,310
Kavitem Lock	24,160
Do. Weir	1,070
Palkoli Lock	22,570
Do. Weir	4,370
Tidal Lock	29,330
Do. Weir	2,380
Earthworks—Mogultur extension	18,500
Minor improvements in the several reaches of the canal and to the Chinchinada branch	26,010
Compensation for land	3,760

The canal itself is already generally of sufficient capacity to carry the necessary supply of water, and only some minor improvements, in this respect, are necessary at a cost of about 1,000 Rupees a mile. The old locks with the exception of that at Nursapore, which is a masonry work and quite efficient, are kutchas, and have done all that was expected of them; it is now necessary to replace them. The canal is a first-class line of navigation, and the locks will have chambers 150 x 20. The Itempudi lock having been reported likely soon to become useless,

* Proceedings Madras Government, No. 506, dated 12th February 1870. the construction of a new lock was sanctioned* last year under the authority given by the Government of India, and

† Proceedings Madras Government, No. 2,742, dated 15th November 1870. similarly recently it has been considered necessary to allow† the Peravelly lock

to be proceeded with. The new weirs in connection with these locks have been completed, and it will be seen from the Statement Appendix No. 5, that Rupees 2,510 had been expended prior to the 31st March last out of the sum set down above for minor improvements. The average traffic will be given in a subsequent paragraph of this note. The Martair and Kavitem lock weirs require only improvement, hence the small amount of their estimates. The Mogultur extension of the Nursapore canal is, it will be seen, estimated to cost for—

	RS.
A Tidal Lock	29,330
Earthworks	18,500
	47,830

It is altogether 7½ miles in length, and regarding this work the Executive Engineer says, paragraph 28, "It was always intended to connect the canal at this point with the important tidal river the Uputair, through which there is already a good deal of trade, small native craft working out through it both up and down the coast." I am not quite satisfied of the propriety of incurring so large an outlay. Looking at the map of irrigation and navigation, which accompanies these estimates, it will be seen that the Nursapore canal is connected with tide-water by the Nursapore lock. That thence the navigation is connected with the Uputair both by the creek which the canal would join near Mogultur and by the sea; and, as the creek route would add only 5 miles to the distance, some further explanation seems to be necessary. I shall have an opportunity shortly of seeing what the circumstances of the case are, and there may be considerations which will justify the expenditure proposed. From the traffic returns it appears that on the average about 1,250 laden boats, carrying 21,500 tons, passed through the Nursapore lock yearly in the last three years, and about the same number of empty boats. The Mogultur lock design shows that the lower sill is to be placed at — 9, or 9 feet below high water, and the Executive Engineer says that this will give a depth on the sill of 4 feet at low water. The only information which this office possesses indicates the rise of the tide to be 4.50 feet, and, if this be correct, the minimum depth would be 4½ feet. It is thought that a minimum depth of 3 feet at low water, or a minimum depth of 5 feet at mean tide, whichever may place the sill lowest, should govern its level, and general instructions to this effect have been issued, as it was found that designs varied by many feet. It is extremely difficult to found masonry at levels much below low water, and a difference of 1½ to 2 feet will make a material saving in the cost of the work. It is of course necessary that most of the boats used should be able to enter the locks at all times of the tide, and this would probably be secured with a minimum depth of 3 feet, while with a depth of 5 feet at mean tide none of the boats would be detained except for a short time.

The tail weir of this canal should have its floor placed on a lower level. For a width of 10 feet from the body wall — 7 will suffice, and the rest may be at — 5: this will give a minimum depth, on the part of the floor receiving the over-fall, of 2½ feet, and a mean depth of 4 feet 9 inches, and with a little management the principal discharge may be made with a depth of not less than 3½ feet. In constructing this weir it will be better to provide for working the shutters from the roadway by screw gearing as at most of the new weirs in the delta.

11. *Bank Canal, Estimate Rupees 1,29,460.*—This is another branch of the Karkarapurru canal, and the acreage under it will be 23,800. The work provided for in the estimate is—

	RS.
Earthworks	20,000
Compensation for land	2,500
Lock at Khandavelly	14,400
Head sluice, Mukamala channel	175
Lock at Siddhantum	17,720
Alterations to weir do.	35

	RS.
Head sluice, Kodamanchilly channel	250
Widening and improving Kodamanchilly channel for eight miles	3,000
Lock at Kodair	18,570
Weir do.	3,260
Head sluice to parallel channel	200
New parallel channel 4 miles	1,320
Sluices to Illapalunka and Vadilunka channels at 160	320
Drainage tunnel under Deva channel	750
Tidal Lock at Dodiputla	34,370
Weir do.	2,340
Sluice Vallur drain	500
Surplus weir into Nakala, 2nd mile	4,310
Dam at 22nd mile below bridge	250
Improvements to Chinchinada channel	660
Drop in rear of Cattupalem Aqueduct	830
Alterations to Mukamala calingulah	600
Tail race to surplus channel, 2nd mile	2,500

At present this canal is navigable only as far as Kodair in the 16th mile, and it will be a great advantage to give the tract of country through which it runs through communication, by building locks at Kodair and near Dodiputla. With regard, however, to the other locks provided for in the estimates, I am, as at present informed, of opinion that the one at Khandavelly may be omitted, for the drop is only 2 feet, and the water throughout is well within soil. I made a reference to the Superintending Engineer on the subject, but his reply, while adverse to the

No. 2,590, 2nd November 1870. alteration, assumes a different condition of the canal to that shown in the longitudinal section; and if, on the grounds named, it were necessary to build a lock at this point, it would likewise be requisite to increase considerably the cross section of the canal; for, as arranged, the latter is to have a surface fall of about 4½ inches per mile, whereas Major Fischer takes 3 inches as the maximum allowable. A new lock at Siddhantum is also included in the estimates, but as the kutchha lock there is efficient and suitable there is no occasion to incur the expense of a new lock, and Rupees 17,720 may accordingly be removed from the estimates. I am sorry that I have been unable to settle finally whether the Khandavelly lock can be dispensed with, but as this has not been done I propose to leave this item in, it being of much importance that the general scheme should be sanctioned, so that all parts of the improvements, which may have been suitably designed, may be gone on with in a regular manner. This is the reason also why alterations in the design of many of the works have not been made before submitting the estimates to Government. Provided the estimates give a fair idea of the cost of the improvements as a whole, the alterations of some details subsequently will not be attended with practical inconvenience, while the saving of delay will be very beneficial.

The tidal lock has been designed with its lower sill at — 6. This would seem, in connection with the remarks made on the Mogultur lock, to be about 18 inches too high. The Bank canal is to be a second-class line of navigation, and all the locks to be built upon it should have chambers 105×15 and not 110×18 as shown in the plans. The discharge of the canal appears to have been calculated on Eytel-

wein's formula. It will however carry enough water for irrigation, though only about half of the special provision of 8,500 cubic yards for navigation. The work should be laid out so that the bottom width may be increased 1 yard hereafter if found requisite. It will be better to give a depth of 3 feet to the cushion of the Kodair weir. The width of roadway here and elsewhere should be in accordance with Circular No. 14, May 1869. The shutters should be worked from the roadway and by screw gearing. The crest of this weir is rather short, and it will be better to make it 15 feet, which, it may be observed, is the length given to the Dodiputla weir lower down, and on which the depth is to be $2\frac{1}{2}$ instead of 2 feet.

The Dodiputla weir will need modification.

1st—As regards the shutter arrangements as noticed above.

2ndly.—The floor of the cushion is put at — 1 or 3.50 feet above low water. It is said the weir is to be placed in the west bank, and apparently it will discharge into the navigation creek. The top of the rough-stone apron should be at about low water level, the top of the cushion wall not higher than high water level, and then the proper level of the floor of the cushion will be — 4.75. The rough-stone apron for a width of 9 feet should be $2\frac{1}{2}$ feet thick, the rest may be half a yard. I have sketched a more suitable cross section in pencil. The estimate for this work will require raising from Rupees 2,340 to about 3,500.

The total of the Bank canal estimate, pending the settlement of the question about the Khandavelly lock, will then be Rupees 1,07,900.

Rs.	
1,29,460	{ Rs 17,720 Siddhantam lock.
Deduct 23,720	{ " 6,000 reduction of side of 3 locks.
1,05,740	
Add 2,160	for Dodiputla and other weirs.
1,07,900	

The drainage tunnel under the Deva channel has been completed. It must be noticed here that no regular estimate has been submitted for the earthworks of this canal, for which provision to the extent of 20,000 Rupees has been made in the estimates. The requirements, however, of the canal appear to have been worked out in detail, and probably, therefore, the omission of the estimate was an oversight.

12. *Venkia and Weyairu, Estimate Rupees 11,960.*—This estimate provides for

Vide Appendix 5.

a number of sluices, for improving the Chillacampad escape, a work which has been completed, and for earthworks to several channels. With regard to the sluice plans a few general remarks seem necessary.

1st.—The shutter arrangements do not seem to be convenient. All the shutters should be worked by some simple power, such as the screw, windlass, or bar and lever.

2nd.—The tunnels should generally be considerably larger than the sluice vents, so as to reduce the velocity after the water has passed the vents. This is desirable in itself and, if not done, the rear wings and revetments would have to be lengthened.

3rd.—It is not clear how the widths of roadway over the sluices have been determined; they vary from 8 feet 9 inches to 11 feet. If district roads are to be accommodated, Circular 14 lays down the proper widths; if otherwise the normal top width of the canal bank should govern the distance between parapets.

13. *Undi Canal, Estimate Rupees 1,10,700.*—This estimate provides for—

	Rs.
Head Lock, Chillacampad	14,510
Weir, do.	4,060
Surplus weir at $7\frac{1}{2}$ miles	4,910
Lock into Yennamadurru	22,890
Surplus weir do.	5,110
Do. at $15\frac{3}{4}$ miles	3,550
Dam at do.	1,480
Dam at end of channel	650
Earthworks	26,600
Minor channels {earthworks	12,150
{masonry	8,200
Drain	1,600
Compensation for land	4,990

Some parts of this canal are already larger than is necessary for the discharge allowed. Where enlargement is required the dimensions given are somewhat too small. Thus, at $1\frac{1}{4}$ miles the cross section, coupled with the average fall 3.9 inches, of the first 6 miles, gives a discharge of under 89,000 cubic yards an hour, instead of the allowance of 100,000, and as this latter is none too much for the 58,900 acres to be irrigated by the canal, the bottom width of the latter should be increased from 64 to 73 feet. Similarly, at $4\frac{1}{4}$ miles the section would give a discharge of 71,568 cubic yards instead of the 79,700 required, and here the bottom width should be increased from 58 to 65 feet. Again, at $8\frac{3}{4}$ miles the discharge will be about 8 per cent. too little, and at $15\frac{3}{4}$ miles 11 per cent. under the quantity allowed. In carrying out the works, therefore, the requisite alterations should be made.

At present this canal is navigated, but it can hardly be said to be navigable, for the entrance is extremely difficult and there are no facilities for the traffic. It is intended to place a lock at the head, and a second near Mahadevapatnum to connect this canal with the Yennamadurru drain or river, which is there tidal and navigable. The part of the canal west of the Bondada drain will not be navigable, as it would require a considerable outlay to make it so, and the tract of country through which it runs is already fairly provided for by the Akeed canal.

This will be a second-class line of navigation, and the lock chambers should be 105×15 , instead of 110×18 . The saving thus effected will go to remedy defects in the designs.

Head Lock at Chillacampad.—The side culverts, which should be on both sides of the lock, are inconveniently narrow, being only 18 inches wide; $2\frac{1}{2}$ to 3 feet will be a proper width. The side walls are shown with their tops at 18.50, the water level being 17.96; the margin is altogether insufficient, and as the Venkia, of which the Undi canal is a branch, receives a great deal of drainage, an addition of 18 inches should be made to these walls which will then be at 20. The masonry floor is $2\frac{1}{2}$ feet thick, and the lower sill is shown at + 9.50 or the base of the foundations is at 7; the bed of the channel is nominally at 7.66, but really somewhat below that; the foundations are therefore only 3.16 feet below bed of channel, and the lower sill might with advantage be lowered 6 inches, and then perhaps the foundations at 3 feet below the sill will do, if the lock site be at some distance from the old channel and if the soil be good. The width of

Where there is through navigation all the locks on any line of canal should be of the same dimensions, but on a blind canal it may be worth consideration whether, in some cases, it may not be advisable to save expense by introducing a smaller class of lock where the size of the canal and the traffic may both be small. A blind canal may, at a certain point, be treated as a branch channel, and where it may be desirable to render branch channels navigable, where also such channels, when completed to the full dimensions intended, will be under 20 feet in width at the water surface, a small sized lock might with advantage be introduced. I do not think, however, that in the present case it is advisable to make a difference in

the sizes of the locks. I do not anticipate that there will be any very considerable difference between the amount of traffic passing the two locks, and as Attili is an important market, and as the lower part of the canal will draw produce from a large area of country, I recommend that it should be arranged as a second-class navigation for the whole of the sixteen miles to Attili; the depth of water up to this point will be 5 feet, and its width 26 feet; there is, therefore, nothing to prevent the ordinary boats from using it.

Weir at 13½ miles.—The shutters should be regulated by screw gearing or levers. Base of body wall need be only 5 instead of 6½ feet. Width of water cushion at cushion wall crest level should be 12 feet.

Floor of cushion should be at	... 13.50
Crest of cushion wall	... 15.85
Top of rough-stone apron	... 12.75
Concrete under cushion wall	... 8.75

Head Sluice, Ralinghy branch.—The allowance for this channel is 15,000 cubic yards an hour, the acreage being 8,750. This may suffice for the average supply, but it will not do for the maximum, and the vents should be made $3\frac{1}{2} \times 2\frac{1}{2}$, which can be done without difficulty; the maximum discharge will then be 18,600 cubic yards an hour, which will perhaps be enough. There should be a proper shutter platform, and the shutters should be regulated either by screw gearing or other simple power.

Weir or Dam, 16 miles.—The bridge is so placed that it would be of no use in working the shutters; the latter should be attached to an upright bar passing through a slot in the bridge girder, or in a separate joist, and the shutters could then be regulated by a lever.

The reduction of the size of the Godicherla lock will cause a saving of about 1,500 Rupees, and the substitution of a second for a third-class lock at 13½ miles will add about 7,500 Rupees to the estimate, and, similarly, 1,200 Rupees may be added for improving other works, the total of the estimate will then be Rupees 86,000.

15. *Gostanaddi and Velpur Channels, Estimate Rupees 1,41,060.*—The alterations contemplated in the present arrangements are considerable; they are described in paragraphs 7 and 8 of the Superintending Engineer's letter and in paragraphs 32 to 52 of the Executive Engineer's report. The saving alluded to by Major Fischer has not been fully explained, and the increase of these estimates over those prepared by Captain Ryves for this part of the project, after making allowance for the 14,000 Rupees saved on the Karkarapurru canal, is not far from 100 per cent. However, the arrangements will be far more complete and efficient, and I think that

the results will justify the extra cost. In the classified abstract none of the expenditure is put down as belonging to drainage,

Appendix No. 6.

and only a small amount to navigation, but in reality the greater part of the whole proposed outlay will be in the interests of drainage and navigation, though these may be secured indirectly rather than directly.

The present area of cultivation is between 26,000 and 27,000 acres, and the proposed area 36,200. For this the canals are to carry 60,000 cubic yards an hour, or at the rate of $1\frac{1}{2}$ cubic yards per acre per hour, which, as the Gostanaddi receives drainage and surplus, will be enough.

The items of the estimate are—

	RS.
Earthworks	... 64,000
Head Lock	... 17,780
Do. Weir	... 4,670
Gostanaddi Weir, 14th mile	... 6,230
Head sluice, eastern branch	... 1,020
Lock at Penumentra	... 15,000
Aqueduct Buswarowkodu	... 11,270
Surplus below aqueduct	... 1,480
Drop do.	... 1,470
Three Head Sluices	... 3,810
Surplus into Gostanaddi near Razukodu	... 3,160
Minor masonry works	... 3,230
Compensation for land	... 5,750

Head Lock.—This is a second-class line of navigation, and the chamber should be 105×15 . The passages from the side culverts to the chamber are together of insufficient area; the velocity of the water entering the chamber would, on first opening the sluices, be 8.8 feet a second. If the sills of the openings be placed 6 inches below the floor of the chamber (the floor being lowered to this extent for a width of 3 or 4 feet) three openings on each side, $2\frac{1}{2}$ feet wide and 3 feet high will do. This canal is a branch of the Karkarapurru, and the height of the side walls of the lock is therefore barely sufficient; 34.70 instead of 34.50 will be an improvement.

Head Weir.—This needs alteration—

The cushion floor should be at	... 18.50
The top of cushion wall at	... 22.50
Do. of rough-stone apron at	... 20.50

Gostanaddi Weir, 14th mile.—Four bays of 11 feet each are allowed, but it will be better to give five bays of 9 feet or six bays of $7\frac{1}{2}$ feet each, as the larger span is too great for convenient working of the shutters. The details requisite for checking the other arrangements of this work are not given on the plan, or in the longitudinal sections; the top of cushion wall should not be less than 3 feet below lower water surface.

Head Sluice, eastern branch.—Full supply level below sluice not given; acreage 5,800. Discharge allowed 10,000 cubic yards an hour, the maximum should be at least 13,000; the sluice vent is $4 \times 3\frac{1}{4}$ feet, it should be 4×4 , or $4 \times 3\frac{1}{2}$, for depths of $4\frac{1}{2}$ and 4 feet in the channel respectively. The intended arrangements for working the shutters are not clear, proper platform and gearing will be required.

Lock at Penumentra.—The design is said to be the same as that for the head lock of the Undi canal, and the observations on that will be generally applicable to this. The levels marked on the lock plan do not correspond with those of the longitudinal section.

Aqueduct over Buswarowkodu.—I do not feel sure that this is the best arrangement which could be made. As there is to be a drop of 2 feet on the Velpur channel immediately below the aqueduct, navigation has not to be considered.

Major Fischer indeed mentions (paragraph 8) that this canal could be made navigable through to the Yennamadurru drain for about 40,000 Rupees, but it is not stated what the arrangements would be, and the subject need not be considered at present. The floor under the aqueduct is to be at high water level, the Buswarowkodu bed is at + 2.30, and the drain water rises to 8.75 or 2.50 feet above the upper floor of the aqueduct. The design shows cast-iron girders of 15 feet clear span with arches between them, and the bottom flange of the girders would be 3.25 feet below drain water level. The girders themselves are somewhat under the proper strength, as the breaking weight would be less than four times the weight they would have to carry. The area of the waterway under the aqueduct is 219 square-feet, against 457 square-feet, the area of the drain cross section, and this difference is, I think, too great, and five spans instead of three would appear to be required. On the whole it seems probable that it would be better to pass the irrigation water under the drain rather than over it. The discharge of the canal entered in the statement as required is cubic yards 36,950, but 45,000 might be allowed for in planning the work: the head available is 2 feet, and the velocity would be about $7\frac{1}{2}$ feet a second; the waterway of the under tunnel would be in round numbers 5 square yards, and a culvert of 9 feet span and 5 feet high to springing would be ample. I calculate that the total length would be about 170 feet, and that the cost would be 7,000 Rupees instead of Rupees 12,740 for the aqueduct (with three spans) and the drop combined, or instead of about 18,500 for an enlarged aqueduct. This subject can be considered by the local officers before the contemplated improvements are carried out.

Three Head Sluices.—In the absence of information as to the water level below the sluices, it cannot be ascertained whether they are properly designed for the discharges required; the vent is $6\frac{1}{2}$ feet wide by 3 feet high, and it would be better to divide the width by a pier.

The sluices should be capable of discharging as a maximum the quantities prescribed in Circular 27, dated May 1870. The saving effected by the reduction of the dimensions of the locks will be, to a considerable extent, absorbed in improving the side culverts and passages, and in alterations to weirs. I propose to leave the amount of the estimate therefore unaltered, until the arrangements at the Buswarowkodu are determined upon.

16. *Nakala Drain, Estimate Rupees 11,000.*—This estimate provides for the construction of an out-fall sluice, combined with an aqueduct, near Kattapolem, for the purpose of shutting out Godavery floods. This work promises to be a very useful one. The design is somewhat cramped; an additional 5 feet in the width of the cross section will be much more convenient, and will allow room for working the shutter gearing. The parapet on the river side should not be less than $2\frac{1}{2}$ feet above flood level, and care must be taken to connect it with the embankments in an efficient manner. The foot of the cast-iron standards on the river side should be bolted down to the masonry; the hinges and piers of the swing shutters are much too slight.

The alterations suggested will raise the estimate to Rupees 13,200.

17. *Drainage from Gostanaddi via the Buswarowkodu to the Vempah creek, Estimate Rupees 91,900.*—This work will, it is anticipated, have an important influence

on the desired improvement of the drainage of this part of the delta. At present, with the exception of water which escapes over the surface of the country, the whole of the Gostanaddi drainage finds its way into the Yennamadurru, which is unable to carry off the accumulated discharge. The total discharge of the Gostanaddi is estimated at 366,000 cubic yards per hour (2,745 cubic feet a second), and of this it is proposed to divert 160,000 along a natural line of out-fall, the Buswarowkodu, and to regulate the discharge into the Yennamadurru by a sluice. The works provided for in the estimate are—

	RS.
Earthworks	81,500
Compensation for land	2,500
Sluice at junction of Gostanaddi and Yennamadurru	7,900

I calculate that the discharge of the drain will be considerably less than the 160,000 cubic yards required, and as it is of importance that the drainage should be made efficient, it will be better to increase the area of the water-way one-tenth, which will make the discharge about one-ninth more. The face wall of the sluice on the Yennamadurru side should be raised to 14.50, or to $2\frac{1}{2}$ feet above flood level, a margin of 1 foot is insufficient; the shutter platform need not be raised. On the other hand, the height of the work on the Gostanaddi side may be reduced 18 inches. The shutters should work in a groove; a shoulder only is shown in the drawing.

The increase of the capacity of the drain will affect materially only the first 2 miles of the Buswarowkodu; below that the distance apart of the embankments will regulate the discharge. Rupees 2,100 will cover the additional cost, and the estimate will become Rupees 94,000.

18. *Yennamadurru Drain improvements, Estimate Rupees 28,800.*—This estimate provides for raising and strengthening the banks where necessary and for admitting drainage by sluices, so as to prevent the flooding of the adjacent lands.

	RS.
Earthworks	20,130
Ten masonry inlets on west bank, at 250	2,500
Four on east bank, at 1,000	4,000
Contingencies	2,170

19. *Other drainages, Estimate Rupees 28,200.*—These with the Yennamadurru drain make up the 57,000 Rupees of one of the estimate for drainages. They are the—

Bondada drain	Rupees 9,900
Rudrazakodu	1,650
which affect the country between the Yennamadurru and the Akeed canal.	
Kaza drain	Rupees 5,760
for the lands between the Nursapore canal and the Chinchinada channel.	
Drain west of Nursapore canal	Rupees 18,320
about one-third of the work here has been done, vide Appendix 5.	
Baggeswarem drain	Rupees 6,050
this is an old shallow drain between the Rapaka Junnur channels, and it requires to be deepened and the out-fall improved.	
Razukodu drain	Rupees 1,320
an old drain to the west of the Attili canal which needs deepening	
Erlakodu	Rupees 3,200

runs from the Gostanaddi near Dantepully in a westerly direction, and then south to the same river near its junction with the Yennamadurru. Only earthworks have to be executed, except on the drain west of Nursapore, on which two bridges are to be built. The span of these bridges is much less than the mean width of the drain, but aprons have been provided to protect them from the effects of the increased velocity of the water. It might be better not to cause any obstruction of the drainage. Probably hereafter it will be advisable to give an out-fall sluice to this drain, for I notice that much of the land near the lower end is below high water level.

20. *Ellore Canal, Estimate Rupces 2,49,500.*—This canal forms the northern boundary of the delta, and it is also the junction canal between the systems of navigation in the Godavery and Kistna Deltas. At present the irrigation under it is about 24,000 acres, and the ultimate area will be about double this extent or 48,200 acres. Its length to the Ellore lock, the only one on the line, is 46 miles.

i. e., from Vizaisweram, the length of the Ellore canal proper, from the Nundamoor aqueduct, is 38 miles

The Ellore canal estimates are divided into the following sections:—

	RS.
Main Canal	55,000
Mid-level Channel	64,180
Low do. do.	19,290
Pundikodu Drain	59,530
Drain from 9½ miles on the mid-level channel to Beckley's drain, with other drains	24,000
Drainage diversion above mid-level channel	21,700
Two Rest-houses	5,800
<i>Main Canal.—The works estimated for are—</i>	
Earthworks	29,363
Eight Sluices at 525	4,200
Ten do. „ 450	4,500
Eight do. „ 375	3,000
Thirty-two miles of Distribution Channels at 220	7,040
Twenty Dams across do	3,000
Contingencies	3,897

At present the bed of the canal at the Ellore lock is higher than the lock sill, and it is proposed, according to the longitudinal section, to place it nearly one foot below the sill. This does not seem to be advisable, and I do not see anything to prevent an adjustment of the bed and water surface falls, so as to bring the former to 20.91, and the latter to 26.91, at the lock. I would reduce bed and surface falls down to 31 miles by one foot: the average bed fall will then be—

0.166 instead of 0.209 per mile.

and the surface 0.215 do. 0.259 „
and from 31 to 46 miles the levels will be—

Surface at 31 miles	+	28.18
„ 46 „	+	26.91
Slope 0.085 per mile.		
Bed at 31 miles	+	22.18
„ 46 „	+	20.91

Slope 0.085 or the same as at surface.

The velocity will be more regular which will be another advantage.

The under-tunnels already built appear to have been constructed without much reference to the circumstances of their position. Many of them might have had much more headway, and consequently capacity for discharge.

Design for Sluices.—This requires modification—

1st.—Its elevation is insufficient, the ordinary depth of water in the canal will no where be less than 5.80 feet, and in many places considerably over 6 feet; the shutter platform should be 6 inches above full supply level, and the roadway over the sluice 3 feet above that level.

2ndly.—The tunnel should be considerably larger than the sluice vent, as there will generally be a head of water.

3rdly.—The intrados of the tunnel should be at least 1 foot higher than full supply level in the channel below.

4thly.—The side walls would make a better joint with the earthwork were their thickness increased, and reduced 6 inches in alternate lengths of 6 feet or so.

It is not clear why the pathway over the sluices is to be 9 feet 4½ inches wide.

Leakage.—In the water distribution statement 1,875 cubic yards per hour are put down as running to waste from leakage at three escapes; the arrangements ought to be made much more efficient than this would indicate.

Mid-level Channel.—The general direction of this channel is parallel to the main canal at a distance which gradually increases from 1 to 2 miles. Above the bifurcation of the low level channel it is intended to carry 27,500 cubic yards an hour for 16,000 acres of irrigation, or 1.71 cubic yards per acre per hour. I have already pointed out that the total discharge of the Ellore canal proper should be 91,000 instead of 96,000 cubic yards, and even then the share belonging to the mid-level channel should be considerably more than 27,500 cubic yards. It has under it one-third of the total area, and its full share would be 30,300 cubic yards an hour, and prior to the reduction of the Ellore canal supply it would have been 32,000. It will receive some surplus from the Ellore main canal, and under these circumstances 29,000 cubic yards will probably suffice, and this quantity should be given.

The items of the estimate are—

	RS.
Earthworks	23,800
Compensation for land	8,440
Head sluice	1,480
Four Bridges at 980	3,920
Two do. at 1,930	3,860
Under-tunnel, 7th mile	4,330
Four Drops at 700	2,800
Escapes and regulating bridge at 9½ miles	2,840
Do. do. do. 11½ „	3,600
Do. do. do. 12½ „	1,530
Three Drops	1,580
Twelve Village sluices at 420	5,040
Six Metalled crossings	960

I believe that a great deal of work has been already done on this and the low level channel, but no statement of it has been forwarded. A reference has been made to the Superintending Engineer, the reply to which will accompany these papers, though it will not come in time to be noticed in detail in these observations. It will be necessary to accept, under these circumstances, the general arrangements, whereby the irrigation water is conducted by the main canal and two branches across the drainage of the country. I know that Captain Ryves gave much attention to the subject, and, though this plan is an expensive one, it is very possible that no cheaper one could be devised.

There are no cross sections of the channel, but the statement of quantities and discharges gives the bottom widths, depths, etc.

The channel will require a little enlargement to enable it to carry 29,000 cubic yards; also below the bifurcation the discharge should be 18,400 instead of 17,500, and here also a slight increase of width will be needed.

Under the arrangements sanctioned in G. O., No. 2,300, dated 23rd September 1870, the restoration of the navigation between the canals and the Weyairu will be effected by making the mid-level channel, as far as the bifurcation, navigable, and thence the low level channel to near Madapuram, whence a new canal for navigation only will be taken to the Weyairu. The carrying out of this plan will ensure the requisite capacities for the channels down to their respective head sluices.

The velocities, on the parts of these channels, which are to be used for navigation only, appear to be lower than is necessary, but, I think, no alteration is now practicable.

Under-tunnel, 7th mile.—The design is an expensive one, and in some respects not what is requisite.

1st.—The junction of the wings with the channel banks on the north side is not an efficient one; a wing about 10 feet long parallel to the axis of the channel would be required on each side of the drainage.

2ndly.—There is a waste of masonry in the abutments which, for spans of 6 feet, do not need to be 6 feet thick at base and $4\frac{1}{2}$ feet at springing.

3rdly.—If a bridge over the drain be necessary it would be cheaper to lengthen the aqueduct piers, and to turn arches at the required level, than to build a separate bridge of one span. A culvert would be a cheaper work altogether.

Escape and Regulating Bridge at $11\frac{1}{4}$ miles.—I do not understand what the intended arrangements are to be. The channel is to have a bottom width of 20 feet and mean width of 23.51 feet. What appears to be the bridge has a span of 15 feet, and the other work three spans of 10 feet each. Paragraph 13 of Executive

No. 482.

Engineer's letter says that shutters are to be put at times in the bridge, and at times in the escape, but only one of the works, which appears to be the escape, is adapted for shutters. It is not clear why, with a bridge of much less span than the mean width of the channel, a masonry bar is to be placed across the bed, or why the sill under the escape shutters has been placed lower than the floor of the escape; also

why, when the depth of water is to be 2.24 feet, the escape shutters are to be 3 feet high and the roadway $7\frac{1}{2}$ feet. Then whence the water, to be discharged by this escape, is to come is not evident. The longitudinal section shows that the tail race of No. 1 under-tunnel, meaning, it is supposed, the tunnel under the Ellore canal, is to cross the mid-level channel here, but paragraph 19 of the Executive Engineer's letter, and the drainage diversion marked on the survey, indicate that all, or nearly all, this water is to be diverted to the Colair lake. The discharge of the channel is under 10,000 cubic yards an hour (75 cubic feet a second). Below the mid-level channel no drain is shown to conduct the water from the escape.

At $12\frac{1}{8}$ miles another regulating bridge and escape is estimated for, but apparently the diversion cuts off all drainage except that from a very trifling area of country. In each case the escapes are to be just below drops, and, as far as I can judge, the proper plan would be to put a weir or a surplus sluice at (immediately above) the drop if there be any surplus to be got rid of; the channel water is generally below ground level throughout each reach.

At any rate the arrangements appear to require re-consideration.

The design for sluices will be noticed in connection with the low-level channel.

Low Level Channel.—The proper discharge for this channel, as revised, will be cubic yards 10,600 per hour. The estimate allows for—

	RS.
Earthworks	6,150
Compensation for land	2,760
Head sluice	1,140
Bridge and drop, Madapuram	1,430
Four drops	2,070
Escape at $2\frac{1}{2}$ miles	1,000
Bridge, Duvva road	1,100
Six sluices at 420	2,520
Seven metalled crossings	1,120

Some of the arrangements will be modified by the navigation to the Weyairu. The head sluice, if not already built, will not be required, as the site will be altered, and a sluice has been provided for in the navigation estimate.

Design for Sluices.—The crest of the rear retaining wall is about $1\frac{1}{4}$ feet above the sluice sill. This arrangement appears to be objectionable, and would have the effect of rendering the sluice useless with less than $1\frac{1}{4}$ feet in the channel. The pathway over the sluice would generally not need to be more than 5 or 6 feet wide, or whatever may be the normal top width of the banks.

Pundikodu Drain.—This includes the whole of the drainage work from Bodapod to the Pundikodu. It is described under the names of the Bodapod drain and Pundikodu, in paragraphs 16 and 17 of the Executive Engineer's letter, No. 482. The items are—

Earthworks.

	RS.	RS.
Drain from Bodapod to aqueduct	4,722	34,600
Do. under aqueduct to Weyairu	2,846	
Do. from aqueduct to Pundikodu and deepening the latter	25,336	
Contingencies	1,696	
Land compensation		5,385
Aqueduct under Chinnakapavaram channel and altera- tions to the latter		RS. 18,240
Bridge near Chillacampad over Bodapod drain ...		1,305

The Venkia water is retained at a high level by the Peramella lock, and below that the Chinnakopavaram channel cuts off the lands to the north from all drainage, except in a westerly direction, into the Colair lake, and nothing had been done until recently to give facilities for drainage in any direction. The Bodapod drain has been cut, and the aqueduct built so as to allow of the accumulation of drainage up to this point being discharged into the Venkia, or, as it is called, the lower Weyairu. Further westward the drainage will be carried into the Colair lake by the Pundikodu, which will be deepened and otherwise improved. Appendix 5 shows the expenditure which had been incurred up to the 31st March last; and the effect has been that 1,500 acres of land have been reclaimed and brought under cultivation, and a further area only awaits the completion of the irrigation channels.

The drain from near the aqueduct to the Pundikodu will be a little less than 3½ miles in length. It is not clear why a bottom width of 20 feet is to be given to this drain immediately west of the aqueduct, neither has any information been given as to the relation of the dimensions of the drain to the area of country relieved.

Drain from 9½ miles Mid-level Channel, etc.—The estimate provides for—

	RS.
Earthworks	12,500
Land compensation... ..	2,100
Five Drops	3,370
Drains from under-tunnels of mid-level channels ...	1,600
Tail races from Kykaram under-tunnels in the 30th mile of the Ellore Main Canal	4,430

It would be advisable, I think, to have foot-bridges at all the drops except the fourth. A pier in the centre where the crest is more than 12 feet long, and two piers for crests of more than 24 feet, would make it easy to afford this accommodation. The length of the drainages included in this estimate is about 14½ miles.

Drainage diversion from Bathampudi tail race.—This starts from the 20th mile of the Ellore main canal, and falls into the Colair lake; its length is about 9 miles.

The works include—	RS.
Earthworks	16,375
Land compensation... ..	2,175
Two Drops	1,550
Sluice to Chinnanindracoli channel	1,220
Bar at 5¼ miles	380

The shutter arrangements of the sluice are complicated, and I think an efficient sluice might be built at a less cost. The shutter should close on the highest part of the sill, and the parapets should not over-hang the face wall.

21. *Rest-houses, Estimate Rupees 34,800.*—In sending up the estimates for the eastern section of the delta, the Superintending Engineer asked for sanction for five rest-houses on a design the arrangement of which was suitable. It was intended, however, to construct a large part of the main building of mud, and this appearing to be objectionable, suggestions*

were made that the foundations and some other important parts of the walls should be of masonry, and the rest of burnt brick-in-clay. Major Fischer has accordingly revised the estimate, but he now proposes that the walls throughout should be of brick-in-chunam, and he shows by a comparative statement that the additional cost will only be Rupees 200 for each house. The places where it is proposed by the Superintending Engineer to build these houses are as follow:—

One at Chettipett, which is close to the heads of all the principal branches of the main canal, and which therefore is a very convenient situation. One at Kodair on the Bank canal, and this site appears to be well chosen.

Two at Peramulla and Akeed on the line of the Venkia and Weyairu, the former being at about 15 and the latter at 23 miles from Chettipett, and these I think, may be allowed.

Three on the Nursapore canal at Peravelly, Martair, and Mogultur. It appears to me that two rest-houses will suffice for this canal, one of which should be built near Peravelly, but a little to the north of it, which will be about 9 miles from Chettipett and equally convenient for the bank and Nursapore canals and the other at either Martair or Palkoli, whichever may on the whole be considered by the Superintending Engineer to be the more convenient. Both places are on district roads, but the latter, if not undesirable from its proximity to Nursapore, will divide the length of the canal into two sections more conveniently than Martair.

Three on the Undi canal at Undi Bhemavaram and Veeravasaram. Of these places Undi is alone on the canal named, and as it is only 5 miles from Akeed, it will not be necessary to allow another rest-house at Undi. Bhemavaram is close to the Yennamadurru drain, on the road between Palkoli and Akeed via Undi, and as it is about 10 miles from Akeed and 13 from Palkoli the situation will be convenient. Veeravasaram is only 7 miles from Palkoli and 6 from Bhemavaram, and I think therefore it is unnecessary to give a rest-house here.

Lastly, two rest-houses on the Ellore canal at Prettipad, between 7 and 8 miles from Chettipett, and at Poola, which I have not been able to find on any of the plans. The whole distance from Chettipett to Ellore is a little under 40 miles, and if this be about equally divided into two parts by a rest-house, all that is absolutely necessary for convenience will be secured. The proper site will then be at or near Chabrola.

I recommend, therefore, that eight Rest-houses be sanctioned, namely:—

1. At Chettipett.
2. „ Peravelly.
3. „ Kodair.
4. „ Palkoli.
5. „ Bheemavaram.
6. „ Akeed.
7. „ Peramella.
8. „ Chabrole.

The estimate for these houses has been examined, and it has been found that the difference between the cost of using chunam for the walls of the main building throughout will be only about 200 Rupees, as shown in the comparative estimate transmitted by the Superintending Engineer. Such being the case, it will be advisable to adopt the estimate which provides for this mode of construction, and the amount to be included in the estimates for this section of the delta will be Rupees 23,200 or Rupees 2,900 for each of the eight buildings.

22. *Total of Estimates.*—With the alterations which I have suggested the estimates for this section of the delta will be as follows, and for convenience the amount of the Superintending Engineer's estimates are shown along side:—

Description.	AMOUNTS		Remarks.
	Of estimates as received from Suptg. Engineer.	Of estimates as recommended for sanction.	
	RS.	RS.	
1. Head Sluice, Main Canal ...	19,500	19,500	
2. Main Canal ...	49,000	49,000	
3. Karkarapurru Canal ...	33,000	33,000	
4. Nursapore Canal ...	2,09,600	2,09,600	
5. Bank Canal ...	1,29,460	1,07,500	Subject to a reduction of about Rs. 40,000 should the Mogultur extension not be finally sanctioned, <i>vide</i> paragraph 10.
6. Venkia and Weyairu ...	11,960	11,960	Subject to a further reduction of 13,000 (14,400—1,400) Rupees should it be decided to omit the Khandavelly lock.
7. Undi Canal ...	1,10,700	1,10,700	
8. Attili Canal ...	78,800	86,000	<i>Vide</i> paragraph 14 above.
9. Gostanaddi and Velpur Canal...	1,41,060	1,41,060	Will be diminished or increased some 5,000 Rupees according to the plan ultimately adopted for crossing the Buswarowkodu. <i>Vide</i> paragraph 15.
10. Nakala drain ...	11,000	13,200	<i>Vide</i> paragraph 16.
11. Gostanaddi out-fall and sluice.	91,900	91,000	Do. do. 17.
12. Yennamadurru drain ...	28,800	28,800	} 57,000, <i>vide</i> paragraph 19.
13. Other drains ...	28,200	28,200	
14. Drain west of Nursapore ...	18,320	18,320	
15. Ellore Canal ...	*2,49,500	†2,43,700	{ * Including two Rest-houses. † Rest-houses provided for separately.
16. Rest-houses ...	29,000	23,200	
Total...	12,39,800	12,18,140	

The total of the estimates for the Western Delta will then be— RS.

The 16 items as above ... 12,18,140

Restoration of navigation with Weyairu, the estimate for which was sanctioned in Proceedings Madras Government, No. 2,300, dated 23rd September 1870 ... 72,500

Grand Total ... 12,90,640

23. *Proportion of estimates belonging to Irrigation and Navigation respectively and cost of drainage.*—Of the sum thus shown to be required, inclusive of the expenditure incurred up to the 31st March last upon these improvements, the classified abstract, Appendix 6, shows that navigation will absorb Rupees 4,11,470, and irrigation Rupees 8,79,170; while of the former amount Rupees 24,490, and of the latter Rupees 2,93,930, will be for the drainage of this part of the delta. The estimates may therefore be roughly considered to provide for:—

	RS.
Irrigation ...	5,85,240
Navigation ...	3,86,980
Drainage ...	3,18,420
Grand Total ...	12,90,640

24. *General remarks on some details of works.*—Many remarks and suggestions have been made in reviewing the estimates for the several canals, but a few observations which are generally applicable to the delta works may be usefully added.

Puddle.—This material should be used above all walls which have to sustain a pressure from water. In none of the designs has any been shown, though attention was called to this subject a long time ago.

Gearing.—The machinery for the regulation of shutters, sluice gates, etc., should, where practicable, be so arranged that the power may be applied at a fixed or nearly fixed level. Where screws are worked by horizontal levers, it is inconvenient that the latter should be at the ground level when the sluice is closed, and several feet higher when the gate is fully open—this inconvenience can easily be avoided.

Widths of roadway over masonry works.—These should be fixed in the case of bridges for regular roads with reference to Circular 14 and elsewhere upon the same principle. Foot bridges may be from 3 to 5 feet wide, and should, when on the line of embankments, correspond with the normal top width of the bank.

Shutter platforms.—A proper platform, not less than 2½ feet in width, should be provided for the convenience and safety of establishments employed in regulating

shutters, sluice gates, etc. If it be necessary for them to work on both sides of the line of the shutter a safe width must be allowed on that side also. All regulating shutters should be worked from bridge platforms, unless the maximum depth passing over the crest or sill of the work will not exceed 1 foot.

Metalling over arches.—Arches carrying roadways, which are to be used by carts, require to be protected at the crown by at least 1 foot in depth of metal or gravel.

Margin to be allowed at masonry works above flood level.—This margin should always be ample. It is a great mistake to risk injury, and the resulting inconvenience, by cutting down this margin to a minimum. In the Delta canals the water level is nearly everywhere liable to rise above ordinary full supply level, either from the admission of drainage, or from the closing of irrigation sluices; lock walls and other works should therefore have such an elevation as will allow of a considerable rise without risk of damage and in order that time may be given for adjusting the shutters of escapes and other works of regulation. Special care should be taken that every masonry work, whether constructed formerly or now to be built, is properly arranged in this respect.

25. *Extent of navigable canals.*—The lengths and classes of the navigable canals of this part of the delta are as follow :—

1st Class.	Main canal	8 miles
	Ellore canal	38 "
	Karkarapurru and Nursapore canals	40 "
	Total 1st Class	86 "
2nd Class.	Bank canal... .. .	24 1/2 "
	Gostanaddi and Velpur	29 "
	Attili canal	16 "
	Undi canal and Yennamadurru drain	28 "
	Venkia, Weyairu, and Akced canals	35 "
	Total 2nd Class	132 "

Besides the above 218 miles of navigation, there are about 50 miles of navigable creeks and drainage nullahs by which many villages are enabled to transport their surplus produce.

26. *License fees on boats, rafts, etc.*—The collections or amounts due for license fees for the use of the navigable canals

* Appendix 7.

1869-70 to Rupees 15,687. The Ellore canal does not appear to be included in this Statement of Remunerative Works, Appendix 8. return. Nearly one-third of the tolls were for passenger boats. On the other hand, the management of the navigation of the whole delta cost Rupees 14,000, and of this amount Rupees 5,500, or a little more than one-third of the receipts, may be taken as chargeable to the western section of the delta.

27. *Traffic on the Canals.*—The traffic on the canals is shown in the statements forming Appendix No. 9, and the following is an abstract for the years 1867 to 1869 :—

Nursapore Canal.

					BOATS.		
Locks.					Number.	Tonnage.	Empty.
				{ Up ...	786	14,748	478
Nursapore	...	...	...	{ Down ...	352	6,763	822
				{ Up ...	735	14,416	586
Palkoli	...	...	...	{ Down ...	562	9,030	789
				{ Up ...	635	12,686	456
Kavitem	...	...	...	{ Down ...	554	10,386	588
				{ Up ...	758	15,326	419
Martair	...	...	...	{ Down ...	504	9,741	638
				{ Up ...	847	17,522	573
Itempudi	...	...	...	{ Down ...	702	12,963	738
				{ Up ...	1,163	23,747	336
Peravelly	...	...	...	{ Down ..	892	19,001	565
Average...					...	1,66,329	...
						13,861	...

The length of the canal being 40 miles, altogether 1,108,880 tons were carried one mile, and with the proviso that, in the absence of water carriage, such a traffic would be non-existent, the value of the canal may be estimated from the difference of the cost of carriage by land and water respectively.

	RS.
1,108,880 tons, at 2 Annas	1,38,610
1,108,880 ,, at 1/2 Anna	34,652
Difference...	1,03,958

Bank Canal.

Locks.					BOATS.		
					Number.	Tonnage.	Empty.
Khandavelly	...	...	...	{ Up ...	167	3,956	28
					{ Down ...	74	1,621
Siddhantum	...	...	...	{ Up ...	36	720	11
					{ Down ...	15	315
Average...					...	6,612	
						1,653	

This canal will probably never carry as much traffic as the Nursapore canal has done in past years, but the effect of the absence of facilities for navigation is nevertheless very striking, and a very different result may be anticipated five years hence, when the contemplated improvements shall have been carried out and borne

fruit. The length of canal in use may be taken at 15 miles, and the tonnage carried 1 mile will then be 49,590.

			RS.
Cost of Land carriage 49,590, at 2 Annas	...	...	6,199
Do. Water do. at $\frac{1}{2}$ Anna	...	...	1,550
Difference...			4,649

Venkia and Weyairu Navigation.

Locks.						BOATS.		
						Number.	Tonnage.	Empty.
Nundamoor	...	...	...	{ Up	...	851	20,984	135
				{ Down	...	417	10,128	516
Peramella	...	...	...	{ Up	...	600	15,027	115
				{ Down	...	360	8,558	360
Average...						...	54,697 13,674	

The year 1868 showed a very marked increase in the traffic, and 1869 would apparently have exhibited a still greater development had not the closing of the Nundamoor lock unfortunately put a stop to through navigation. The traffic returns at the Yalurpad lock, which is the tail lock on this line of canal, are incomplete, but apparently the trade may be estimated at half the above average tonnage carried 35 miles each way or 478,590 tons carried one mile.

			RS.
Land carriage, at 2 Annas	...	...	59,824
Water do., at $\frac{1}{2}$ Anna	...	...	14,956
Difference...			44,868

Eventually the traffic on this line will probably reach one million tons carried one mile, and the value of the navigation to the community would then be about one lac of Rupees annually.

Ellore Canal.

Locks, etc.						BOATS.		
						Number.	Tonnage.	Empty.
Nundamoor Aqueduct	...	...	...	{ Up	...	1,005	23,565	766
				{ Down	...	1,450	33,014	355
Ellore Lock	...	...	...	{ Up	...	674	15,915	1,046
				{ Down	...	1,715	37,051	126
Ellore Aqueduct	...	...	...	{ Up	...	275	6,614	455
				{ Down	...	692	15,025	80
Average...						...	1,31,184 21,864	

The length of the canal in the Godavery District being 38 miles, the trade was equivalent to 1,661,664 tons carried one mile, and the value of this means of communication to the population would be approximately the difference of the cost of transport by land and water or

			RS.
Land carriage, at 2 Annas	...	...	2,07,708
Water do., at $\frac{1}{2}$ Anna	...	...	51,927
Difference...			1,55,781

This canal will, relatively, be the most costly both for construction and maintenance in the delta. Appendix 10 shows that the past capital expenditure has been upwards of 7 lacs, and the proposed outlay is nearly $2\frac{1}{2}$ lacs, so that altogether the capital investment will amount to, in round numbers, some 10 lacs of Rupees. In return for this 48,000 acres of land will be irrigated and the country drained, while a trade of no inconsiderable magnitude has been developed and will no doubt be largely extended in the future. The results will be very satisfactory, for the returns will be about 16 per cent.

28. *Probable results of expenditure.*—The present proposed outlay is, as already detailed, Rupees 12,90,640, and the returns expected from this expenditure is the water rate on 94,000 acres of additional irrigation, which for the first or principal crop only will be 3,76,000. There will no doubt be some second crop cultivation, and there will be some extra receipts from navigation, but it will suffice to consider the ultimate gross returns from the outlay recommended to be as above. The additional expenditure for maintenance may be taken at 8 Annas an acre or Rupees 47,000 annually, and this is considerably in excess of what is at present allowed. The net receipts will then be Rupees 3,29,000 or 25.4 per cent. It is not supposed that such a return will be immediately or very soon realized, but as, in order to ensure a net return of 10 per cent., it will be requisite to bring only 37,000 out of the 94,000 acres under irrigation, it may, I think, safely be assumed that the improvements will not be any tax on the resources of the State for more than one or two seasons at most. The work already done has been executed within the estimated amounts, and the Executive Engineer has, in framing his estimates, allowed rates somewhat in excess of those at which he can now get his work done, so that although a good many modifications of detail have to be made in carrying out the improvements, I do not think that there is any probability of the amount of sanction asked for being exceeded.

The above remarks show the aspect of the project as regards future expenditure, and it may be useful to see what the general results are likely to be, taking past expenditure also into account. The statement, Appendix No. 10, shows that the total expenditure chargeable to capital, on the works of the western section of the delta, amounted, up to the end of 1869-70, to Rupees 14,81,311. Of this sum Rupees 1,20,291 appertain to the works provided for in the estimates now submitted for sanction, leaving Rupees 13,61,020 as the expenditure prior to the commencement of the improvements. In addition to this amount this section of the delta is chargeable with a share of the cost of the anicut (Rupees 15,66,574), and this will be 50 per cent. more than the sum debited to the eastern section of the delta or Rupees

4. The statement marked A. exhibits the extent of land now irrigated and that which it is expected will be brought into cultivation when the project is completed as far as we can now provide for it. These statements have been prepared by the Range Officer and the Revenue authorities, and considerable differences appear in them; but, for the reasons given with the Eastern Delta project report, the figures of the Range Officer have been adopted as the basis of the scheme. At first the statements furnished by the Tahsildars through the Collector differed so widely from those given by Mr. Rundall that I had to return all the papers for re-consideration, and a good deal of delay was caused thereby. It will be observed that the great differences occur only under the Nursapore and Velpur Canals; the others are merely nominal, and even under the former canals the differences are not so great as to require material alterations. The total area for which water has been provided is

See paragraph 109 of Mr. Rundall's report. 296,000 acres, and the quantity of water (526,000 cubic yards per hour, or rather more than $1\frac{3}{4}$ cubic yards per hour per acre, a full supply of 2 cubic yards per hour per acre) has not been provided in this delta, as there is a vast extent of low-lying lands which do not require so much water, and would be very difficult to drain if more water were to be given. As it is, a great deal of land is now swamped by the supply as existing.

5. The main canal conveys this volume of 526,000 cubic yards per hour for the first mile, where a small branch running towards Muddoor takes off and is now capable of carrying about 43,000 cubic yards per hour. This branch was omitted in the former project; but I have retained it in this, as, in the event of more water being required to be supplied to this delta, the head for the first mile and this branch alone will require to be improved to convey the necessary quantities, and in the latter the work can be more economically executed than in any other part of this large channel, as may be observed from the several cross sections. Near the second mile the channel again divides, and at the fourth mile all these several branches unite and flow down to the Chettypet Calingulah at the sixth mile, whence the general distribution is made as follows:—

1st.—Karkarapurru Canal takes off 220,000 cubic yards per hour.

2nd.—Ellore Canal head takes off 156,000 " "

3rd.—150,000 cubic yards per hour are passed over the calingulah itself for the supply of the Venkia and Weyairu.

6. The Karkarapurru Channel at the head has to convey water for three large distributing channels, which have all to be made navigable. These are—

1st.—The Gostanaddi and Velpur Channels.

2nd.—The Bank Canal.

3rd.—The Nursapore Canal.

There are some minor channels requiring no particular notice.

7. I have somewhat altered the arrangements originally proposed for the Gostanaddi and Velpur Channels by allowing the entire supply for the latter to be dropped into the former and conveyed by it to a suitable site, whence a weir will divert it as required. By this plan a good deal of saving can be effected—first, the Karkarapurru Canal has not to be widened and deepened for several miles so much as formerly allowed for; second, the navigation for this tract, by being taken out

of an old delta drainage channel, has been very considerably improved; and thirdly, by removing the calingulah to a point much above Penumuntra the water is kept well within soil and the drainage below is left entirely free, so that there is no occasion now to embank this and provide drainages with outlets below Penumuntra.

8. The several plans, sections, and estimates herewith sent explain exactly the work to be done for these two channels. The only point I need notice particularly is whether the Velpur Channel should not be made navigable into the Yennamadurru Drain and so connected with the Undi Canal. At present it is left as a blind canal, an arrangement I do not like, and have only acquiesced in because the extension would be so very expensive. About 40,000 Rupees would be required to complete this work, which, however, can be added to the estimates if approved of.

9. The Bank Canal is the next work to be considered herabouts. This channel has been sadly neglected considering its vast importance, being capable of irrigating, as it was intended it should do, some of the most fertile lands in the delta. The present design provides for completing this work with all necessary masonry works and to make it navigable into the Godavery by a tidal creek below Dodecputtah. This line will then be an alternative line for the Nursapore Canal, and this part of the delta will then be provided with most efficient means of communications.

10. I have finished the Bank Canal into the Dodecputtah Creek, instead of into the river itself as had been suggested, as this latter arrangement offered no advantages to recommend it, and was, moreover, more expensive to adopt.

11. The Nursapore Canal now remains to be noticed. This is a high-level navigating and irrigating canal, in very good order as far as its earthworks and general sectioning are concerned; but the locks on it are in very bad order. All, except the new one at Nursapore itself, require re-building, and the canal itself has to be extended to Mogultur to complete the navigation with the Uputair. The designs, etc., for the necessary works are all sent with this report.

12. It was originally proposed to surplus the Karkarapurru Canal waters into the Nakala Drain by the Mukamala Channel; but this design has now been somewhat modified, as it was found so much work would have to be done to the Mukamala Channel to make it capable of conveying the required volume of water, and this would have to be done every year, as this channel is now only a blind one and this would have to be done during the irrigating season. The existing calingulah on it has silts up very much during the irrigating season. The existing calingulah on it has to be lowered, and will then act as a surplus for a portion of the waters to be got rid of; but the main surplus work is to be constructed in the Bank Canal at the head of the Nakala Drain. This arrangement provides means of reducing the water at the heads of both the Nursapore and Bank Canals, and the former is, moreover, to be supplied with a surplus weir in the last reach to discharge any waters finding their way down the canal and being in excess of its requirements. The Bank Canal will also have a surplus weir at the Dodecputtah Lock.

13. Returning to Chettypet, the next main distributing canal is the Ellore Canal head. This has to convey 156,000 cubic yards per hour—60,000 cubic yards for the Uttali Channel, and 96,000 cubic yards per hour for the Ellore Canal proper.

14. The Uttali Channel, which takes off three-quarters of a mile below this head, is at present entirely unprovided with the necessary masonry works. It is now proposed to put a couple of locks into this canal, and to make it navigable as far as the large village and market of Uttali. The head lock is to be a second class one, of the dimensions generally proposed for the delta; but the second lock is to be third class, as it is not proposed to make this a through navigation, and it is very undesirable to allow the larger class of boats using our canals to pass into channels not supplied with sufficient water for their use; and, as a good deal of expense could thus be saved, I have adopted the above arrangement.

15. This canal is at present in a most unsatisfactory state, being a high-level channel and running on the natural dividing ridge of the country unprovided with any proper head. On other masonry works the velocity of the water passing down it is very high on such an inclination, and the usual results have, of course, taken place—banks worn away, side slopes destroyed, and the irrigation and navigation imperfect, notwithstanding that an abundant supply of water has always been available, and the people are most anxious to obtain it both for irrigation and navigation. Mr. Rundall expects there will be an increase in the cultivation of some 11,000 acres, and the Revenue authorities rate this somewhat higher; and, looking to the results already obtained with such imperfect means and with a total absence of all proper facilities of transport for conveying surplus produce to markets where an increased value could be secured for it, there is no reason to doubt this work will in time be highly remunerative and fully realize all that we expect from it.

16. Taking up the Ellore Canal proper from the head of the Uttali Channel, there is one unbroken line of navigation for nearly 40 miles to the Ellore Lock, where the junction with a similar canal from the Kistna is effected. It will be seen from Mr. Rundall's report that I have adhered almost entirely to the arrangements made by my predecessor for the distribution of the water for irrigation and the passing off the drainage waters. The only point on which I consider it is very advisable to insist is that, as the navigation here is so very important, the canal should be kept open by dredging. I am fully aware that this kind of work is most expensive; but it is nevertheless well worth incurring the expenditure to develop as fast as possible the resources of the country by keeping its communications as perfect as possible.

17. The designs sent up for this work explain in detail the general principles on which these have been framed. I may perhaps be permitted to remark here that I am not much in favour of the proposed arrangements; but the works had been too far advanced to make any alterations even should these have been approved of; it is, therefore, unnecessary to discuss this matter. One arrangement only I have disallowed, and that is to have so-called self-acting shutters. These I consider utterly useless in our canals, carrying so much silt, as these do, in the irrigating season, and it is certain those we now have are worse than useless—in theory nothing could be more perfect, in practice nothing less so.

18. It is expected that this canal will irrigate some 48,000 acres of land, and up to date 25,000 acres are under cultivation by its waters. A large increase it is believed having taken place in the last year, the ryots appear fully alive to the benefits of irrigation; and, as the distribution of the water becomes more fairly

regulated, the demand for it constantly increases, and no doubt, when the roads proposed for this tract of country are completed to connect it with the canal and the markets, to which this affords such facilities of access, the demand for the water will go on increasing.

19. The outlay proposed for this canal is doubtless large, nearly 2½ lacs of Rupees; but the returns expected when the whole area is taken up for cultivation are sufficiently remunerative to justify the proposal. The water-rate on 23,000 acres of increase of cultivation, at 4 Rupees per acre, would be 92,000 Rupees a year, which is nearly thirty nine per cent. on the proposed expenditure, and it must not be forgotten that this canal, like many others in this project, is yet in an imperfect condition; in fact, the water distribution has never yet been fairly arranged; no facilities of communications for conveying surplus produce from the fields or villages to the main line of navigation exist; the drainage of the lands is yet very incomplete all over this tract of country; and the population is very sparse. When all these causes for retarding progress have been removed, or even partially mitigated, if even only half, the results we expect are realized. The scheme is a very promising one, but the prospects are brighter I trust.

20. I have not included in the above proposed outlay the cost of restoring the means of communications at its head, or from the Aroolah Head-sluice, with the Venkia, owing to the failure of the old Nundamoor Lock. Separate designs for this project have already been submitted for the consideration and orders of Government; and, whichever plan is adopted, the cost can be added hereafter to the estimates now sent up for the Western Delta. I have nothing further to add to what I have already urged in this matter, beyond referring to the opinion expressed by Mr. Rundall, in paragraph 73 of his report, that soon even the Lower Weyairu below the Peramulla Lock must be abandoned for the very same reasons I have all along maintained, and the line of the Chinakapaverum Canal adopted for the navigation; and no doubt nothing could be worse than using the drainages of a delta for navigable purposes when the supply of water has to be furnished direct from a river whose waters convey silt enough to fill them up and destroy the natural uses for which they exist. The nature of the soil in all deltas is such that these drainages, except when artificially restrained, take any course and are tortuous to the last degree; and, as they become filled with long grass and jungle from the constant presence of water, the navigation is about as bad as bad can be, and tiresome even to the patience and endurance of a native boatman. Sir A. Cotton used the drainages at first only to let the people see the anicut was not a myth, and to afford a supply of water for drinking purposes to villages which knew not what it was to have fresh water in the worst seasons of the year. Some of these lines were subsequently adopted as lines of navigation only because funds were not forthcoming to adopt a more perfect system; but, now that the success of the project is beyond all doubts in spite of all neglect and opposition, no reason whatever exists why these expedients should not be abandoned at once and a better system adopted, such as we have in the Nursapore Canal, bad as its locks are.

21. Returning once more to the distributing head at Chettypet, we have the general system of the Weyairu navigation and irrigation to describe. For these purposes 150,000 cubic yards per hour are passed over the calingulah at this place:

these flow by a natural channel below the Weyairu Aqueduct as far as the Venkia head in a channel described in paragraph 55 of Mr. Rundall's report as fast silting up, a result which might naturally be expected to take place considering it has to receive the drainage waters of some 900 square miles of country besides the waters of the Godavery during the time this river is conveying its maximum quantity of silt, and has had a calingulah placed across it to suit the requirements of the navigation and irrigation in this tract of country.

22. This work is known as the "Duvva Calingulah," and raises the water into the Venkia Canal. The channel at the head is in soil, but very tortuous; below Ravipad, however, it is carried between embankments more direct to the Peramulla Lock, and these no doubt are perilously high; but the arrangement has been in existence for many years. The lock is in good order, all except the gates; there is, therefore, no alternative now which can be resorted to to change the existing arrangements, but to provide a better system of discharge for flood-waters, which has been adopted. At any future time, when the line of the Chinakapaverum Channel is to be taken up for the navigation, this matter should be looked into and arrangements made for lowering the head as much as possible. It is, I consider, a very wrong principle to adopt almost anywhere, and certainly in such a flat country as a delta is composed of, to have great heads of water against earthen embankments, so liable to breach from even natural causes.

23. The chief irrigating canal hereabouts is the Undi High Level, at present affording a supply of water to 36,000 acres, and it is expected an increased area of 24,000 acres of land will ultimately be brought into cultivation. The discrepancies which appear in the statement of the Revenue authorities and the Range Officer for this canal are merely nominal, one authority proposing to irrigate more from the Venkia, and the other from the Undi Canal itself.

24. This is another of the most valuable channels of this delta which has been totally neglected notwithstanding its vast importance and the immense interests at stake under it—the canal it is now proposed to make a through navigation, and to be connected with the Yennamadurru Drain so as to afford an outlet to the Uputair and the markets of the coast. This tract of land has suffered fearfully for want of proper means of communications.

25. In paragraphs 69 to 74 of his report Mr. Rundall describes the other general arrangements which exist, or have been proposed for the irrigation and navigation of this tract of country. No alterations have been made in the original designs, the estimates and levels alone having been revised and corrected. There is only one proposal which I would advocate, and that is to cut a tidal canal from below the Yelloorpad lock towards Mogultur and so improve the navigation by taking it out of the old Uputair. This, however, is a matter for future consideration; at present we have enough to do to perfect the other works.

26. The statement of water distribution explains in detail how the waters are to be disposed of for each main canal and its several branches. With regard to these latter it will be observed that matters are not in a very satisfactory state. Mr. Rundall, who has been for many years in charge of this range, alludes to this in

paragraphs 107 and 108 of his report, and the only wonder is that so much of the prospects originally held out for this project has been realized at all, considering the manner in which the scheme has been dealt with for so many years. This could not possibly have been the case if the project had been put forward on any wrong principles, incorrect data, or crude notions. Fortunately the officer entrusted with designing this truly noble work had some better knowledge and firmer faith than to imagine a scheme of this scope could be matured by a rigid adherence to the imperial formulae of Hydraulics or to any other of the petty details on which so much stress is laid by some. Had he occupied the time of his officers on such trifling matters the anicut alone might by this time have been built without a single channel leading from it, as has been the case in other parts of India.

27. The tables of calculations which accompany the sections of all the canals exhibit at once the velocity which is to prevail in them. The velocity in the Main Canal for four miles is high for easy navigation; but I know not how it can be avoided in so large a canal having to deal with such a volume of water, and which it will most probably be necessary to augment as the population of the delta increases and its resources are more and more developed by facilities of transport being established and connected with the coast and the interior. In the Karkara-purru Canal again the velocity is very high, and I believe myself we originally laid out this channel with too great a slope. There is, however, no help for it now; but, with these exceptions, I think all the other canals have been designed to suit the requirements of the delta for both navigation and irrigation in as good a manner as can be devised. The former has been made as easy as possible without unduly sacrificing the demands of the latter.

28. The locks for the several lines of navigation are to be similar to those sent up for the Eastern Delta. I regret to say by some misunderstanding, which I cannot at all account for, the double culverts in the plans for the second class locks have been omitted in the plans, but I have provided funds for their construction in the estimates. The third class lock is a new design, which can be modified if not approved of. I consider the width allowed by us too much, and 7 feet would probably meet all the requirements of the minor navigable channels.

29. The new Nundamoor Lock has been estimated for as a first class lock as ordered, but I consider the design most unnecessarily expensive on such a line of communications. No reason whatever that I am aware of has ever been assigned for considering this a first class line of navigation beyond the circumstance of an officer once entering it as such; and, with the Peramulla Lock in good order and constructed of the old dimensions, namely, 15' x 100', it is going, I respectfully submit, to great and avoidable expense to build locks above it 20' x 150'. Nothing that I am aware of can justify the outlay. The traffic in that direction is large; but no passenger boats ply there, only dhonies. There are no large markets to which crowds desire to resort, and, even if the canal should ever be extended to Masulipatnam, that place is by no means of such importance now as to require a first class canal being made for it, and year by year its value will probably decrease as the anchorage gets worse and worse.

30. All the calingulahs, as far as it was possible, have been arranged on one uniform design and fitted with screw shutters to facilitate the discharge of water

over them. This arrangement is the best we have yet tried, one man can in a few minutes raise or close these shutters with no noise, and the level of the waters are thus regulated in the most perfect manner. When our irrigating sluices are as conveniently fitted with proper shutters, and those abominations—the old palmyra tree sluices—are done away with, the regulating of the water will be brought to as great a perfection as it is capable of, and then, but not till then, will these daily quarrels and disputes between villages cease, and then only shall we be able to determine the duty a cubic yard of water should do.

31. Having described the principal irrigating and navigable canals, I proceed to the main drainages. These are described in detail in paragraphs 87 to 99 of Mr. Rundall's report, and are as follow:—

1st.—Nakala	Drain.
2nd.—Gontair	do.
3rd.—Gostanaddi	do.
4th.—Yennamadurru	do.
5th.—Bodapad	do.

32. The Nakala is a large natural drainage channel of great capacity, having an inclination of about a foot a mile in its bed. It was originally intended to make this a line of navigation, and a lock had actually been built at its head; but the design was most fortunately abandoned in favour of the Nursapore Canal. This drain is quite large enough to discharge all drainage waters coming into it without any enlargement. The only thing required for it is to prevent the flood-waters of the Godavery running up its bed and destroying the villages and cultivation on its banks on either side. It is proposed to effect this by a sluice aqueduct, as shown in the plans herewith sent. In constructing this work I consider it would be advisable to have a pathway alongside of the aqueduct for foot passengers only. Some little additional expense may have to be incurred on this account, but the work would be made far more useful. The embankments on either side below this require to be maintained constantly at the proper height, for the flood-waters of the river affect this valley very seriously. Mr. Rundall explains why he had to remove the sluice up above the site originally proposed to suit the navigation from the Bank Canal. The river embankments have to be maintained to protect the land below the sluice. By this work also a tract of land, to which the Chinchinada Canal was unable to convey water, can now be most conveniently irrigated from the Bank Canal.

33. The Gontair Drain requires no particular description having been already partially improved, and its further improvements are provided for in the Gostanaddi drainage estimates.

34. The Gostanaddi Drain has to be used at its head for navigable purposes; but the arrangements proposed make a much larger portion of the lower end available for drainage purposes, whilst the Velpur Channel will relieve it of all irrigating duties. This drain is affected by the Yennamadurru, and this again is affected by the floods of the Weyairu and Ralli Madugu. To relieve it in its lower parts a cut is proposed *via* the Buswarow kodu into the Gontair Drain, and provision for the work is made in the estimates as originally designed; but all this system of drainage will be more or less affected by the construction of the reservoir at Unnamoolunkah, the surveys for which are well advanced. In ordinary years I consider the provision

now made will suffice for all purposes and mitigate the inconvenience now so loudly complained of. Should the reservoir be built even in hurricane years, I believe the drainage waters of the Weyairu will be so controlled by it as not to affect the delta very much, for these hurricanes usually occur after periods of long drought, when the reservoir would be either empty or very low, and it would then take a vast body of water to fill it, all which, however, in the event of such a thing occurring, now finds its way over this delta.

35. Such works as are required for the Yennamadurru Drain have been entered in the estimates, and no particular description of this is now required.

36. The next is the Bodapad Drain, which has to carry the drainage waters of the tract of country north of the Venkiah and below the Ellore Canal. The works for this are complete, and were executed under the general sanction accorded by Government; and, as no alterations or additions are proposed, it is not necessary to enter more fully into the details.

37. The minor drainages required for this delta are enumerated in paragraph 101 of Mr. Rundall's report, and the several designs and estimates for the works required in them are sent up with this project.

38. The data on which provision has been made for these drainages are the same as those used in the Eastern Delta project, namely, one inch of rainfall to be run off each square mile of drainage area in twenty-four hours; and, as stated in the report accompanying that scheme, I consider the provision unnecessarily large and expensive, and it would be far better to begin on a much smaller scale. At present no good data can by any possibility be obtained on which reliable estimates for drainage works can be framed. The water supplied for irrigation purposes is far in excess of actual requirements, and runs to waste in torrents. No proper outfall has been made anywhere to get rid of surplus waters or rainfall, and the natural drainages have been allowed to get choked up; there is, therefore, absolutely nothing whatever to guide us, and, to take the results of what has been proposed for a part of Northern India as our guide under very different circumstances, is worse than for the blind to lead the blind if possible.

39. In paragraph 113 of his report Mr. Rundall has attempted to give an idea of the cost of irrigation, including drainages and that for navigation. The division appears to me very arbitrary, but it may be of more use than I can find in it. I cannot but still maintain with Mr. J. S. Mill that these distinctions are without meaning. His words, however, will probably put the matter in a clearer light, and I beg to add them:—"When two conditions are equally necessary for producing the effect at all, it is unmeaning to say that so much of it is produced by one and so much by the other: it is like attempting to decide which half of a pair of scissors has most to do in the act of cutting, or which of the factors 5 and 6 contributes most to the production of 30." It is easy enough, then, to see how impossible it is, when several conditions are required to produce an effect, at all to attribute so much to one and so much to another; but it is perfectly certain what results will follow if all the necessary conditions are not fulfilled; there is no chance or hope of attaining the object sought for at all.

40. If the anicut and its subsidiary works with the river embankments had not been completed, neither irrigation nor navigation was possible. If the irrigation had

been promoted without the navigation, the result would have been a state of affairs such as that now existing in the Central Provinces in Bhundara and Raipore. In these two districts alone there are upwards of 15 lacs of acres of irrigated rice lands, and 6 Annas an acre is considered too high a rate of assessment. In them, of course, there is not the vestige of a road or any other means of communications in either of them, and yet officers in authority in India actually hold that the consideration of the subject of communications in connexion with irrigation is "positively mischievous," and recommend Engineers employed in the Irrigation Department to leave it out altogether unless it can be done cheaply, and one officer actually prints a book in which he lays down this most extraordinary dictum, "Roads and railways will be required as trade and traffic are developed." It would be difficult to place the argument in a more contradictory manner as regards the real circumstances of the case.

41. Any standard work on "Political Economy" will give us at once the conditions absolutely necessary to fulfil to develop the resources of an agricultural country. Turning again to Mr. Mills' work on this science, he says, "Analogous in effect to this second class of agricultural improvements, are improved means of communications. Good roads are equivalent to good tools. It is of no consequence whether the economy of labour takes place in extracting the produce from the soil or in conveying it to the place where it is to be consumed, not to say in addition that the labour of cultivation itself is diminished by whatever lessens the cost of bringing manure from a distance or facilitates the many operations of transport from place to place which occur within the bounds of a farm. Railways, and canals are virtually a diminution of the cost of production of all things sent to market by them, and literally so of all those the appliances and aids for producing which they serve to transmit. By their means land can be cultivated which would not otherwise have remunerated the cultivators without a rise of price; improvements in navigation have, with respect to food or materials brought from beyond the sea, a corresponding effect."

42. Again he says, "To obtain auxiliary supplies of corn from the interior in any abundance would, in the existing state of communications, be hopeless. By improved roads, and eventually by canals and railways, the obstacle will be so reduced as not to be insuperable; but this is a slow progress, in all food exporting countries except America, a very slow progress," and how slow it has been in this one it is needless to describe when the very first principles on which the subject is based are either denied altogether or totally ignored. Mr. Mill, of course, in referring to corn, alluded to the staple food of the country for which he was writing. The principles, however, which he lays down are applicable to all countries alike, but he is not our only authority in this matter. "In estimating," says Ricardo, "the exchangeable value of stockings, for example, we shall find that their value, comparatively with other things, depends on the total quantity of labour necessary to manufacture them and bring them to market." And if this be true of stockings or any other manufactured articles, as it no doubt is, how much more applicable is it to the manufacture of the staple food of a country that its production should be cheapened as much as possible and the means of disposing of it over as large an area as possible fully developed if the price to be obtained for it is not to

be maintained as a monopoly. In his work "The Progress of the Nation," Mr. Porter says, "There is not any circumstance connected with the whole condition of England which more strongly excites the admiration and the envy of foreigners than the degree of perfection to which we have brought our means of internal communications. The skill and labour that have been applied to this object are among the chief existing causes of that high degree of activity which characterizes and pervades the productive classes in every part of the country. The perfection to which we have carried the means of transporting persons and property from one part of the country to another has indeed become one of our national characteristics. Placed, by its insular condition, in circumstances which render efforts of that kind less indispensable than would have been necessary if our country had formed part of the interior of a continent, we have done more than any other nation of Europe for facilitating communications from and to every nook and corner of the land. If we examine the map of England, we shall find that, as regards one mode of public communication, there is not any spot south of the country of Durham at a greater distance than fifteen miles from water conveyance. In the largest part of the area thus described that distance is not greater at any spot than ten miles, while in that portion which is the principal seat of our manufactures canals have been constructed or rivers rendered navigable, so as to provide means for cheap and easy communication from the very heart of each town to every other part of the kingdom and to our chief commercial ports. By this means the raw materials of manufactures are delivered, unencumbered with heavy charges, at the doors of our factories, and finished goods are carried away from them with the utmost facility and economy for distribution to the different markets of the civilized world.

"The advantages to a commercial people of roads upon which they can pass at all times with comfort and celerity between distant markets can hardly be appreciated too highly. By this means the peculiar wants and capabilities of every part of the community come to be understood, and are supplied on the one hand, or made available on the other, to a degree which could never be attained by correspondence with local agents, whose information would, in general, be limited to the circumstances of the spots"—in India, the villages—upon which they reside.

"In the whole range of the science of public economy there is perhaps no principle more easily or more clearly demonstrable than the advantage of possessing, at the cheapest possible rates, the raw materials of manufacture, and it may with equal facility be shown that, of all those materials, there is not one—unless, indeed, food may be so considered—which is of more universal importance than iron."

The subject of the production and distribution of food at the cheapest possible rates is what we are, however, dealing with at present, and the above remarks may tend to explain of what paramount necessity it is that our means of communications should be as perfect and as extended as it is possible to make them.

43. In "The Wealth of Nations," Adam Smith lays down the same principles. "Good roads, canals, and navigable rivers," he says, "by diminishing the expense of carriage, put the remote parts of the country more nearly upon a level

“with those in the neighbourhood of a town. They are upon that account the greatest of all improvements. They encourage the cultivation of the remote, which must always be the most extensive circle of the country.” Again he says, “In an extensive corn country, between all the different parts of which there is a free commerce and communications, the scarcity occasioned by the most unfavourable seasons can never be so great as to produce a famine.” Further on he adds, “In China besides, in Hindoostan, and in several other Governments of Asia, the revenue of the Sovereign arises almost altogether from a land tax or land rent, which rises or falls with the rise and fall of the annual produce of the land. The great interest of the Sovereign, therefore—his revenue—is in such countries necessarily and immediately connected with the cultivation of the land, with the greatness of its produce, and with the value of the produce. But, in order to render that produce both as great and as valuable as possible, it is necessary to procure to it as extensive a market as possible, and consequently to establish the freest, the easiest, and the least expensive communication between all the different parts of the country, which can be done only by means of the best roads and the best navigable canals.” Adam Smith nearly a century ago, without ever having been in India, laid down the general principles on which the prosperity of the country rested, and his views have been acquiesced in by the most eminent economists of the day as regards developing the resources of agricultural districts; but even Adam Smith had been anticipated as regards the subject of communications in connexion with land improvements. Old Burton, in the preface to his quaint work “The Anatomy of Melancholy,” has the same thought, though oddly enough expressed, more than a century before.

44. In his notes and dissertations appended to “The Wealth of Nations,” Mr. McCulloch significantly adds, “Differences of proximity to markets are a source of rent precisely analogous to differences of fertility. When corn, cattle, etc., raised on different lands sell in the same market and consequently at the same price, the land which is nearest to the market and pays least for carriage has the same sort of advantage over the others that it would have were it more fertile. The price of the articles sold must be sufficient to indemnify all who bring any part of them to market; but if it indemnify those who bring them from the greatest distance, it will more than indemnify those who bring them from the least distance; and competition will compel the latter to pay the owners an additional rent equal to what they save in the reduced cost of carriage. The increased demand of towns occasioned by the increase of population not only tempts the cultivators in their vicinity to improve their lands more highly, but frequently makes large portions of their supplies be brought from a great distance. Hence it sometimes happens that the advantage of vicinity more than counterbalances the disadvantage of comparative barrenness, and that lands of inferior fertility in the immediate environs of a large town yield a considerable rent, while much richer land at a distance from good markets yields little or perhaps no rent. As vicinity to a town is a cause of rent, so vicinity to a road, navigable river, or canal, by diminishing the expense of carriage to some great market, may have a similar effect. It must be kept in mind that it is not the

“absolute fertility or position of any given lands, but their superiority in these respects, as compared with other lands supplying the same market, that enables their cultivators to pay a superior rent. It is obvious, too, that the larger the surface from which any particular market draws its supplies the higher in proportion to their fertility will be the rents of the lands in its immediate neighbourhood. The two sources of rent above described—fertility and proximity to markets—are totally distinct from those peculiarities of soil or situation which afford a rent on the principle of monopoly.”

45. I have ventured to quote thus largely from works treating of this matter, as it appears to me very necessary to guard against a prevalent opinion that the mere affording the means of increasing the produce of the land will suffice of itself to realize the results we expect to obtain by the construction of so-called remunerative works from loans, however carefully planned these may be, and however minute the examination of the details. I crave to submit the maturing of a project of this kind does not consist entirely in the correctness of the fractional or decimal parts of levels, in the greater or less slope of earthworks, or in the batter to be given to masonry works on which so much stress is laid and such pretentious importance made to attach. It is quite evident from what has been above stated that, unless the essential conditions by which alone land can be made of an enhanced value are fulfilled, we shall be only saddling the country with an enormous debt at a heavy rate of interest, with little or no prospects of obtaining any adequate results. If the wealth of nations consisted in merely raising agricultural produce and consuming it, then we might say happily enough, Let us eat and drink, for to-morrow we die; but, as this is not the case and never can be, it is imperatively necessary to look into all the circumstances and work them up together to secure the results we desire, so far as the experience and knowledge of others teach us and existing means will enable us to do.

46. Before quitting this part of the subject I would again beg to bring to notice how utterly isolated this district, with this great work in it, is in regard to the markets of the interior, and of what paramount importance it is to secure, as early as possible, the means of communications with these by the river, by roads, and by a railway to Hyderabad to connect with the Bombay line. It is proposed to incur a very large expenditure to complete the works of the delta, and a very heavy responsibility attaches to all concerned in recommending this in anticipation of great results being obtained hereafter. It may, therefore, be permitted to me to say at the outset that I only hold to these expectations provided all the conditions required for the development of the scheme are fulfilled in their integrity, otherwise failure will be the result to a certainty, as it has already been in Orissa and in the Ganges Canal.

47. As regards the revenue, past and present, of the several talooks forming this delta, I am sorry to say that I am unable to give any more detailed information than I was able to supply for the Eastern Delta. The fact is that, at the time the anicut was projected and for many subsequent years, no proper survey of the delta existed. This is shown in the reports of Sir A. Cotton, Colonel Orr, and Mr. Prendergast, the then Collector of the district; moreover, as this department has nothing whatever to do with the collection of the water-rate, it can only compile general statements from such information as is supplied to it from time to time by the Revenue Department, and it would save an enormous deal of both time

and labour if the requisitions made so frequently on this account now were addressed to the department actually responsible for the details.

48. Omitting the Ellore Canal for the present, the estimates now submitted amount to Rupees 9,90,300 for completing the works in the Western Delta, and it is expected we shall then obtain an increase in revenue from 60,000 acres of land to be converted into wet cultivation. The water-rate from this, at Rupees 4 per acre, would be Rupees 2,40,000. This is nearly twenty-five per cent. on the proposed outlay; and, if we were to take the figures of the Revenue authorities, the returns would be higher. This increase is in addition to all the Government have already received from the works as they exist, and which amounts to some 90 lacs of Rupees during the past twenty years. From the latest returns I have it appears the water-rate for these talooks for Fusly 1,279 was Rupees 8,11,891, and, from the circumstance of the people being so anxious to be supplied with water both for navigation and irrigation, I judge there is every reason to believe the revenue will be enhanced in due time as the works are completed and the water-supply maintained with greater regularity and more security.

49. The expenditure in previous years up to date for this delta, including the Ellore Canal, was Rupees 20,76,598, and to this has to be added a proportionate share of the cost of the anicut, etc., Rupees 13,54,000, making the total in round numbers Rupees 34,30,000, and the average annual outlay Rupees 1,72,000 nearly. The proportionate amount paid into the Treasury for this delta from the Remunerative Works Statement of last year is 90 lacs of Rupees, or at the rate $4\frac{1}{2}$ lacs a year for twenty years; hence it will be seen how very remunerative the works have been, and what prospects we have for the future by the experience of the past years.

50. I would here take the opportunity of stating that some arrangement should be made with the Revenue authorities to give us correct information regarding the extent of actual wet cultivation under the anicut works. In last year's Administration Report the Board of Revenue put this down at 221,000 acres for the entire Godavery District. This is manifestly wrong; it may be the extent of land which pays water-rate, but it cannot be the extent of land which actually receives water from the anicut, and it is a matter of indifference to us what the revenue is almost in comparison to knowing the exact area irrigated and for which water must be provided. We have nothing to do with the settlements as made, and by which a vast extent of land now irrigated is allowed to escape paying the water-rate on one excuse or another; but we have to provide the water-supply for this nevertheless, and it is essential we should know the exact area as well as possible in order to provide for all requirements. If the Board were to furnish a statement showing the entire extent of wet lands under the anicut and then were to show the area paying water-rate and that escaping it, we should know exactly the real circumstances of the case, for the anicut was constructed to supply water to the delta lands, and the extent to which this has been actually carried out should be recorded year by year. It is nothing to the purpose to omit this because no revenue is obtained from it. It gets the water securely every year, and the remission on its account could never have been afforded without the anicut works, and, therefore, these tell as much in favour of that work as the actual collections. Without the security these works afford in the way of protection from floods, a constant supply of water when most required, and facilities of access to markets at the cheapest

rates for all surplus produce the lands now escaping all water-rate could not have been cultivated to the extent they now are, and so the works should have full credit for them also.

51. The accompanying statement exhibits the traffic on the several canals of this delta since 1866, and the totals for each year show how this has been increasing year by year notwithstanding the imperfect state of the means of communications. As fully eighty per cent. can be saved by water carriage over the ordinary land carriage of this country, it will be seen what great advantages this delta is already enjoying by having been furnished with some navigable canals. In the last year upwards of 244,760 tons were moved on them. There is a falling off in the totals for 1869 as compared with the previous year, which I cannot at present account for, probably it is partly due to the closing of the Nundamoor Lock for so long a period; but in sending up the Central Delta project, now all but ready, I will prepare and send in a statement showing the traffic through the three head locks of the delta, when, if it should appear there has been an increase in any of these over the Western Delta, it will be quite apparent the traffic has been diverted from one to the other.

52. The estimates now submitted amount to Rupees 9,90,300, and may be divided under the following main heads, namely:—

	RS.
Masonry works	4,66,885
Earthwork for canals	2,39,560
Drainages	1,36,290
Minor works	92,505
Compensation for land	26,060
Overseers' sheds	29,000
Total	9,90,300

I have again omitted the cost of the Ellore Canal works in this, as we do not yet know the totals for this till the new locks for Weyairu and Venkia navigation have been determined upon. This item I beg you will be good enough to include in your office with the increased area to be irrigated, namely, 2,300 acres.

53. The Minor Works cost amounts to Rupees 92,505, which is at the rate of Rupees $1\frac{1}{2}$ per acre for 60,000 acres of land, the same as for the Eastern Delta nearly, and this is not excessive for a water-rate of Rupees 4 per acre per annum with a probable increase hereafter to Rupees 6 per acre.

54. Having already, in the report on the Eastern Delta, shown the causes which have retarded the progress of cultivation by these works, and having in this report endeavoured to detail the conditions which it is absolutely necessary to satisfy before the land can be made remunerative, it is unnecessary for me to enter further into this subject beyond noticing the very sparse population of the Bhimavaram Taluq, which will, I fear, make progress there very slow indeed at first.

55. In conclusion, I would beg to bring before Government the great assistance I have on all occasions received from Mr. Randall in the preparation of this project at the same time that he was discharging the onerous duties of a large and most important range. These he has always attended to with the utmost zeal and assiduity, and the great increase in the cultivation in the past year by the channels under his charge will more satisfactorily establish this. Now that his long connexion with this district is about to be severed, I would take this opportunity of particularly noting this in the hope that his services here may not be forgotten, and that he may soon obtain the promotion he so well deserves and has worked so well for.

From J. W. RUNDALL, Esq., Executive Engineer, No. 3 or Western Delta Range, Godavery District, to the Acting Superintending Engineer, 1st Division, dated Nursapore, 31st May 1870, No. 189.

I HAVE the honour to forward, herewith, the remaining plans and estimates for the Western Delta Completion Project, and beg to offer the following remarks in doing so.

2. The plans and estimates now sent have been prepared in accordance with the written and verbal instructions received from you from time to time, and I trust that everything has now been shown in sufficient detail and that the maps which accompany the plans will enable the revising authorities to understand each proposal.

3. The general scheme of the delta arrangements has been clearly shown by Captain Ryves in his memorandum, and it is only necessary to point out where any deviations have been made from his proposals and the reasons for them.

4. *Main Canal.*—The main canal discharge for full supply has been assumed at 526,000 cubic yards per hour (3,945 cubic feet per second,) with depth of 8 feet on the head-sluice floor and surface fall of 4 inches per mile. From these data the sections have been calculated. This discharge is 26,000 cubic yards per hour less than Captain Ryves calculated for—first, because the prospective area has been assumed to be 295,100 acres instead of 300,000, and because it would hardly be necessary to send two cubic yards per acre per hour down each main canal at the same time, and by the regulating works, as now designed, it will be possible occasionally to flush each canal in succession if necessary. It is difficult, in the present state of the works, to say what the duty of a cubic yard of water is, there being much waste owing to the water being thrown into old channels and to the want of regulating works and minor sluices. Captain Ryves has demonstrated our being able to draw 560,000 yards from the river when wanted; there is, therefore, no doubt as to our getting 526,000.

5. I would in any case deprecate the main canal being widened more than allowed for, because from December, when almost all water passing into the head is run to surplus, it is necessary to lower the water so much as to reduce the depth on the head lock sill to 4 feet; the more capacious the channel, the greater quantity to be run to surplus to maintain a proper depth for navigation. The maximum discharge and velocity would be required only for thirty to forty days in the year according to season.

6. The following table shows the number of days the water has stood on the head-sluice floor at heights from 6 feet to 9 feet from 1st June to 31st December during the last six years. The reason we have not required to have so much water passing into the head in the last two years is that in 1867 the Chettypet Calingulah was raised and fitted with screw shutters; before this was done the water used to run to waste over that work whenever a full supply was let into the canal:—

Statement showing the number of days on which water stood at various heights on head-sluice floor from 1st June to 31st December in each year.

Years.	9 feet.	From 8 feet 6 inches to 8 feet.	From 8 feet 5 inches to 8 feet 6 inches.	From 7 feet 6 inches to 7 feet 11 inches.	From 7 feet 5 inches to 7 feet 6 inches.	From 6 feet 6 inches to 6 feet 11 inches.	From 6 feet 5 inches to 6 feet 6 inches.	Below 6 feet.
1864...	37	13	17	18	23	38	20	48
1865...	35	22	44	15	28	17	5	48
1866...	5	17	69	18	20	10	25	50
1867...	...	2	10	36	37	31	40	58
1868...	...	...	...	22	68	27	45	52
1869...	...	...	...	33	55	38	33	55

7. The main canal discharge being taken, as above stated, at 526,000 cubic yards per hour (3,945 cubic feet per second), the whole of this volume is carried in one channel as far as the first mile, where the Muddoor branch takes off 43,000 cubic yards (322½ cubic feet per second), returning it again to the main stream lower down. The sections of this channel are shown in the

drawings of main canal. 483,000 cubic yards (3,622½ cubic feet per second) are carried in one channel as far as 2½ miles from the head, where the channel separates into two; the old or natural channel being larger and deeper carries 325,000 cubic yards (282,000 + 43,000 already taken by Muddoor branch); the new Apparao or chord line takes 201,000 cubic yards (1,575 cubic feet per second.) The former or old channel is sufficiently capacious to carry the 309,000 yards allotted to it; but the new Apparao requires deepening and improving to enable it to carry the 210,000 assigned to it. Its present and proposed sections are shown in the drawings, and all necessary work has been estimated for.

8. The old Apparao (joined near Nedadavole by the Muddoor branch) and the chord line or new Apparao re-unite at the fourth mile, and the whole body of water flows in one stream through an old channel to the sixth mile. The dimensions of this channel are much larger than would be required to enable it to carry the 510,000 cubic yards necessary; these two miles (fourth to sixth) require, therefore, only to be banked in order to improve the tow-path. The work necessary for this has been included in the estimate.

9. As a survey of the main canal and the old channels which carry the water accompanies the estimates, I trust the arrangements will, with the above explanation, be quite clear.

10. At the sixth mile the Ellore Canal and Nursapore Canal separate, and the water required for the Venkia and Weyairu is dropped over the Chettypet Calingulah or weir.

11. *Chettypet Calingulah or Weir.*—This work has recently been improved and altered, and nothing further is required to it. The calingulah is 100 feet long* clear, with crest at + 30

* 5 bays, 20 feet each.

feet, and, with the water at + 34 feet and the shutters fully open, would discharge about 360,000 cubic yards per hour (2,700 cubic feet per second). For ordinary working the shutters would be raised about 1 foot 4 inches to pass the 150,000 required for irrigation below.

12. 220,000 cubic yards (1,650 cubic feet per second) pass down the Nursapur (or Karkarapurru Canal, as the first reach is called) Canal, and 156,000 cubic yards (1,170 cubic feet per second) pass on to the Uttali and Ellore Canal.

13. *Karkarapurru Canal.*—The discharge allowed is, for the first 1½ miles, 220,000 cubic yards (Captain Ryves allowed 230,000), and, after dropping 45,000 cubic yards into the Gostanaddi carried on 185,000 with a channel 9 feet deep. It would be very difficult to excavate the channel to this depth, and it would be necessary to close it for two or three years in succession for such long periods that any course which would diminish the volume to be sent down this channel would be an advantage. By throwing an extra quantity into the Gostanaddi, 15,000 yards less will have to be carried down the Karkarapurru Channel. The Gostanaddi and Velpur Channel will be noticed to be carried down the Karkarapurru Channel. The plans and estimates as now made out allow for presently; but, instead of 45,000 cubic yards, the plans and estimates as now made out allow for 60,000 cubic yards to be passed into Gostanaddi at 7½ miles from the head, 160,000 cubic yards (1,200 cubic feet per second) passing in for the supply of the Bank and Nursapore Canals. The depth proposed for the Karkarapurru Channel is 8 feet beyond Gostanaddi off-take. This involves some deepening, and widening, and removal of banks. The whole of this is shown in detail in the sections sent up to you, and the velocities and discharges for each quarter mile are exhibited in the tabular statement. At 14½ miles from Vijaiswarum the Bank Canal takes 45,000 cubic yards (337½ cubic feet per second), of which 5,000 go to the Mukamala Channel and 40,000 to the Bank Canal. The *Mukamala Canal* is about 2½ miles long from the head to the Mukamala Lock, which is a pukka lock 15 feet × 100, upper sill + 13 feet, lower sill + 13 feet, which drops into the Nakala, an old natural stream to be noticed hereafter. The calingulah attached to this channel is only 15 feet long with crest + 28 feet, and is at present of very little use as a surplusing work. For ten months out of the twelve the Mukamala Canal is a pond, from which only two minor branches are led, irrigating 2,500 acres. Hence from July to October it is a mere silt trap. Captain Ryves proposed to place an extra 30-foot surplus in this channel; but being, as it is, a channel through which no large volume of water is passed at the very time the water contains the greatest quantity of silt, any surplus placed at the end of these two miles of channel would work at a great disadvantage, and an annual expenditure would be necessary to keep the channel of sufficient section to discharge the volume proposed to be sent over the two calingulahs, viz, 100,000 cubic

yards (750 cubic feet per second). In accordance with your instructions I have, therefore, estimated for placing a new surplus work to discharge 40,000 cubic yards at the second mile of the Bank Canal, that is, 16½ miles from head; also by lowering the crest of the present Mukamala Calingulah 1 foot we shall be able by these two works to surplus into the Nakala Drain 66,000 cubic yards out of the 160,000 full supply of the Karkarapurru Channel when it is necessary to reduce water rapidly. These two surpluses would also be required in December and January, when channels have to be maintained at full depth for navigation, but when water is not being drawn off for irrigation. At present the surplus power above the head of the Nursapore Canal is quite insufficient.

14. *Bank Canal*.—Returning to the Bank Canal, the discharges are shown in the tabulated statements, and the proposed sections are shown in the Book of Sections. The earthwork and sections have been re-calculated, though no alterations of Captain Ryves' proposals have been made in the first nineteen miles. This is intended to be a second class navigation line.

15. The first lock on this channel is at Khandavelly, five miles from its head and 19½ miles from Vijaiswarum. At present there is a catcha lock at this point. It is, however, in bad order; the upper sill is too high, being + 25 feet; the lock would in any case have to be re-built. The previous estimates allowed for a new catcha lock; but, as ordered by Major Mullins, the lock has been designed with masonry chamber walls, and according to your instructions the dimensions are 110 feet × 18 feet, the upper sill being + 23 and the lower sill + 21.

16. The Khandavelly Calingulah or weir is 30 feet long, crest + 25.50, and is capable of passing down the quantity of water necessary, namely, 38,000 cubic yards per hour (285 cubic feet per second).

17. In the next five miles some improvements and re-sectioning are required, which are duly shown in the sections and tabulated statements. The Siddhantam Lock at the 10th mile is a substantially built catch a lock, 15 feet × 100 feet, and the sills are both on the correct level upper + 20 feet, lower + 14 feet; but, as masonry chamber walls have been ordered to be allowed for, a new lock has been designed with dimensions ordered by you, namely, 18 feet × 110 feet, and is included in the estimates. The existing Siddhantam Calingulah requires slight alterations which have been estimated for.

18. In the present Bank Canal there are no locks below Siddhantam; there is, however, a rough-stone cross bank at Kodair, 16 miles from head (30½ miles from Vijaiswarum). Here it is proposed to put a new lock and calingulah, and a new parallel channel from above this lock will be required.

19. The areas and discharges for the various branches of the Bank Canal are shown in the Distribution Statement. I have in this channel allowed a less volume per acre than in any other of the channels, the reason being that about one-third of the whole irrigated area consists of land cultivated with chillies, which do not take water till October and November, and for which, therefore, no water is required at the time that the paddy crop requires its maximum supply.

20. Below Kodair the irrigated area is small, and it is necessary to pass an extra quantity of water for navigation.

21. According to the instructions given by Major Mullins, provision has been made for connecting this line with the Godavery, which is navigable at all times from its mouth to Kodair, just mentioned. A lock into the Godavery at this point, where it is subject to a rise of 14 feet to 15 feet in the freshes, is not advisable, and a lock directly into the river even lower down is likely to be expensive, as protection might be necessary to check any encroachment from the river. The tidal lock has, therefore, been placed just below Dodeputtah village, advantage has been taken of a creek from the Nakala to form the tail channel. This involves an alteration of the site of the sluice aqueduct, which I now propose to place 2½ above the embouchure of the Nakala into the Godavery. The Kodamanchilly Channel, which already runs down close to the point where the sluice aqueduct will be constructed, will be improved and made capable of taking the 2,000 yards required to be conveyed into the Chinchinada Channel.

22. The tidal lock is an expensive one, the sills being, upper + 5 feet, intermediate — 1 foot, lower — 6 feet. The estimates provide for deepening out the creek from site of lock up to its junction with the Nakala, which from this point has its bed — 5 feet to 6 feet.

23. With regard to the sluice aqueduct, which, as explained by Captain Ryves, is intended to prevent the freshes from backing up the Nakala and damaging the crops on both sides of this drain, Major Mullins' pencil instructions on the original drawing have been attended to; a cast-iron standard has been designed instead of the minor cut-stone piers. I have allowed for seven instead of eight vents, the Vallur and Illapacurru drainage joining the Nakala below the sluice. The sluice as now designed will discharge about 480,000 cubic yards per hour (3,675 cubic feet per second). A surplus weir 15 feet long is proposed to be constructed at the site of the tidal lock. The irrigation under Bank Canal is at present about 17,000 acres, which ultimately will, it is supposed, be increased to 22,000.

24. Returning now to 14½ miles from Vijaiswarum, or 8½ miles of the Karkarapurru Canal, this latter channel takes 115,000 cubic yards per hour (862½ cubic feet per second), of which 9,000 cubic yards are given to minor branches, 4,000 cubic yards to the Bhupiah Channel, and 102,000 cubic yards pass to the Nursapore Canal over the Peravelly Calingulah at the 16½ miles from Vijaiswarum.

25. *Nursapore Canal*.—This canal is intended to be a first class line of navigation. The canal itself was originally dug of large sections, and is capable of carrying the supply proposed to be sent into it. It has, however, silted in a few places.

26. The locks on this canal were originally called temporary ones, and, being designed with the minimum of material, are now all in bad order. The estimates provide for re-placing these locks by substantial first class locks, 150 feet × 20 feet. The levels of sills and working levels of water are shown in the statement accompanying the estimates. The tidal lock at Nursapore is of more recent construction than the locks on the main line, is a well-built work, and of the standard dimensions of a first class lock, viz., 150 feet × 20 feet.

27. The two head weirs—Peravelly and Itempudi—it is necessary to re-build (to make them capable of discharging the full quantity of water required), and some minor improvements are wanted to the third (Martair) and fourth (Kavvitam) weirs, for which the estimates provide. It is proposed to re-build the fifth weir (Palkoli) on a design similar to that of the first and second weirs, the necessity for re-building the Palkoli weir being that the present work is only 12 feet long, and, though it can supply the lower reach with the quantity of water required for irrigation below it, yet it will not discharge sufficient water when, owing to the upper sluices being closed, it is necessary to surplus off a portion of the water entering the head of the canal. The estimates, therefore, include a new calingulah at Palkoli of two 9-foot bays.

28. At Nursapore, as explained above, the canal is connected with the Godavery by a tidal lock; from Nursapore town the canal turns to the westward, and has been partially excavated up to the large village of Mogultur. It was always intended to connect the canal at this point with the important tidal river (the Uputair), through which there is already a good deal of trade, small native craft working out through it both up and down the coast.

29. The estimates provide for improving the existing channel between Nursapore and Mogultair and extending it up to the Uputair; they also provide for a tidal lock with sills 3 feet × 9 feet H. W. to give a minimum depth of 4 feet at low tide. A surplus work 15 feet long is also allowed, there being no surplus weir at present in the last reach of the Nursapore Canal, the lock culverts at Nursapore being used to surplus through when it is necessary.

30. The irrigation under the Nursapore Canal is at present 40,000 acres, which, by improvements and extension of branches and by land being drained which is now swamped, will, it is estimated, be ultimately 54,000 acres, and for this the water-supply has been provided. The area and discharge for each branch is shown in the Distribution Statement.

31. Some of the sluices on this canal require to be re-built; for these, for the new branches required, and for the extension and improvement of existing branches, provision has been made in the estimate.

32. *Gostanaddi and Felpur*.—Returning now to the Gostanaddi head, I proceed to notice the arrangements proposed for this channel. I have already explained that it is proposed

to send 60,000 cubic yards instead of 45,000, as originally proposed, down the Gostanaddi, and to irrigate from it the land, or rather the greater part of the land, at present supplied by the Bhupiah, and drawing its supply from the existing calingulah at Peravelly.

33. To do this it becomes necessary to place the calingulah proposed to be constructed across the Gostanaddi higher than proposed by Captain Ryves, for which alteration there is a second reason, namely, that, as the Gostanaddi and Velpur Channel is to be a second class navigation line, it is extremely advisable to avoid the numerous bends and windings of the old stream above Penumuntra. As directed by you, I have, therefore, designed the calingulah across the Gostanaddi to be at the 14th mile from its head instead of the 26th.

34. The Velpur Channel at this point is close to the Gostanaddi, and a cut of about a quarter mile will connect the two. By this there will be 7 miles of good navigation to Penumuntra, instead of 12, through a channel so tortuous that in navigating it you successively face every point of the compass. This is true likewise, to a great extent, of the first 14 miles of the Gostanaddi, but it is better to have only 14 miles of such a channel than 26.

35. The Gostanaddi itself is a drain, and, therefore, it is necessary to arrange for the water to be always within soil, and to ensure this the channel requires deepening and widening for the first 9 miles from the head. The present channel would doubtless carry the 60,000 cubic yards wanted without any further excavation; but this would be done by its backing up at the head, thus increasing both the fall and depth, and, consequently, the velocity. The cost of the improvements between the Gostanaddi head and the 14th mile is Rupees 10,670.

36. There is a lock at the head of the Gostanaddi 12 feet $\times$ 60 feet with upper sill + 27 feet 6 inches and lower sill + 23 feet 6 inches, differing in dimensions from all other locks in the range. The lower sill is too high, a new lock, 18 feet $\times$ 110 feet, with lower sill + 20 feet 6 inches, upper sill + 27 feet 6 inches, has, therefore, been included in the estimates.

37. The existing calingulah at the head (crest + 30 feet 6 inches, length 30 feet) would, as far as waterway is concerned, discharge the 60,000 cubic yards required. It is, however, one of the old works with a rubble slope instead of a drop, and protected floor and with a narrow wooden bridge, and the masonry is not good; I have, therefore, in accordance with your directions, designed a new calingulah fitted with screw shutters.

38. The 60,000 cubic yards are, therefore, carried down the Gostanaddi with a fall of 6 inches per mile, till at the 14th mile they are turned into the Velpur Channel, which will require very considerable widening and deepening.

39. It is proposed to construct a calingulah across the Gostanaddi at this point to pass off the drainage water from the 38 square miles which the Gostanaddi drains above the point where it is to be built, and also to surplus off water when it is necessary to reduce it in the Velpur Channel. This calingulah has been designed to be 44 feet long, its crest being + 15.50, the water above it + 18.58. It will, therefore, discharge 100,000 cubic yards per hour (750 cubic feet per second.)

40. The arrangements proposed for the Gostanaddi below this point will be treated of under Drainage.

41. The level of ground at the site of calingulah at 14th mile is from + 10.00 to + 20.00, and the water-level, as proposed, is + 18.58 or within soil; it is not, therefore, necessary to embank up the Gostanaddi and to dig out side drains.

42. As already mentioned, the Velpur Channel requires very considerable enlargement to enable it to carry 60,000 cubic yards; the present sections and proposed improvements are shown in the Book of Sections. The fall given is 4 inches per mile.

43. One lock will be required at Penumuntra to drop the water from + 16.25 to + 12.50.

44. From Penumuntra the western branch of the Velpur Channel is followed, as proposed by Captain Ryves. This is at present quite a minor branch, and requires to be entirely re-excavated; it is, however, dug on the proper line for the new channel to follow.

45. Just beyond Vendra, viz., 29 $\frac{1}{2}$ miles from Gostanaddi head (36 $\frac{1}{2}$ from Vijaiswaram), the channel crosses the Buswarowkodu, which it is proposed to improve as a new outfall for the Gostanaddi drainage. The channel crosses by an aqueduct 3 spans 15 feet each as designed by Captain Ryves, modified to carry a greater depth of water, and will be navigable up to this point.

46. Major Mullins suggests a lock into the Buswarowkodu at this point; but it has not been included in the present estimates, as it is doubtful whether the Buswarowkodu would have water in it the whole year round sufficient to give permanent navigation.

47. Captain Ryves allowed for only 25,000 cubic yards to pass this aqueduct. The present cultivation in the tract this is intended to supply is 15,500 acres, which I estimate will be ultimately increased to 22,600, the area of the whole tract south of Gostanaddi at Vendra and bounded by the Buswarowkodu and Yennamadurru drains being about 40 square miles besides swamp.

48. The various branches which this new channel will pick up are at present supplied direct from the Gostanaddi by bunding it above its junction with the Yennamadurru Drain. The bund breaches when heavy rains occur, but not before damage has probably been done to the lands lying on the right of the Gostanaddi. Nothing can be worse than the present makeshift, which makes the lower portion of the Gostanaddi alternately an irrigation duct and a drainage, and with no means of regulation beyond the putting up or removal of an earthen bund.

49. Whether the arrangements now proposed are approved or not, it is essential that something be done to improve the condition of that tract of the delta north and south of the Gostanaddi from Vendra to Palcodair, when, in addition to defective drainage and irrigation, the villagers in this neighbourhood suffer from a Yerracalwa flood as in 1865, the condition of the ryots is pitiable and heavy remissions have to be made. It seems, therefore, to me that the improvement of this tract is the most important part of the delta project. The villagers themselves say they are the only people who have not benefitted by the anicut.

50. Beyond the Buswarowkodu Aqueduct a surplus is provided to discharge 16,000 cubic yards per hour into the Buswarowkodu Drain, and a second surplus at the end of the channel to discharge 20,000 cubic yards into the Gostanaddi near the Razikodu head, at the 31 $\frac{1}{2}$ miles from head (39 miles from Vijaiswaram). Sluices for the heads of the various branch channels are provided for in the estimate.

51. I should mention here that the levels of the western Velpur Channel taken by Overseer Bay in 1868, and on which Captain Ryves worked, were found incorrect when checked by Mr. Bay himself and also by Mr. Ellis, Supervisor. The correct levels have been adopted in the plans and estimates now forwarded.

52. I trust these remarks will, with the map and plans, sufficiently explain the arrangements proposed for this channel. It remains to notice the irrigation from the Bhupiah Channel between Peravelly and the point where the Gostanaddi is to be cut into the Velpur Channel. This irrigation is at present 2,300 acres, and will, as heretofore, be supplied through the Karkarapurru main canal from Peravelly. I estimate the irrigation will be ultimately 2,500 acres, and have allowed 4,000 cubic yards per hour for it. Two dams will be required to the old Bhupiah Channel, one below the mouth of the Gontair branch channel and one a short distance above the point of Gostanaddi junction with Velpur Channel. These have been included in the estimate.

53. *Venkia and Weyairu.*—We now return to the 6th mile from the head, where 150,000 cubic yards have been dropped over the Chettypet Calingulah for the supply of the Venkia and Weyairu. The channel immediately below the calingulah is an old one, and, after a circuitous course of about three miles, passes under the Ellore Canal at the 8th mile from the head, and at this point the navigation line joins it, the Nundamoor Lock dropping boats into the lower channel, or the navigation line joins it, the Nundamoor Lock dropping boats into the lower channel, or point the navigation line joins it, the Nundamoor Lock dropping boats into the lower channel, or Weyairu, which a little higher up-country is called the Yerracalwa, and drains above 800 square miles of country. This old channel is used as a navigation for 6 miles below the Nundamoor Lock, namely, as far as Duvva.

54. The Nundamoor Lock it has been necessary to close owing to its unsafe condition. I presume that the cost of the new lock and its necessary channels will be added by you to the estimates before sending them on, as the plans are being prepared in your office.

55. The channel from Nundamoor to Duvva (6 miles) is very broad, viz., 150 to 180 yards in some places and 7 feet to 8 feet deep. It is, however, fast silting up.

56. The Duvva Calingulah, 1 $\frac{1}{2}$ miles from Vijaiswaram, is 300 feet long, its crest being + 16 feet 6 inches, and it is provided with three rows of wooden shutters in 10-foot lengths, which are removed as speedily as possible when the Yerracalwa is found to be rising. The stream

below Duvva Calingulah is called the Weyairu in its upper portion, and the Yennamadurru Drain in its lower portion. It is not navigable in the upper portion, and will be more fully noticed under the head of "Drainages."

57. The other branch above Duvva Calingulah through which the irrigation water is carried is called the Venkia Channel from Duvva to Peramulla. The distance from the bifurcation to Peramulla Lock is 8 miles, the ground at the head being 2 to 3 feet above the water at ordinary supply-level (namely, + 18 feet 9 inches at this point), but falls rapidly, and at Peramulla Lock is 5 to 6 feet below the water surface. In noticing Captain Ryves' remarks as to the quantity of water coming from the Yerracalwa, Major Mullins remarks that the proper course to follow is to divide this water into two, sending part into the Yennamadurru Drain and part into the lower Weyairu below Peramulla, and thence to tide water. Though not explained in Captain Ryves' memorandum, this is what is really done. There are two calingulahs (weirs) above Peramulla Lock, one, the calingulah proper, used for ordinary working, which is 30 feet long, and one, called the escape, which is 60 feet long and used in the event of Yerracalwa floods coming down. This escape, which is unprovided with shutters, it has been usual to keep banked off, the Lock Goomastah at Peramulla having orders to breach the bund when the water rose to 8 feet on the lock upper sill (*i. e.*, to + 18 feet 3 inches). This, of course, is a most clumsy arrangement. In the estimates now sent it is proposed to lower the crest of this escape to + 14 feet 6 inches, and to fit it with screw shutters which can be raised in a few minutes whenever necessary. These two calingulahs together will discharge about 220,000 cubic yards per hour, or 1,650 cubic feet per second. There is no irrigation from the Venkia on its right bank, till at the 8th mile the Chinakapaverum main branch is led off.

58. *Undi High Level Canal.*—There are about 4,600 acres irrigated by the Venkia Channel above Peramulla, which I estimate will ultimately be 5,000; at the $12\frac{1}{2}$ mile from Nundamoor or $20\frac{1}{2}$ miles from Vijaiswarum is the head of the Undi High Level Canal. This is the principal irrigating channel of this tract, the irrigated area at present being about 36,000 acres, which it is estimated will be ultimately increased to 60,000. This, as explained by Captain Ryves, cannot be expected immediately; but, when the works have been completed, it is reasonable to suppose the greater portion of the area commanded will be irrigated, as the nature of the soil is such that it cannot produce anything worth cultivating unless irrigated. The population is small, about 200 to the square mile, and that will be the principal drawback to the rapid extension of cultivation. Some immediate increase may be expected, though the full estimated increase may be a matter of time.

59. The Undi Canal is at present supplied by a head-sludge of 4 vents 3 feet $\times$ 6 $\frac{3}{4}$ feet with the floor at + 11.10. As there is no lock at the head, the canal is at present shut off from the general navigation system of the delta; this, of course, is a great disadvantage to the producer.

60. As designed by Captain Ryves, the estimates provide for an extra calingulah at the head 30 feet long in 3 bays with crest + 16.25, and also for a lock 18 feet $\times$ 110 feet with the sills + 12 feet and + 9.50 feet respectively.

61. The channel itself requires re-sectioning to some extent. The present and proposed sections are shown in the Book of Sections accompanying the estimates, and the discharges and velocities in the tabulated statements.

62. For 12 miles the channel runs almost due south and then turns to the west along a ridge. From the 12th to the 16th mile very considerable widening is required, and a glance at the present and proposed sections of this portion of the channel will explain why not one-third of the area of the villages south of the channel and lying between the Yennamadurru and Rudrayacodu drainages is cultivated. The surface fall allowed to the channel is 4 inches to 3 inches up to Undi (16th mile), and 6 inches to 8 inches beyond. The fall above Undi Aqueduct is restricted to that now allowed by the fixed level of the floor of that work, namely, + 7.34.

63. In the estimates now forwarded it is proposed to connect the Undi Canal with the Yennamadurru Drain by a lock near Godalakoderu at $11\frac{1}{2}$ miles ($32\frac{1}{2}$ miles from Vijaiswarum). This drain is now generally navigable up to this point, and can easily be made always so. At present a good deal of the grain of this tract is shipped away through the Yennamadurru Drain and Uputair. The sills of this lock are proposed to be + 5 feet and — 1 foot, and dimensions 18 feet $\times$ 110 feet.

64. As allowed by Captain Ryves, two surplus calingulahs, one at $7\frac{1}{2}$ and one at $11\frac{1}{2}$, are provided. In his memorandum Major Mullins states that he considers this unwise; but I do not think any other arrangement, except to surplus only into the Bondada Drain at the $15\frac{1}{2}$ miles, is practicable, and this would dangerously raise the water on the lower portion of the channel if the sluices were closed above. When the Yennamadurru Drain is in full flood (which, though rare, must be considered), these surpluses would not act thoroughly; but in an average of years they would probably be effective for 355 out of the 365 days. A third surplus to discharge 20,000 cubic yards per hour into the Bondada Drain is provided at $15\frac{1}{2}$ miles from the head immediately above the aqueduct already referred to, which carries the canal water over the Bondada Drain. This aqueduct, built some years ago, consists of 3 arches 16 feet span. The waterway above and below being ample, it does not require altering; but, as already remarked, the upper floor is rather too high. This cannot be remedied without re-building the work.

65. Some new branches for the channel are required, and the sluices will nearly all have to be re-built to suit the altered conditions of the canal.

66. The channel will be navigable up to the 16th mile (Undi village), though only properly navigable up to the aqueduct, the depth on which will be only $2\frac{3}{4}$ feet.

67. Captain Ryves suggested a lock at the end (20 miles from head) to connect it with the Akced Canal, but the Rudrayacodu drainage is between the two, and, owing to the low level of the ground here, an aqueduct would probably be inefficient.

68. I have provided a masonry drop below the aqueduct, and a small surplus into the Rudrayacodu at the end of the channel.

69. *Venkia and Weyair*.—Returning now to the Venkia Canal; immediately below it on the left bank of the Venkia is the 60-feet escape already alluded to, and on the same side, 400 yards above, the Peramulla Lock: 14 miles from Nundamoor (22 miles from Vijaiswarum) is the Peramulla Calingulah or weir; both escape and weir discharge into the Lower Weiyaru.

70. Immediately above the Peramulla Lock on the right bank is the head-sludge of the Chinakapaverum Channel. The sluice consists of 2 vents, 3 feet $\times$ 1½ feet. Considerable alterations are proposed to the head of the channel, which, however, are due to the arrangements necessary for draining the tract lying north of the Venkia Canal, and will be explained under "Drainage." This channel will take 23,000 cubic yards of water for the irrigation of 16,000 acres of land. Although up to this time this channel has been irrigating lands on its right side, it will not in future irrigate at all from its right bank for a distance of 4½ miles from its head, the tract hitherto supplied from it being, under proposed arrangements, irrigated from the Ellore High Level Canal. Some extent of increase of cultivation may be expected south of the Pundikodu when the proposed drainage improvements have been carried out.

71. Below Peramulla only 20,000 cubic yards are required for the irrigation of about 12,000 acres of land.

72. The Peramulla Lock is a double one, built many years ago, and consists of two chambers each 15 feet $\times$ 100 feet, the level of the sills being upper + 10 feet 3 inches, intermediate + 2 feet 3 inches, and lower — 4 feet 9 inches. There are ordinarily from 9 feet to 11 feet of water on the lower sill. The masonry of the lock is good, but the gates are now old and bad. The stream is small but shallow stream, rather tortuous, and

73. The Weyairu below Peramulla Lock is a broad but shallow stream, and is rapidly silting up. Some day no doubt the Chinakapaveram Channel will have to be converted into the main navigation line.

74. At 14 miles from Peramulla Lock (or 36 miles from Vijaiswarum) near Chinakapaverum, is the head of the Akeed Canal, the flood calingulah, and the lock and calingulah into the Colair Lake. The flood calingulah was constructed only in 1868 to pass off to tide water the Yerracalwa flood-water, which may be sent over the Peramulla weir and escape, also the drainage which comes into the Weyairu underneath the Peramulla Aqueduct, and the local drainage falling into the Weyairu for the first 11 miles below Peramulla. This calingulah is 100 feet long, crest + 3 feet, and water passing over it is carried by a large excavated channel into a salt creek (feeder of the Upatair) near Akeed. The Chinakapaverum Calingulah, which discharges into an old channel leading to the

Colair Lake is 40 feet long, crest + 3 feet 3 inches : thus these two calingulahs can, therefore, pass off about 300,000 cubic yards of drainage water per hour.

75. *Akeed Canal*.—For the Akeed Canal, which has just been completed, no new works are required beyond irrigation sluices and some minor branches, which have been included in the estimates.

76. For 4 miles from the head of the Akeed Canal at Chinakapaverum, an old channel, the Rudrayacodu has been made use of, but from a mile above Akeed village the channel is an excavated one. At 38 miles from Nundamoor, or 46 miles from Vijaiswarum, the Akeed Canal is connected with tide water by the Yelurpad Lock 20 feet $\times$ 150 feet, the upper sill being H. W. — 1 foot 4 inches and lower sill — 9 feet 4 inches. There is also an escape calingulah 15 feet long to pass off water when the sluices are closed.

77. Returning again to Chettypet, the 6th mile from Vijaiswarum, 220,000 yards having gone down the Karkarapurru Canal and 150,000 passed over Chettypet Calingulah. The 156,000 which pass westward are divided, the Uttali Canal taking 60,000 and the Ellore Canal 96,000 per hour.

78. *Uttali Canal*.—The Uttali Canal head is situated three quarters of a mile below the Karkarapurru Channel, or $6\frac{1}{4}$ miles from Vijaiswarum.

79. There is at present no regulating work at the head of this canal except a rough-stone bank, over which there is always more or less of a fall, and boats work through it with difficulty ; and, as the canal sometimes gets more water than it ought to, damage is frequently done below, there being no surplus work on the channel. It will be readily understood that both irrigation and navigation are both imperfect under such arrangements. It is proposed, therefore, to put a lock and calingulah at 4 miles from the head as arranged by Captain Ryves, and, though it is not practicable, except at great cost, to make this channel a through line of navigation, yet, as it is advisable to give navigation up to the large village of Uttali, where there is a considerable market, a second lock has been allowed $13\frac{1}{2}$ miles from the head, or $20\frac{1}{4}$ miles from Vijaiswarum.

80. The lock at the 4th mile has been designed 18 feet $\times$ 110 feet with upper sill + 26.25 and lower sill + 22.25. The calingulah to discharge 47,000 cubic yards (352 $\frac{1}{2}$ cubic feet per second) is 27 feet long in 3 bays with crest + 30.25.

81. Not much earthwork is required in the first 4 miles of this channel, but considerable widening and deepening is necessary below the head lock. The present and proposed sections are shown in the Book of Sections. The fall above the lock at 4th mile has been allowed 4 inches per mile, and 6 inches per mile for the lower reach.

82. At $10\frac{1}{2}$ miles from the head a surplus is allowed in the left bank to discharge 30,000 cubic yards into the Gostanaddi.

83. As directed by you, the second lock, at $13\frac{1}{2}$ miles from the head, has been designed of smaller dimensions than other locks, namely, 10 $\times$ 70 feet, to work with a single gate.

84. Beyond this lock the channel will be navigable for $2\frac{1}{2}$ miles, namely, to Uttali, where it separates into two branches, through the principal of which, the Comara branch, any extra water will be passed to surplus into the Yennamadurru Drain, which, however, is not supplied with water to be navigable at this point, and it would not be advisable to construct locks or weirs across it, besides which the Undi Canal, being close to this point, will carry off all the produce of villages which lie nearer to it than to Uttali.

85. The present irrigated area under Uttali Canal is 22,000 acres, which I estimate will ultimately be increased to, 34,000. The principal increase will take place under the Ralinghy main branch in the tract lying between the Gostanaddi and Yennamadurru Drain. There is no proper supply to this tract at present, the Ralinghy main branch being of insufficient dimensions, and the tract also much damaged whenever heavy floods occur in the Yennamadurru, which back up the Gostanaddi whenever the Yerracalwa comes down. The widening of the Ralinghy main branch, which has been provided for, will provide water, and the drainage arrangements proposed for the Gostanaddi will relieve this tract from the floods from which it has hitherto suffered.

86. The Ellore Canal not having hitherto been under my charge, and the estimates for the work required for it not having been worked out by me, will be reported on separately.

I have now noticed all the main canals and the existing and proposed arrangements of each, and will now endeavour to explain the drainages of the delta.

87. *Nakala Drain*.—Commencing at the east, the first main drain is the Nakala, which is also used as a surplus. It is, as already explained, connected with the navigation system of the delta by the Mukamala Lock, but there is scarcely any traffic down it. This is owing to the water-supply being necessarily uncertain (i. e., only surplus water) ; and, as there is a heavy fall down it, the current is very strong.

88. The Nakala drains the tract lying between the Bank and Nursapore canals, and, when the river is low, efficiently carries off all drainage and surplus water sent into it ; but, when the freshes rise, they stand up the Nakala and flood considerable tracts of land on both sides. To keep out the freshes a large sluice has been designed and estimated for. Captain Ryves proposed to place this at Latchmipalem, but the site has been altered to Cattupalem in the present estimates to suit the navigation arrangements proposed for the Bank Canal. There are already embankments to the Nakala as far as the point where the sluice aqueduct is proposed to be constructed.

89. *Gontair Drain*.—Proceeding towards the west, the next main drain is that lying between the Nursapore and Velpur channels, and called the Gontair. This is a wide shallow drain which has already been improved to some extent in its upper portion, but which requires to be dug out in its lower portion, the necessary provision for which is made in the estimates being included in the Gostanaddi outfall drain, which the Gontair joins above Viravasaram.

90. *Gostanaddi Drain*.—Proceeding again west, the Gostanaddi is the next main drain. This has already been alluded to, as in its upper portion it has hitherto been, and still is proposed to be, used, to convey water for irrigation and also as a navigation channel. Below the 14th mile from its head it will, under proposed arrangements, be entirely a drain.

91. The Gostanaddi discharges into the Yennamadurru ; but when floods come down this, the drainage discharge of the Gostanaddi is not only stopped but the Yennamadurru water backs up the Gostanaddi, flooding all land south of a line drawn from Aravilly to Mypah. To remedy this it is proposed to excavate the Buswarowkodu as an outfall for the Gostanaddi. This is lowest of the Gostanaddi branches, which, flowing from Vendra past Viravasaram, where the Gontair Drain joins it, eventually joins tide water near Vempa.

92. I have, as directed by you, allowed for only a portion of the total drainage discharge from the Gostanaddi to pass down the Buswarowkodu. The area to be drained above Vendra is 80 square miles, and, in addition to the drainage water from this area, 30,000 cubic yards per hour surplus from Uttali Channel and 50,000 from the Velpur Channel, one inch per day off 80 square miles = 286,000 cubic yards per hour, giving a total probable discharge of 366,000 cubic yards per hour (2,745 cubic feet per second), of which the sections of the Buswarowkodu new drain have been calculated for 160,000 cubic yards per hour, leaving 206,000 to be discharged by the sluice proposed to be constructed at the junction of the Gostanaddi and Yennamadurru, and which will probably act efficiently for all except ten days in the year.

93. *Yennamadurru Drainage*.—Proceeding again west is the Yerracalwa, the Weyairu or Yennamadurru, for it is called by all these names ; the Yerracalwa beyond delta limits north of Nundamoor, Weyairu from Nundamoor to Pipara ; and the Yennamadurru Drain below that.

94. This drain, which passes to the Uputair, the drainage of 850 square miles of the upland country, is embanked below Duvva Calingulah to the village of Yennamadurru about ten miles from its junction with the Uputair, below Yennamadurru when in flood, its water spread over the swampy tracts which lie north of the Uputair.

95. The embankments require further raising and strengthening, and they are quite unprovided with sluices for the local drainage. The estimates provide for these two works.

96. The division of the Yerracalwa water between the Yennamadurru Drain and Lower Weyairu has been explained under the Venkia Canal.

97. *Bodopad Drain, Peramulla Aqueduct*.—To drain the tract north of the Venkia Canal considerable drainage works are required.

98. The Chinakapaverum Channel as originally carried out shut off from its natural outlet the Weyairu, the drainage of the tract lying between the Venkia and Ellore Canal, and a large area was thus permanently swamped

99. The estimates include a drain from Bodapad 4 miles above Peramulla Lock, running parallel to the Venkia and Chinakapaverum Channel banks and an aqueduct under the Chinakapaverum Channel to pass the drainage into the Lower Weyairu near the village of Canara.

100. The aqueduct consists of five arches of 10 feet span. To get the necessary headway for the aqueduct the Chinakapaverum Channel is embanked from the head-sluice to the aqueduct, the irrigation water being dropped immediately in rear of the aqueduct to the level required for irrigation.

101. *Minor Drains.*—The following are drainages for which improvements are required, and for which provision is made in the estimates :—

The Caza, between Chinchinada Channel and Nursapore Canal.

A new drain on the west of the Nursapore Canal from Jinnur to Mogultur.

The drain lying between the Nursapore Canal and the Rapaka main branch, which is an old shallow channel, requires to be deepened and dug into the Gontair and Gostanaddi outfall.

The Razikodu, lying to the west of the Uttali Channel, requires improving and to be dug down to the Yennamadurru Drain and provided with an outfall sluice.

The Erlakodu, lying between Gostanaddi and Yennamadurru from Skinnerpuram, requires to be dug down to the Gostanaddi.

The drain from Rayellam to Annacodair, on the west of the Yennamadurru, requires improvement, also the Bondada Drain below the Undi Aqueduct requires considerable deepening.

The Rudrayacodu below Akeed requires deepening and digging down into tide water south of Dodanapudi.

The necessary provision for the above works has been made in the estimates.

102. With regard to the plans and estimates themselves, I would beg to remark that the works have all been designed to be substantial. No extraordinary ornament or finish is provided, and I trust that on examination the details may be approved of.

103. With regard to the rates in the estimate, I would beg to state that the rates are from five to seven per cent. above those at which we are now working. The whole of the works will necessarily occupy some years, and, as the tendency of prices is to rise, I consider this increase a necessary precaution. Ten per cent. on the estimate has been allowed on the totals of masonry works for superintendence and contingencies, and a smaller percentage on earthworks.

104. The plans and estimates have been carefully considered in all their details, and I know of nothing that is omitted, and have every reason to suppose that the works may be executed within the estimated sum.

105. The increase of present estimate over that sent in by Captain Ryves is due—first, to the extra number of locks; secondly, to all locks being designed with masonry chambers; thirdly, to all second class locks being made of a larger size.

106. With regard to financial results of the scheme, you are in a better position to speak than I am. I know, however, that the moderate increase in the irrigation allowed for will take place in course of time; and, as the swamps in the southern portion of the Undi (Bhimaverum) Taluq are re-claimed, a further increase may perhaps take place.

107. I would, however, beg to make one remark, namely that a good deal of land is now held in hope that its improvement will be shortly effected. The ryots know that estimates are being sent up for the completion of the channels and excavation of drainage channels, and hold on to lands now badly irrigated and worse drained, and, should the works not be carried out, an actual loss of present revenue would result.

108. The present limited scope of the works, the numerous makeshifts on all channels, and confessedly temporary nature of many of the present masonry structures, all render imperative the

carrying out of the present scheme, even if by doing so the revenue were not materially increased. But I believe the present project will yield good returns.

109. The average area irrigated during the last five years is 202,275* acres for first crop. The area for the last fusly was 213,430.

The estimated ultimate acreage is 2,96,300; taking the last year's figure, this would be an increase of 83,000 acres, the water-rate on which would be 3½ lacs of Rupees.

110. The total of the estimates now sent up is Rupees 9,90,300, to which must be added, say 2,49,500 for Ellore Canal, not included, and say 70,000 for the new Nundamoor Lock, etc., or a total of 13½ lacs.

111. From the net returns there would be a deduction of say 20,000 Rupees per annum extra cost of maintaining the additional works, and Rupees 5,000 for extra establishment, leaving a net return of 3½ lacs, or about 25 per cent., on the estimated outlay.

112. Should the works of navigation now proposed be carried out, the district will be so well provided with cheap communications that the value of the land will be permanently increased, which will enable higher rates to be fixed at the next revision of the present settlement.

113. Major Mullins in his memorandum requests that some idea may be given of the respective cost of the navigation and irrigation. It is almost impossible to separate these items, for having to provide for a channel being navigable increases the cost of the earthwork, as the velocity, and, therefore, the fall in the channel have to be kept as small as possible. The following, however, exhibits the cost of navigation works only as compared with irrigation works :—

Channels.	Irrigation.	Navigation.
	RS.	RS. *
Head-sluice ...	19,500	
Main Canal ...	49,000	
Karkapurru Canal ...	33,000	
Nursapore do. ...	69,110	1,40,490
Bank do. ...	44,400	85,060
Undi High Level Canal ...	71,700	39,000
Venkia and Weyairu ...	11,960	
Uttali Canal ...	54,300	24,500
Gostanaddi and Velpur ...	1,08,280	32,780
Drainages ...	1,78,220	
Total...	6,39,470	3,21,830

114. I beg to forward an estimate for the plant and tools required for carrying out these new works, and would beg that, in the event of sanction being accorded to the estimate, the Secretary of State be moved to send out the iron boats of the dimensions specified as quickly as possible. The wooden boats would, of course, be built here; but it would be cheaper to get the iron boats from England.

115. A list showing all the plans and documents sent up accompanies this letter, and I trust that all required information is furnished by the plans and estimates.

116. A statement of expenditure on the delta works incurred up to date is also forwarded, as called for in your circular memorandum, No. 3,652, dated 18th January last.

From J. W. RUNDALL, Esq., Executive Engineer, No. 3 or Western Delta Range, Godavery District, to the Acting Superintending Engineer, 1st Division, dated Dowlaisheram, 5th September 1870, No. 482.

I HAVE the honour to forward, herewith, the plans and estimates for completing the irrigation and drainage of the tract commanded by the Ellore High Level Canal.

2. The Ellore Canal separates from the main canal at Chettypet, six miles from Vijaiswarum; and, after throwing off the Uttali Canal at $6\frac{1}{2}$ miles, it passes over the Yerracalwa River by the Nundamoor Aqueduct (4 arches of 40 feet span and 42 feet waterway at the 8th mile).

3. Up to this point all work required to the canal has been included in the Western Delta Project estimates submitted to you.

4. The quantity of water allowed by Captain Ryves for this canal was 96,000 cubic yards (720 cubic feet per second), and for this discharge the canal has been calculated, and the acreage and distribution to branches, as arranged by Captain Ryves, have been followed; his figures for the ultimate irrigated area, agreeing very nearly with those subsequently sent in by the Revenue authorities, being 48,200 acres, against 48,300 estimated by the Head Assistant Collector.

5. *Main Canal.*—The sections of the main canal will show that very little is required to be done to it to enable it to carry the required quantity of water. Widening is not wanted in any case, but deepening is necessary in a few places. The principal fault in the channel is the absence of tow-paths owing to the banks originally having been thrown from 30 to 60 feet from the excavation. In some places there are no tow-paths at all where the channel passes through a series of tanks near the 29th mile. The estimate now framed allows for a proper towing-path bank being made.

6. For the small quantity of excavation required I have, as desired by you, allowed a high rate. The line being so important for navigation it is very desirable not to keep it closed for any length of time; hence the excavation will have to be done while the earth is wet.

7. The canal, as at present laid out, will, when discharging its full supply, have a surface fall varying from $3\frac{1}{2}$ inches per mile to $\frac{1}{2}$ inch, the bedfall being less or 1.87 inch per mile on the average. The maximum velocity will be 1,833 yards per hour.

8. Crossing, as it does, the entire drainage of the country above it, numerous works for the passage of the upland drainage, either under or through the channel, according to local circumstances, are required. These consist at present of three under-tunnels of one vent, one under-tunnel of two vents, two of three vents, two of five vents, and one of six vents, the span in each case being 10 feet. It is not, I believe, necessary to add to these tunnels. For the passage in and out of the channel there are 620 feet of pukka and catcha inlets, and 192 feet of masonry outlets in addition to four masonry surplus calingulabs provided with scouring sluices. There is at present no difficulty in running the local drainage out of the channel; but a difficulty is found in making use of the escapes, owing to the tail-race channels leading from them not having been cut out and banked off from the low lying ground below them, so that, when it is required to surplus in December, damage is done to the standing crops by the water flowing over the country. The estimates provide for the necessary improvements and completion of the tail-race channels.

9. The Ellore Canal is laid out on the highest level at which water can be led from the Godavery, and as after the 29th mile (from Vijaiswarum) it skirts the Colair Lake, or unfilled basin between the Godavery and Kistna Deltas, it follows that the fall in this country is very much heavier than in any other of the delta tracts. But the fall is not at all regular, there being many square miles round the Colair only 3 feet to 5 feet above high water. The whole area is commanded by the canal water, but the irrigation is somewhat expensive. If the water is led directly in the line of the fall, numerous drops are required; if led at right angles to the fall, works are required for the passage of the local drainage through or under the irrigation channels. The drainage of this tract of country has scarcely been touched hitherto in the way of improvement, though much more water is sent over the country; the consequence is that at present a considerable extent of land is swamped or the out-turn of the crops rendered precarious owing to the difficulty in draining and drying the land.

10. The total area of land lying below the Ellore Canal and bounded on the south by the Venkia Channel, by the Chinakapaverum Channel, Pundikodu Drain, and Colair Lake, is about 170 square miles; say 80,000 acres of land will be ultimately cultivable, of which it is supposed 48,000 acres will be irrigated. The proposed arrangements for irrigation and drainage will now be separately described.

11. Captain Ryves' arrangements for irrigation will appear from the maps which accompany this. A main irrigating channel takes off $1\frac{1}{2}$ miles below the Nundamoor Aqueduct, (*i. e.*, $9\frac{3}{4}$ miles from Vijaiswarum). This channel is intended for the irrigation of about 16,000 acres of land, and the supply provided for it is 27,500 cubic yards per hour (20.6 cubic feet per second). Should the proposed arrangement for altering the navigation line into the Weyairu and Venkia Canal be carried out, the head from the present site at Nundamoor and using a portion of this channel be carried out, the head-sluice already constructed would have to be removed. 3,000 cubic yards per hour would probably be required for lockage; this has been allowed for. At $1\frac{1}{4}$ miles from its head this channel separates into the mid and low-level branches, 17,500 cubic yards per hour going to the mid-level and 10,000 cubic yards per hour to the low-level branch. Water from the direct irrigation of the Ellore Canal will be picked up, and to some extent re-used in the mid-level channel; similarly water from that will, to some extent, be utilized on the low-level channel.

12. One under-tunnel and three escapes are provided in the mid-level channel below each escape; there is a regulating bridge, when necessary, to surplus or to stop the water-supply down the channel, the shutters to be put in the regulating bridge, and the shutters in the escape opened. The designs for these works are as arranged by Mr. Andrews and Captain Ryves; only I have, as directed by you, substituted shutters to be lifted by screws for the escapes instead of tumbling shutters as previously designed.

13. On the low-level channel there is one escape 10 feet span, just above the Duvva Road.

14. The dimensions of these channels, position, levels, and dimensions of the drops in them are all shown in the tabulated statements accompanying this.

15. In the main canal, sluices discharging from 4,500 cubic yards to 500 cubic yards each are to be built at suitable points. Some of these sluices in the first 18 miles are already built and the minor channels from them dug; but below Chebrole the irrigation at present is carried by the water being let into old channels through temporary wooden sluices; there is, therefore, great waste of water and great difficulty in its proper control and regulation. The points at which all sluices are to be built are shown on the map, and the proposed discharges in the Distribution Statement accompanying this.

16. *Drainage.*—Commencing at the south-east of the tract, above the point where the water in the Venkia Canal strikes the surface of the ground, that is above Ravipaud, the drainage finds its way into its natural outlet, the Upper Weyairu.

Bodapad Drain.—From immediately below this point, or at 4 miles above Peramulla Lock, the Bodapad new drain is commenced, which, running immediately parallel to the Venkia and Chinakapaverum Channel to a point 3,000 yards below the head-sluice to the latter channel, discharges under an aqueduct of five 10-foot arches into the Lower Weyairu. These works have already been carried out, and a large area, not less than 1,500 acres previously swamped, has been cultivated, and more will be brought under cultivation as soon as the irrigation channels from the Ellore Canal are completed.

17. *Pundikodu Drain.*—A drain starting from the west of the aqueduct, running along the side of the Chinakapaverum Channel, is to join the Pundikodu, which already has an outfall into the Colair Lake. Beckley's drain, to be hereafter noticed, falls into the Pundikodu, and considerable enlargement is necessary, the details of which are given in the sections and tabulated statement.

18. *Drain from $9\frac{1}{4}$ miles of the Mid-Level Channel and Beckley's Drain.*—The drain from the escape at $9\frac{1}{4}$ miles of the mid-level channel is for some distance an old channel. The fall is heavy in the first 3 miles, and it is proposed to construct five dams for irrigation from this level channel joins this drain above its third dam, and any surplus from it will be sent over this dam. A channel for the irrigation of Vipparru will have to be led off here. Below this the fall is small, and the channel will act purely as a drain; it is to be led into an old channel known as "Beckley's Drain," which requires to be enlarged and improved up to its junction with the Pundikodu already noticed.

19. *Drainage Diversion.*—This catch water drain and bank from near Upakapad to the Colair near Tokalapilly is to be led out of the Bathampudi or No. 1 under-tunnel tail-race and continued in a south-westerly direction through some old tanks till it joins the Colair, the object being to lead off and prevent from flowing over the country the upland drainage from Nos. 1, 2, and 3 Tunnels under the main canal, and the surplus water from the Bathampudi escape and outlet. The probable discharge with areas of cutting, etc., is shown in the tabulated statement. It is necessary to construct two drops in this drain, for in the first 5 miles I have allowed as heavy a fall and velocity as would be safe, viz., 2 feet per mile bedfall, and even with this the drops are requisite. There will always be a good body of water in this drain from the drainage of the cultivated lands and from the leakage of the escape and outlet. I propose, therefore, to lead off from it, at the 5½ mile, a supply for the Chinanandrocole land. All water up to 10,000 cubic yards per hour will be stopped by a bar 1 foot high across the drain and pass through the sluice.

20. *Sundry Drains.*—The tail races of the following works required to be dug out and connected with some proper discharging channel and the cost of doing this is included in the estimates :—

- (1.) Tail-race from under-tunnel at 6¾th miles on the mid-level channel.
- (2.) Improvements to the tail-race from escape at 11¼ miles of the same channel.
- (3.) Tail-race from the two under-tunnels at Kycadam, at 29th mile of main canal.

The amounts of the estimates sent up now are as follow :—

	RS.
1. Main Canal	55,000
2. Mid-level Channel	64,180
3. Low-level do.	19,290
4. Pundikodu Drain	59,530
5. Drain from 9¼ miles of Mid-level Channel	24,000
6. Drainage Diversion	21,700
7. Overseers' Sheds	5,800

Total... 2,49,500

21. Irrigation and drainage are so intimately connected that it is scarcely possible to separate them from each other.

22. Captain Ryves' estimate was Rupees 1,97,000, and the increase in the present estimates is due to several causes, the value of land for the channels and drains is now included, but omitted before; to some increase in the amount of earthwork for the drainages; to an increase in the rate of earthwork on the main canal and for masonry, especially for cut-stone on the mid-level channel. I have already, in a previous letter, explained this. Several extra drops in the drainages and minor irrigation channels have been allowed for.

23. With the remarks given above I trust that the plans will sufficiently explain themselves, and I trust that the designs and estimates now sent up will be approved of. In making them out Captain Ryves' general designs have been followed, modified by the levels subsequently taken by Mr. Andrews.

24. I trust that any omissions on my part may be excused. Taking up the work, as I did, with the information partly collected but not arranged, and with but little local knowledge of the country to be dealt with, I have been longer in submitting them than I anticipated.

25. The general intention was clearly explained by Captain Ryves, and I don't think they have been deviated from. But, owing to levels before that officer being incomplete, there were some omissions in his estimates, which have been supplied.

APPENDIX No. 1.

EXTRACT from a Memorandum by Captain J. G. RYVES, Superintending Engineer, 1st Division, to accompany estimates for the improvement of the Eastern and Western portions of the Delta of the Godavery.

At Dowlaishwaram the Godavery bifurcates and flows to the sea by two main arms, thus dividing the delta into three parts, distinguished as the Western, Central, and Eastern Deltas. The estimates submitted with this report relate to the Western and Eastern Deltas only.

2. The areas of these three divisions are given in the following table :—

	Total Acres.	Deduct swamp and too high.	Arable area but including roads, village sites, canals, etc.	AREA OF SARWA PADDY.	
				Present.	Estimated ultimate.
	1	2	3	4	5
Western ...	660,000	100,000	560,000	208,000	300,000
Central ...	350,000	90,000	260,000	81,000	135,000
Eastern ...	285,000	30,000	255,000	147,000	190,000
	1,295,000	220,000	1,075,000	436,000	625,000
		Inclusive of			Exclusive of
Polarum Island ...	40,000	15,000	25,000		15,000
Coringa Island ...	16,000	8,000	8,000		5,000

3. The long strip of country, which would be brought under the anicut water by the extension of the Samulcotta Canal to Toonee, is not included in the above.

4. The areas in the fourth and fifth columns are of sarwa paddy, i. e., the first or monsoon crop of rice, and do not include the very extensive crops of chillies, turmeric, onions, etc., for which water is supplied, but of which we have no returns.

5. The population of the delta talooks is, according to the latest census returns, one million in round numbers; and probably 800,000 are located on the 2,000 square miles within the influence of the anicut.

6. In a report, dated 16th April 1866, I proposed that the limit up to which our works should be modified, enlarged, and extended should be the monsoon supply of 600,000 acres of rice. The figures in Column 5 of the above table (which are the totals of returns obtained from each village now receiving water from the anicut channels, i. e., the Village Curnum's estimate of what his village will be able to undertake), show that the actual cultivation of this area may with confidence be expected if an ample supply of water be delivered and the low lying lands be effectually drained, especially as it is proposed to bring several villages, to which water has not yet been carried, within the influence of the anicut; as, for instance, the Polarum Island, the Coringa Island, and the villages beyond the Kokalairu.

7. I do not anticipate a very rapid extension of cultivation immediately after the execution of our part of the bargain; but I think that there need be no doubt about the ultimate result being attained within a moderate period.

8. I have, therefore, adopted as my limit the figures in Column 5 of the above table.

9. The monsoon rice-crop is raised during the six months, June to November. In an ordinary year the river begins to rise about the middle of June; during July, August, and September it discharges* from 20 to 120 (in great floods) during October and November

* Per unit of time.

150) times as much as would be required for the 600,000 acres. During October and November it falls gradually, till, at the end of the latter month, the supply in front of the anicut does not exceed one-and-a-half, or, even in a bad year, one million cubic yards per hour. The supply during November is, however, sufficient in even bad seasons to mature the 600,000 acres of paddy. The crop is reaped early in December.

10. But in a very bad year, when the south-west monsoon rainfall has been below the average and the north-east monsoon has altogether failed, the supply during November would be insufficient to bring to maturity a rice-crop on 600,000 acres. Such a season might occur once in twelve or fifteen years, and would bring with it loss of part of the crop.

11. A dry weather supply enabling ryots to grow their seed plants and plant them out five or six weeks earlier would, besides its many other advantages, ensure a full crop of rice on the whole area in even such an exceptional season.

12. The following table exhibits the (sixteen year's) average number of days on which the river is at the stated heights above the crest of the anicut during the 168 days (15th June to 30th November), and the quantity of water which can be drawn from the river by our head-sluices and delivered at the required levels in the canals :—

River above anicut on crest.		Days.
	+ H. W.	
16 feet.	50 feet.	1
15 "	49 "	1
14 "	48 "	1½
13 "	47 "	1½
12 "	46 "	1½
11 "	45 "	2½
10 "	44 "	2½
9 "	43 "	4
8 "	42 "	5
7 "	41 "	8
6 "	40 "	12
5 "	39 "	19
4 "	38 "	27
3 "	37 "	55
2 "	36 "	19
1 "	35 "	9
0	34 "	
16th June to 30th November.		168
1st December to 16th June.		
4		1
3		48
2		48
1		56
0		32½
-1		6½
-2		6
-3		
-4		

WESTERN DELTA.					
RIVER.	CANAL.		Cubic yards per hour.	Number of days.	Total supply Mns. cubic yards.
	Above crest of Anicut.	+ H. W.			
	More than				
	4'	37.1	680,000	76	1,095
	3'	36.25	585,000	36	506
	2'	35.25	505,000	33	400
	1'	34.2	435,000	15	157
	0'	33.1	375,000	8	72
				168	2,230
RIVER.	CANAL.		Cubic yards per hour.	Number of days.	Total supply Mns. cubic yards.
	On crest of Anicut.	+ H. W.			
	More than				
	4'	37.2	480,000	58	668
	3'	36.4	400,000	27	259
	2'	35.6	330,000	55	436
	1'	34.7	270,000	19	123
	0'	33.8	220,000	9	47
				168	1,533

N. B.—From the above it would be made to appear that the crest of the Dowlaishwaram Anicut is 34 feet above high water. This it has always been supposed to be, but levels lately taken show that H. W. Sp. is — 2.3 with reference to the Anicut + 34, i. e., the Anicut is 36.3 above the highest sea-level and 38.55 above mean sea level.

13. The mean hourly delivery of water being about 560,000 cubic yards and 375,000 cubic yards respectively to the Western and Eastern Deltas, I adopt these quantities and the corresponding levels of water in the following description of the principal canals, in which I trace the delivery of the supply throughout the delta, commencing with the Western Delta.

14. The 560,000 cubic yards passes through the head-slucice, consisting of fifteen vents, each 6 feet × 8 feet, with a velocity of 7,000 yards per hour, the vents being first full to the top, the river register being about + 36.75 and the canal water surface immediately in rear of the sluice + 36.0. The main duct conveys the whole body of water in one channel* for six miles, and delivers it here, opposite the Chettypet Calingulah, and at the point of bifurcation of the Ellore and Nursapore canals, at

* Excepting the two miles of loop channel and straight cut. The first four miles of this main duct will have to be enlarged, the first two very considerably, in order that the required quantity of water should be conveyed with a moderate current. I have provided for enlarging the canal, so that the velocity shall nowhere exceed 2,500 yards per hour. This is a high velocity for a navigation canal; but is not, in my opinion, higher than may be permitted in a broad deep canal like the Vijaiswarum Main Duct. The water section will vary from 2,000 to 2,500 square feet. Full details are given in the table of dimensions and levels and on the drawings.

15. At the sixth mile the 560,000 cubic yards per hour is divided into three parts, one of 175,000 cubic yards being dropped over the Chettypet Calingulah for the supply of the Venkia, Unli, and Weyairu irrigation; 230,000 cubic yards flowing on to the Nursapore and Bank Canals by the Karkarapurru Duct; and 155,000 being taken westward for the Ellore High Level Canal and Uttali canals.

16. *Venkia, Undi and Weyairu.*—The Chettypet Calingulah (weir) over which the supply for the Weyairu and Venkia irrigation is dropped (twelve-and-a-half feet from surface to surface) has a clear length of 100 feet, its crest being at + 30.3, or 3.5 feet below our mean water surface of main duct at this point. The shutters would, therefore, be raised about one-and-a-half feet for the discharge of the 175,000 cubic yards. In the early part of the dry season, when the river is about level with the crest of the anicut and the supply about five-eighths of our mean, the share for the Venkia and Weyairu would be passed clear over the calingulah, the shutters being lifted clear off the water.

17. The shutters are worked by screws in ten-foot lengths; the details are given for similar shutters on the drawings for the new calingulahs at Peravelly and Madapad.†

† See drawing.

18. The water, after dropping over the calingulah, flows in the bed of the Yerracalwa, a river bringing the drainage of some 850 square miles of country; and, after passing under the Ellore High Level Canal, continues in this natural water-course and from three to six feet within soil for six miles as far as Duvva, where a weir three hundred feet long across the course of the drainage serves to retain at the required level the irrigation water, which is here taken by an artificial canal (the Venkia) straight almost due west to Peramulla. At the head of the Venkia the ground is two to three feet above the canal water. At a short distance above Raipad the canal water comes out of soil, and, for the remaining five miles to the Peramulla drop, it is from 0 to seven-and-a-half-feet above the ground.

19. At about a mile above the Peramulla drop is the head of the Undi Canal, which takes 100,000 cubic yards per hour. This canal supplies the greater part of the irrigation of the Undi Talook; it is carried between banks above ground-level almost throughout the whole of its course of sixteen miles up to the town of Undi. The area under irrigation at present is about 36,000 acres, and it is expected that ultimately the sarwa rice-crop dependent upon it for water will cover as much as 60,000 acres. The water section of this canal, therefore, requires to be very considerably enlarged, and the earth excavated will go to strengthen the banks. In some places, where the water section will be sufficient, the banks will require raising and strengthening. I also consider it advisable to construct two or three surplus calingulahs in the left bank to discharge surplus into the Yennamudurru Drain, when, as happens during heavy rains,

the irrigation sluices are closed and it is not possible, with regard to the safety of banks of the Venkia, to close the head-sluice altogether. The existing head-sluice is inadequate to the supply of 100,000 cubic yards, and will have to be supplemented by a small drop calingulah, which I prefer to a sluice. The sections of the canal on sheet and the table of dimensions and levels give full details of the proposed enlargement and the positions of the surplus calingulahs.

20. Immediately above the Peramulla Lock is the head-sluice of the Chinakapaverum Channel, to which 30,000 cubic yards have to be delivered. For this channel, nothing more than what may be properly classed as minor works, and provided for by lump estimate, is required, except certain alterations to its sluice and addition to its banks in the first three-fourth mile of its course, which, being rendered necessary by drainage requirements, are described with, and charged to, the drainage works.

21. Besides the 130,000 cubic yards of water thus disposed of, about 10,000 are allowed for the minor sluices, drawing direct from the Venkia between Raipad XV. and Peramulla XXI. miles; the remainder, about 35,000 cubic yards, is dropped at Peramulla from + 17.75 to + 6.75 over a calingulah thirty feet long, and flows in a (natural) broad capacious channel fifteen miles to Chinakapaverum, in the first part about three feet to 0 feet below the ground level, towards the end 0 to one-and-a-half feet above ground and between artificial banks. At the XXXVI $\frac{1}{2}$ mile (Chinakapaverum) is an escape calingulah 100 feet long for the discharge of flood-water into the Uputair tidal outfall of the Colair. From above this escape the canal is carried round the village of Akeed to its termination at the 50th mile from the head-sluice, where a lock drops boats to tide water in the Uputair.

A canal between the Uputair and Masulipatam via Buntamilly will complete direct water communication between the Godavery and Masulipatam ports.

These works have been just finished. See Proceedings of Government, 6th June 1868.

22. In the last ten miles of its course the water in this canal will be almost still, only a very small quantity being required for the irrigation of the tract between it and the Uputair, 28 to 30,000 having been taken by the Rudrayacodu for the irrigation of the land under it.

23. Taking next in order the Nursapore series; of the 230,000 cubic yards which enter the head of the Karkapurru duct opposite the Chettypet Calingulah, 45,000 will at the VII $\frac{1}{2}$ mile be dropped over the calingulah at the head of the Gostanaddi for the supply of the Bhupiah extension. In this mile-and-a-quarter I propose to enlarge the canal to $\frac{100 + 70}{2} \times 10 = 850$ square feet, (the present section would give a water area of 600 to 700 square feet); the current will, therefore, be as much as 2,430 yards per hour. The canal could not be made wider without considerable extra labour and expense in removal of old banks. Throughout the next eight-and-a-quarter miles from VII $\frac{1}{2}$ to XV $\frac{1}{2}$, the present section would give a water area of from 400 to 600 square feet, which I propose to enlarge to 720 square feet with a depth of 9 feet, so that the current with the mean discharge shall not exceed 2,250 yards per hour. Even with these very considerable enlargements the current will be more rapid than is advisable. In a canal of this size it should not be more than 2,000 yards per hour.

24. Two or three small channels having heads above the XV $\frac{1}{2}$ mile take between them about 8,000 cubic yards per hour, leaving 177,000 delivered at this point at + 30.00, the fall in the nine-and-a-half miles from the head of the canal being 3.8 feet. Here the head of the bank canal takes off, receiving 50,000 cubic yards per hour for the anticipated extended area of irrigation, the acreage at present under paddy crop being some 17,000 acres and the estimated ultimate area being 27,000. This volume of water will be carried for five miles to the first drop, with a waterway $\frac{52+32}{2} \times 6$ to $\frac{58+43}{2} \times 5$ and a fall of two feet in the five miles. The existing channel will here require very considerable enlargement, and, the original excavation having been thrown up close to the channel for a considerable part of the length, the removal of the banks on one side will entail much extra work. The officer who prepared the estimate has, however, over-estimated the earthwork to be done to this reach.

25. The drop at Khandavelly, the fifth mile from head, XXII $\frac{1}{2}$ from Vijaiswarum head-sluice, is thirty feet long, crest level + 25.62, which will serve for the discharge of the 45,000 cubic yards is thirty feet long, crest level + 25.62, which will serve for the discharge of the 45,000 cubic yards to be passed on to the next reach. But the lock here is built too high; its upper sill being laid at + 25.00 would give a depth of only three feet for boats: the lower sill is + 21.0, sufficiently low, so that the tail bay might remain as it is, the front sill and gates only being re-built; but, as it is proposed to throw a bridge for a district road across the tail bay, the estimate provides for building an entirely new lock. In carrying out the work the tail bay foundation walls and sill should be brought into the work if on examination they are found sound and suitable to the new structure. The upper sill will be laid at + 23.00. The next reach receives 45,000 cubic yards of water, which by drafts for irrigation will be reduced to about 27,000 at the end of the reach at the 10th mile, XXVII $\frac{1}{2}$ from Vijaiswarum, where the water is dropped by the Siddhantam Calingulah and lock into what at present is a shallow channel running parallel with the river bank for twelve miles as far as Dodeeputtah. This part of the channel not being well supplied with water and running low is at present of little use for irrigation.

26. It is proposed to extend the channel up to and across the Nakala Drain, and to construct three drops for the regulation of the water for irrigation. At the first of these drops; to be established at the 16 $\frac{1}{2}$ mile near the village of Kodar, there will be a lock which will, with the second additional drop at the 20 $\frac{1}{2}$ mile, add 11 $\frac{1}{2}$ miles of navigation on this line, i. e., up to the large village of Dodeeputtah, XXXVI. miles from Vijaiswarum. The crest of the weir at Siddhantam (10 mile of Bank Canal) being laid at + 24.33, and the water being brought here at + 24.25 the former will have to be lowered to + 21.75, its length being sixteen feet and the water it has to discharge 27,000 cubic yards per hour. The water-surface is here dropped 5 feet to + 19.25, and at the proposed new drop at Kodair will be dropped again from + 18.0 to 13.0.

27. The channel, reduced to a small stream of some 2,500 to 3,000 cubic yards per hour will be passed across the Nakala Drain on the outfall sluice, which is required here for the discharge of drainage and to shut out the river-floods. The water-surface will be held up until it has crossed the drain, and will then be dropped two-and-a-quarter feet to the + 7.25 level and be expended in the irrigation of two or three villages in this neighbourhood which cannot be properly supplied from the Nursapore Canal.

28. Returning to the main canal at the XV $\frac{1}{2}$ mile. A short canal about two-and-a-half miles, between the Bank Canal and the Nursapore Canal, leads to the Mukamala Lock at the head of the Nakala Drain; in connexion with this lock there is a calingulah fifteen feet long, crest at + 27.67. I propose at this point to construct a surplus weir to relieve the heads of the Bank and Nursapore canals of surplus water when in high freshes, and during heavy rains it has not been possible immediately to reduce the delivery at the head, and in the interests of the ryots it is necessary to close irrigation sluices, and so retain in the canals nearly all the water that passes into the head reaches at Peravelly and Khandavelly. The present calingulah would serve for the discharge of about 30 or 35,000 cubic yards per hour, and I propose another of 30 feet length crest at + 26.25, which will make up the total discharge of surplus water to a little over 100,000 cubic yards per hour out of the 175,000. This enlarged escape here, with that at the head of the Gostanaddi and the Chettypet Calingulah, will afford ample means of getting rid of surplus Godavery water.

29. Next, the Nursapore Canal between the XV $\frac{1}{2}$ mile and (Nursapore at) the XXXVIII $\frac{1}{2}$ mile is dropped twenty-six-and-a-quarter feet from + 30 to + 3.75, of which twenty-two-and-a-half feet is by five drops averaging four-and-a-half feet each, the remainder being taken for the fall to give the discharge. I have provided for enlarging this canal where necessary to reduce the current to 1,666 yards per hour, and to deepen it where the depth would be less than six feet. At Peravelly and Itempudi, the first and second drops, entirely new drop calingulahs, will have to be constructed, the old calingulahs being too short and low for the altered circumstances of the canal when conveying the larger volume of water. The first will be 54 feet long with crest at + 26.75 to discharge 100 to 120,000 cubic yards per hour; second, thirty-six feet long at + 21.75 for the discharge of 66 to 80,000 cubic yards per hour. The third and fourth drops at Martair and Kavvitam require only slight alterations to bring them to the proper dimensions and level. The last drop at Palkoli would serve well enough for the discharge of the water which has to be

passed on to the next reach. I have, however, in the estimate, provided for building a new drop here uniform with the other. Bridges will be constructed over all the above drops in communication with the bridges over the lock tail-walls; roadway $12\frac{1}{2}$ feet clear.

30. The locks in this canal are small catcha locks, 100 feet between lift wall and mitre and fifteen feet wide at the gates: they are, moreover, much cracked and damaged, and generally in bad order. I propose, therefore, to construct new locks at the five drops.

31. The tidal lock at Nursapore is 150 feet long and 20 feet wide; the Vijaiswarum head lock, 150 feet long and 15 feet wide; and the Ellore Lock, which connects the Kistna and Godavery navigations, is 150 feet long and 18 feet wide.

32. I propose to make the Nursapore Canal locks 150 feet $\times$ 20 feet, and to build them on what is called the catcha lock plan, * i. e., the sides of the lock chamber lined with dry stone pitching, the front and rear sills, gates, gate-piers, and walls being all exactly as in a pukka lock; but the sides of the chamber for 125 feet on each side being, as above described, retained at a slope of about three-fourths to one by dry stone revetment instead of by masonry walls.

33. The five locks built on this plan will cost about 60,000 Rupees, whereas, with pukka side walls and floors to the chambers, they would cost upwards of 1,10,000 Rupees; where the drop is only from four to five feet (or even under six feet), the catcha plan of lock answers admirably. The objection of greater expenditure of water by lockage and loss of time are practically of but

21,000	22,200
21,600	23,475
22,200	24,835
22,800	25,330
24,800	27,360
1,12,400	1,23,290

little weight—(1), because water has to be passed on for irrigation, and it may as well go through the lock as over the drop calingulah; (2), boats generally travel in batches of three or four, and are locked through by one lockful, so that the only loss of time is that lost in the emptying of the lock. The catcha lock requires about one-third more water to fill it, and the time lost would be something less than that ratio, say ten minutes, instead of seven-and-a-half for emptying the lock, which would amount to only twelve-and-a-half minutes delay on the journey of twelve to fifteen hours from Nursapore to Rajahmundry by passenger boat, or of two to three days by dhony (cargo boat). To save this small delay I do not think it would be right to expend more than half a lac of Rupees extra on the locks of this canal.

I have come to this conclusion at the last moment; the designs and estimates which have been prepared are for pukka locks twenty feet wide at gates, twenty-four feet chambers, designed in accordance with a suggestion thrown out by the Chief Engineer for Irrigation.

34. At Nursapore a lock connects the canal with the Vasista Godavery, here a tidal estuary, the canal water in front of the lock being $+ 3.75$; the drop varies according to tide from five to nine or nine-and-a-half feet. Beyond Nursapore the canal is carried along through a sand ridge to the village of Mogultur near the tidal estuary of the Uputair, with which it was intended to connect it by a tidal lock. This work, which has not yet been carried out, will be of considerable value, especially when the canal between the Uputair and Masulipatam is dug. I have, therefore, included in the estimate the cost of this lock and of enlarging the canal in this reach. A small surplus calingulah will be built in connexion with this lock. The total length from Vijaiswarum head to tide-water at Mogultur will be forty-six miles.

35. We have now to return to the sixth mile, the point of separation of the several main canals. The supply for the Ellore High Level and Uttali canals flow in one channel as far as

Water surface $+ 33.8$.

the $6\frac{1}{2}$ mile, 60,000 being there taken by the latter, the remainder, 95,000 cubic yards per hour, passes on for the former.

36. On this side of the Yerracalwa a lock drops boats from the high level to the Weyairu water (which has been dropped over the Chetty-pet weir, and passed under the High Level Canal. See pp. 16—18). The drop or lift at this lock is twelve to thirteen feet, according to the

state of the supply. This I consider is too great a drop to be worked by one lock, and I recommend that the upper bay of the Nundamoor Lock be re-built with the sill four feet lower than it is at present (i. e., at $+ 21.50$ instead of $+ 25.4$), and that a new catcha lock, with a lift of from four to five feet, upper sill $+ 26.0$, lower sill $+ 21.50$, be built at the head of the lock channel from the main canal, thus breaking the drop into two, one of from four-and-a-half to five feet, the other seven-and-a-half to eight feet. The cost would be between 14,000 and 15,000 Rupees.

The Ellore High Level Canal is passed over the Yerracalwa by an aqueduct forty-two feet clear

with depth of water seven-and-a-half feet on four arches of forty feet span on piers eight feet high. The waterway of the sub-passage is smaller than what I would provide for the discharge of flood-water from an area of 850 square miles. I suppose that the Yerracalwa once in ten or twenty years may bring down at least as much as three millions* of cubic yards per hour, which would require a velocity of about 13,000 yards per hour, through the arches under the aqueduct.

* Perhaps even four millions.

The work has, however, stood the test of ten years, including the cyclone year.

37. The canal having passed the Yerracalwa, flows in one unbroken reach for thirty-eight miles to Ellore, where a lock lifts boats twelve feet up to Kistna water. The surface fall in these thirty-eight miles is about seven feet with the mean supply of water, but is not equally distributed. It varies from 0.34 feet at the head to almost nothing at the end. The canal being carried between banks across drainage hollows and through tanks in these places, the water section is very large and irregular; in some places, however, it requires enlargement. The estimates provide for all that is necessary in this respect, and ample provision for distribution of irrigation is also allowed in the estimate.

Canal surface $+ 33.16$ to $+ 26.16$.
Velocity not to exceed 1750.
Section not less than 300 square feet.
Top width, 7 feet.
Depth $7\frac{1}{2}$ feet at head, 5 feet at end.
See table of Dimensions and Levels.

38. The Uttali Canal, which distributes water for the irrigation of the tract between the Gostanaddi and the Yennamadurru main drain, will, it is expected, ultimately have upwards of 30,000† acres of paddy crop dependent on it; it will, therefore, require some enlargement to enable it to convey the required volume of water at a moderate velocity, and at the required levels sluices have to be provided for the heads of the several branches drawing water from it, and these latter require regulating dams at certain points and numerous little sluices for the delivery of water to the village channels and other minor branches. The Ralinghy branch of this canal requires considerable improvement, its banks being low and weak. At present the head of this canal is still regulated by the rough-stone revetment and dam which was thrown up as a temporary expedient when it was first opened. Over this dam boats are hauled up out of, and shoot down into, the canal. A proper head-sluice‡ and lock are required, and are included in my estimates.

† At present 21,000.

‡ Drop $+ 30.75$, 30 feet long, height of body 4 feet.

39. The only other channels in this delta deserving separate notice are the Booppya, which takes its head from immediately above the first drop of the Nursapore Canal, and the new channel which it is proposed to lead off from the Gostanaddi at Penamuntra for the irrigation of land at present supplied with water by bunding up drainages with very considerable injury to other land which these drainages should relieve of water. Water can be held up in the Gostanaddi above Penamuntara at about $+ 13.5$ without injury by inundation, and with this head the new channel will convey 45,000 cubic yards for the irrigation of the villages at present supplied by the Gostanaddi lower down. kodu, Perinklykodu, Razikodu, and other channels now supplied by the Gostanaddi lower down. The extreme length of this new channel will be eleven miles; it will start with section of 160 square feet 6 feet deep and a current of 2,250 yards per hour; at the $7\frac{1}{2}$ mile it will pass over the new drainage which it is proposed to cut from the Gostanaddi to the Vempa Creek; here its surface will be at $+ 9.00$. The 25,000 cubic yards per hour for the lands beyond this point will be carried over the drain in a shallow aqueduct on cast-iron girders. I propose to leave the head of this channel open, so that boats may use it. The supply will be regulated, and the safety of the channel and of the villages under it secured by means—(1), of the calingulah to be

constructed across the Gostanaddi, the crest of which will be at + 10.5 and 30 feet long, so that, when the shutters are removed, 60,000 cubic yards per hour will be discharged with the water-surface at the head at about + 13.25; and (2), by a surplus calingulah at the 7½ mile (immediately above the aqueduct over the new drain, referred to in the previous paragraph), which I propose to make 20 feet long with crest at + 7.0, which I calculate would keep the channel water surface at this point down to its ordinary level of + 9.0, with from 80 to 90,000 cubic yards per hour flowing in the Gostanaddi above Penumuntra and with the irrigation sluices between the head and surplus calingulah closed.

40. *Western Delta Drainage*.—For drainage purposes this delta may be taken in the following divisions:—

- 1.—The tract between the Bank Canal and the Nursapore Canal.
- 2.— Do. between the Nursapore Canal on the east and the Upper Weyairu and Yenna, madurru Drain on the west, south, and west.
- 3.— Do. between the Undi Canal and the Lower Weyairu, and its extension to the Uputair.
- 4.— Do. between the Weyairu and Colair Lake.
- 5.— Do. between the Venkia and Ellore canals as far west as Oongatore, at the 26th mile on the latter canal.

6.—The long strip of country between the Ellore Canal and the Colair.

41. The Nakala, a natural water-course forming one of the numerous channels in which the Godavery inundation water before the river was embanked collected and flowed either back to the river or direct to the sea, receives the whole of the drainage of this tract, except that from the corner between the Nursapore Canal and its branch, Chinchinada Channel (head at Martair, 26th mile). The Nakala has a capacious channel sufficient for the discharge of the drainage. At its outfall* a sluice is required to keep out the Godavery floods. The area, the drainage from which has to be discharged, is eighty-two square miles. The Nakala has also to carry off the surplus water passed over the Mukamala escape (near Peravelly), which might be as much as 90 or 100,000 cubic yards per hour.

* About seven miles above Nursapore.

42. The sluice which I propose to construct will discharge a maximum of about 540,000 cubic yards per hour. The work is to consist of eight openings of 7½ feet × 5 feet 5 each, with the sills at + 0.5 closed by shutters raised and lowered by screws; below these eight upper vents are double the number of smaller vents fitted with flap shutters opening outwards. The river here rises to about + 10.5 on extraordinary floods. Of course, no drainage can be discharged while the river is in flood; but it seldom happens that heavy rain falls when the great river-freshes come down. For the corner between the Chinchinada Channel and the Nursapore Canal three or four small drainage cuts through old Madagus, and avas are required the outfall of this drainage (near the Nursapore Lock) is already provided with a sluice to keep out river-floods.

43. In the second drainage division of the delta, the Gontair and Gostanaddi are the two main drains, both of them natural water-courses: the former has its outfall by the Vempa Creek into the estuary of the Uputair near Mogultur, the latter at present flows into the Yennamadurru main drain.

44. When the Yennamadurru Drain is flowing full, it backs up into the Gostanaddi, inundating the lands of many villages in the angle between the two. Mr. Rundall, the Executive Engineer of this range, proposes to cut a channel from the Gostanaddi near Vendra to the Gontair at Viravasaram and thus give the former a free outfall, its present outfall into the Yennamadurru to be closed altogether. I believe that this will be found the best plan to adopt, except that, instead of closing the outfall to the Yennamadurru Drain altogether, it will, I think, be better to construct a sluice here similar to that for the outfall of the Nakala, but of smaller dimensions, say eight openings 6 feet × 5 feet each, and without the small vents below.

To carry the whole of the Gostanaddi drainage to the Gontair outfall would involve a very heavy and expensive bit of earthwork; and, as the great floods in the Yennamadurru are not of frequent occurrence and do not always happen when heavy rain is falling on the Gostanaddi tract,

the Yennamadurru outfall would probably, in three out of four seasons, be of great service in quickly relieving the land of floods.

45. The new drainage cut at its head from the Gostanaddi will pass under the new channel described in paragraph 39. I have provided three bays, each 15 feet × 6 feet, the floors of the openings being laid at + 0.0. The cut will be 50 (at 0 mile) to 60 feet (at 6 mile) wide at bottom; the banks to be 120 feet apart between toes of inner slopes; the bed to be carried down to + 0.0 at the 0 mile, and to 2.0 at the 6 mile, where it joins the Gontair Drain. Beyond this to the outfall at the 15th mile the bed to have a fall of one foot only in the whole distance. In the last nine miles the flood-water in the drain will be from 0 to 3, and in some places even 4 feet above the ground, and the work will be chiefly embanking, the excavation in the lower parts being taken out in two parallel cuts, banks 250 feet apart from the 6th to 9th mile, where the Buggeswerum Drain falls in, 375 feet apart from the 9th to 12th mile, 500 feet apart from 12 feet to 15th mile, from the 15th mile to the Mogultur Lock one bank on the left side only. At the junction of the new cut with the Gontair the banks will be carried up the latter on each side, and similarly at the Buggeswerum in full. Several small inlets for local drainage will be required in the left bank in the first six miles (simple wings and sills with shutters); drainage channels outside the banks will carry on the local drainage to be dropped in at convenient points.

46. The area drained by the above channels are—

Gostanaddi	...	...	...	...	75 square miles.
Gontair above Viravasaram	...	...	...	...	45 "
Do. below and Buggeswerum in fall	...	...	...	...	35 "

Total ... 155 "

With the Gostanaddi surface at Vendra kept down to + 7.25, the water areas in the new cut from Vendra to Viravasaram will be 400 to 500 square feet, depth 7 feet to 5½ feet; between the 6th and 9th mile, 1,000 to 1,500 (except about a quarter of a mile through a high dibba, where the area will be 800 square feet); beyond the 9th mile, from 1,500 to 1,800 square feet: surface fall 3¼ feet in the first six miles, one foot from 6th to 9th mile, one-and-a-half feet from 9th to 15th, leaving upwards of two feet fall to the sea-level (H. T. Sp.) in the estuary

+ 7.15 — 0 mile.	120,000 cubic yards per hour.
+ 3.38 — 6 mile.	200,000.
+ 2.37 — 9 mile.	250,000.
+ 1.62 — 12 mile.	250,000.
+ 0.87 — 15 mile.	300,000.
— 1.50 — 22 mile.	"

of the Uputair, seven miles distant. The above areas of waterway sound large; but, with the above dimensions, the channel will not discharge more than 300,000 cubic yards at high tide, at low tide perhaps 500,000.

47. The tract between the Undi Channel and the Weyairu is drained partly by a channel passing under the former at Undi. A catch-water drain running parallel with the Weyairu (where the latter is embanked, Koovidee downwards) communicates with this channel. The upper part of the tract drains into the Weyairu, where the latter is in soil above Koovidee. Another catch-water drain outside the Rudrayacodu has lately been dug in connexion with the Akeed Canal, and has its outfall in a salt creek near Dodanapudi. The Bondada outfall of the drain under the Undi Channel requires enlargement.

48. The fourth tract between the Weyairu and the Colair Lake is divided by the Chinakapaverum Channel into two parts, that on the east of that channel draining into the Weyairu above Koovidee and by a catch-water drain parallel to the embanked Weyairu into the last reach of the Weyairu below the Chinakapaverum Lock; the lands on the west of the above channel drain into the Colair by numerous old kodus and natural channels.

49. The fifth tract between the Venkia and Ellore canals is a difficult one to drain thoroughly. There are many square miles of ground here only six to eight feet above sea-level, and this upwards of twenty-five miles from the sea and fifteen to eighteen from the tidal stream in the Uputair. The drainage to be provided for is what is passed across the Ellore Canal between the 18th and 26th miles, besides that of the local rainfall on the tract of country between

the first 18 (VIII. to XXVI.) miles of the Ellore Canal, the Weyairu and Venkia, the Chinakapaverum Channel, and the Pundikodu; this tract contains some seventy square miles. The area of uplands, the drainage from which passes under the Ellore Canal between the 18th and 26th, is about sixty square miles. The uplands drainage I propose to divert by a cut and bank from opposite the under-tunnel at the 19th mile near the Oppakapad village skirting the Bonmidce and Kigurpad tanks, through two long madagus or shallow reservoirs into the Colair near Tokalapilly; this will also cut off the drainage from about fifteen square miles of country below the Ellore Canal. At present the drainage from these seventy-five square miles flows at right angles to the Ellore Canal into the low tract of country between Vipparru, Ratsur, and Nindrakoll, and, once there, it cannot be got rid of; a very large area of land is thus rendered unproductive of anything except fever. The old native irrigation works tend to aggravate the evil: they consisted of banks constructed to catch in long broad shallow sheets the Godavery inundation water brought to this part of the delta by the old Weyairu. These banks here and elsewhere throughout the delta should be rendered harmless by deep permanent cuts. There is already one cut of this kind which was carried out some years ago by Captain Beckley, but has since been tampered with by interested villages. I have provided for enlarging and deepening it, and for carrying its head further back into the tract to be drained. This cut will carry the drainage of some eighteen square miles of country into the Pundikodu, which I propose to make the main outfall into the Colair.

50. Of the remaining forty square miles, about one-fourth in the angle to the east of the road from Duvva to Pruttipad will be drained by the Weyairu, which is there in soil; the other thirty square miles being below the level of the Venkia (Weyairu) water will be drained partly by a tunnel under the Chinakapaverum Channel into the Lower Weyairu below the Peramulla Lock and partly by the Pundikodu into the Colair.

The drainage works for this tract will then be as follows:—

1st.—Catch-water cut and bank from near Oppakapad to the Colair opposite Tokalapilly for diversion of uplands drainage (nine miles) section from to 60 to 120 square feet.

2nd.—Enlarging Beckley's cut (three miles flood-water to be 225 square feet and continuing it back 2½ miles fifty-four square feet for bank) with bank on left side to the Pantikara surplus calingulah

3rd.—Drain outside right bank of the Venkia Canal and Chinakapaverum Channel (A. B. on drawing) to outfall by under-tunnel (five vents each 10 feet $\times$ 3½ feet sill at + 3.0) to the lower reach of Weyairu.

4th.—Cut in continuation along Chinakapaverum Channel to Pundikodu.

5th.—Enlarging the Pundikodu (making it 250 to 300 square feet) to the in-fall of Beckley's drain, and thence (450 to 360 square feet) to outfall into Colair.

51. The level of the surface of the Colair Lake, when at the ordinary low level, is + 1.50 (the Cotuda Calingulah shutters having been removed); but during an ordinary rainy season the surface would be as high as + 3.0 for many days together. I have, therefore, taken this latter level as my datum for the level of drains falling into this lake. But in exceptional years of heavy rainfall within limited periods the surface would no doubt rise to + 5.0, or even higher than that, choking the outfalls of our drainages and causing injurious inundations of the low lands above referred to, besides flooding a broad margin all round the lake; and these inundations would not be of short duration, as the lake, when once filled to the above high level, would take a long time to empty by its insufficient outlet at Cotuda. To remedy this state of things very costly works would be required. I have not attempted, with the limited time at my disposal for the preparation of this report, to go fully into the question. A plan was, I believe, submitted for the consideration of Government by the late Colonel Winscom for carrying the flood-waters of the Budmair and Tummalair, the two principal feeders of the Colair, across the lake between high banks; in this case our local drainages would be carried outside these banks to Cotuda, and be discharged separately into the Uputair. If the floods were carried thus direct to the Uputair, that river, for at least six or eight miles of its course, would have to be very strongly embanked.

52. If the feeding streams be allowed to spread over the lake as at present, and the flood surface is to be kept down to + 3.0 or not to exceed that height for more than a couple of days, the outfall calingulah or the set of tidal sluices which would be required at Cotuda would have to be given a discharging power far greater than that of the present work (300 feet long at + 0.0.) The lake receives the drainage of upwards of 1,400 square miles, and between + 0.0 and + 3.0 its storage capacity does not exceed 320 million cubic yards.

53. The last division of this delta, with reference to drainage, is the long strip between the Ellore and the Colair Lake; here there is nothing to interfere with the direct drainage of each square mile straight to the Colair. The drainage of the uplands across the Ellore Canal has been fully provided for (see Proceedings of Government, dated August 1865), the works referred to in these Proceedings having been all completed, except the additional under-tunnel at Bhimadole, which is now being built.

54. Of course, this thorough provision for cross drainage throws water in larger quantities and at a quicker rate into the tract below the canal; but, so long as the embanked tail-races of Colair is not filled by extraordinary rains, there need be no difficulty; the embanked tail-races of the under-tunnels should be carried on further towards the Colair. This should be treated as part of the cross drainage project above alluded to as nearly complete. The improvement required here is the reduction of the Colair surface to a permanent low level.

55. The last work to be noticed in this delta is one of the first importance, viz., the embanked channel, which is called the Yennamadurru main drain, a misnomer, for it does not drain the delta, but conveys across it the flood-water of the Yerracalwa, a river which drains some 850 square miles of hill and jungle.

56. In paragraph 18 I described how the channel of this river is used for canal purposes between the Nundamoor Aqueduct and Duvva, and how at the latter place the flood-waters are passed over a weir. This weir is 300 feet long, crest at + 16.4, ground here about + 23.0. With the water-surface above the weir at + 22.50, the banks of the Venkia Canal would be in serious danger, even with the irrigation sluices open as well as the escapes; * if the flood rose to + 23.00, the Venkia would be breached, with enormous damage done to crops and villages.

57. At the former level I estimate the discharge over the Duvva weir would be about 1½ millions of cubic yards per hour. The Venkia, by means of its sluices and escapes, would get rid of about 300,000 cubic yards, together a little over two millions of cubic yards per hour for the flood drainage of 850 square miles. Some day no doubt three millions of cubic yards per hour will flow down the Yerracalwa, and destroy the Venkia Canal and the villages, under it.

58. But, supposing the length of the weir be doubled and three millions per hour passed over it without the slightest risk to the Venkia, this enormous volume of water has to be carried bodily through the delta for thirty miles, and for two-thirds of the distance from 0 to 3 feet above the level of the country. The total fall available for the thirty miles is about twenty feet; a river of 7,500 square feet waterway 10 feet deep would, therefore, be barely sufficient to ensure safety. The waterway provided is now here more than one-third of this area; the average is about one-fifth. The three millions per hour will, therefore (when it comes), burst the banks and cause great ruin in the delta.

59. The construction of the tank alluded to in paragraph 6 of the Chief Engineer's report, dated 11th December last (in Proceedings, 27th January 1869), would secure us from this danger, or rather this deferred certainty. Its cost would be considerably less than that of making the drain sufficiently big; and it would besides pay for itself, and give this Western Delta the great advantages of a dry weather supply.†

† One million cubic yards per diem at the end of February to four millions per diem in June.

60. For the present I have provided in my estimates for strengthening the banks of the drain throughout. When the tank above referred to has been constructed and the floods brought down by the Yerracalwa reduced to a manageable volume, the floods of the Ralli Madugu, which falls into the main duct midway between Vijaiswarum and Chettypet, should be carried direct to the channel which carries the Chettypet weir water to the Yerracalwa. I have sketched out a plan for this diversion; but have not included it in the works now proposed, as I think that it should not be carried out until after the construction of the Unnamoolunkah Tank. The Ralli Madugu drains (about 280 square miles) the strip of country between the hills and the Godavery; a small portion of the drainage at the upper end of the catchment basin might be cut off and turned into the Godavery through an outfall protected by a sluice.

The principal lines of water communication are—
Western Delta Range.

- 1.—The Nursapore Canal.
- 2.—The Ellore Canal.
- 3.—The Venkia, Weyairu, and Akeed Canals.

As already stated, I propose a complete set of new locks for the Nursapore Canal, and I recommend (but have not provided in my estimate for) an additional lock above the head-lock of the Venkia and Weyairu navigation. It is proposed to extend the Nursapore Canal seven-and-a-half miles, and to connect it with the Uputair navigation by means of a lock in the neighbourhood of Mogultur. One more under-tunnel for passing drainage under the Ellore Canal has to be built, (it is now in hand.)

The second class canals are—

- 1.—The Bank Canal.
- 2.—The Uttali Channel.
- 3.—The Gostanaddi.

The first, as already stated, requires considerable improvement, enlargement of the first reach, re-building the head-lock, and an additional lock to break the canal into four reaches. The second requires a head lock.

The third* will be made a better navigation by using it to convey the supply for the new channel described in paragraph 39. The

*Gostanaddi.

drain between the Gostanaddi and the Gontair and on to the tidal creek at Mogultur will have its bed so low that there will always be water in it, so that it will be available for light draft boats; and it will perhaps be found worth while to connect this navigable drainage with the Gostanaddi and main duct, by a small lock at the 7½ of the new channel of the same dimensions as that at the head of the Gostanaddi, i.e., 60' × 12'; it would cost about 7,500 Rupees. The Undi Canal should be connected with the Venkia by a catcha lock 100' × 15'; the lift† will be from two to five feet, and at the other end by a similar lock with a drop of about four‡ feet with the Akeed Canal.

†Venkia + 16 to + 18,
Undi + 13 to + 16;
‡ + 9.25 Undi.
+ 5.25 Akeed.

APPENDIX No. 2.

Statement showing the amount of present Estimates for the Western Delta Completion Project compared with Captain Ryves' Estimates.

Names of Channels.	Captain Ryves' Estimate.	Present Estimate.	Brief reasons for differences.
	RS.	RS.	
Head-sluice Shutters. ...	19,500	19,500	
Main Duct, 8 miles... ..	48,000	49,000	Due to allowance having been made for the purchase of land.
Karkapurru Canal	47,000	33,000	Section of channel has been reduced.
Nursapore Canal	1,76,070	2,09,600	Excess due to extra cost of pukka locks.
Bank Canal	70,110	1,29,460	Excess due to extra cost of pukka locks and to extra lock to connect channel with tide water.
Venkia and Weyairu	18,000	11,960	As Captain Ryves' detailed estimate for this channel was not found amongst the papers sent, I cannot say whence the difference arises.
Undi High Level	61,700	1,10,700	Due to extra cost of locks.
Uttali Canal	58,070	78,800	Do. do.
Gostanaddi and Velpur	68,300	1,41,060	Do. do. and to extra cost of earthwork also.
Ellore Canal	1,14,000	2,49,500	This has been included in the Bank Canal.
Mukamala Surplus Calingulah	9,500		
Drainage.			
Nakala	14,000	11,000	This Rupees 11,000 is for the drainage sluice. Captain Ryves' detailed estimate was not amongst the papers sent to me.
Gostanaddi Outfall and Sluice.	88,000	91,900	This increase is due to a sluice at junction of Gostanaddi being included. Included in Ellore Canal estimates.
Drainage works at Peramulla including Ellore drainage.	79,000	28,800	The item in my estimates includes only those works belonging to this range.
Yennamadurru	28,200	18,320	An extra allowance for sluices has been made.
Drain west of Nursapore	16,500	11,550	Do. for two bridges has been made.
Bondada and Rudrayacodu... ..	13,500	5,760	
Caza Drain	5,750	6,050	
Buggesweram Drain		4,840	
Minor drainages		72,500	
Navigation Canal by Low Level Channel to Weyairu.		29,000	
Rest-houses on Overseer's sheds			
Total...	9,35,200	13,12,300	

NURSAPORE,
31st May 1870.

(Signed) J. W. RUNDALL,
Executive Engineer.
(Signed) J. F. FISCHER, Major, R. E.,
Acting Suptg. Engr., 1st Division.

APPENDIX No. 3.

Statement showing the Irrigation Area for first Crop in the Western Delta Range from Fuslies 1275 to 1279.

Names of Canals.	AREA IRRIGATED						Average of four years Cultivation of 1279 ... Increase... 13,944
	In Fusly 1275.	In Fusly 1276.	In Fusly 1277.	In Fusly 1278.	In Fusly 1279.		
I.—Karkarapurru Canal.							
1. Gostanaddi and Velpur	...	...	...	...	...	...	199,486
2. Bank Canal, including Mukamala Canal	...	...	...	...	...	...	213,430
3. Bhupiah Canal	...	...	...	...	...	...	...
4. Nursapore Canal	...	...	...	...	...	...	...
5. Minor branches	...	...	...	...	...	...	...
II.—Venkia and Weyairu.							
1. Minor branches above Peramulla	...	...	...	...	...	...	...
2. Undi High Level Channel	...	...	...	...	...	...	...
3. Chinakapaverum Channel	...	...	...	...	...	...	...
4. Weyairu	...	...	...	...	...	...	...
III.—Ellore Canal.							
1. Uttali Channel	...	...	...	...	...	...	...
2. Ellore Canal	...	...	...	...	...	...	...
Total...	...	...	...	...	...	...	...

A portion of the area now irrigated by Weyairu will, when new works are carried out, be supplied from Undi High Level Canal.

The area under Ellore Canal for Fusly 1279 is approximate, the Irrigation Register not having been completed in No. IV.

* As the detailed registers of the branches of Weyairu is not found, the totals under the whole Weyairu, including branches, is entered against it.

NURSAPORE,
31st May 1870.

(Signed) J. W. RUNDALL,
Executive Engineer.
(Signed) J. F. FISCHER, Major, R. E.,
Acting Suptg. Engr., 1st Division.

Done 75

A.

Statement showing the area of Land now irrigated, as well as the increase expected under each Canal in the Western Delta, Godavery District.

Canals.	AS PER EXECUTIVE ENGINEER.		AS PER REVENUE AUTHORITY.		Remarks.
	Non-irrigated.	Increase expected.	Non-irrigated.	Increase expected.	
Nursapore Canal, including branches of Mukamala and Karkarapurru Channels ...	47,102	12,454	*2,43,186	17,381	* This includes Mamul Pullum, which pay no water-tax.
Venkia and Weyairu ...	39,919	— 1,929		4,900	
Undi High Level Channel ...	34,550	24,379		19,285	
Uttali Canal ...	24,621	11,241		11,969	
Bank Canal ...	13,587	8,252		8,107	
Velpur and Gostanaddi ...	28,521	6,257		9,379	
Yennamadurru Drain ...	1,496				
Total...	189,796	60,654	243,186	71,021	

DOWLAISHWERAM,
19th September 1870.
(Signed) J. F. FISCHER, Major, R. E.,
Acting Suptg. Engr., 1st Division.

B.

Statement showing the area of Land irrigated during the Fusly 1279 as well as the revenue and water-rate in the Western Delta Range.

	Land irrigated in Fusly 1279.	Revenue.	Water rate.
Nursapore	66,682	193,481	273,645
Tanuku	74,570	141,315	296,842
Bhimaverum	101,936	241,494	244,404
Total...	243,186	576,290	814,891

DOWLAISHWERAM,
19th September 1870.
(Signed) J. F. FISCHER, Major, R. E.,
Acting Suptg. Engr., 1st Division.

APPENDIX

Statement of Water Distribution,

Names of Channels.	POSITIONS.			DISTANCES FROM HEAD OF CHANNEL.			AREA.		FALL OR SLOPE PER MILE.		Maximum depth.	ORDIN	
	M.	F.	Y.	M.	F.	Y.	Commanded.	Supply provided for.	Bed.	Surface.		Depth.	Area of cross section.
Main Canal ...	...	...	...	...	...	...	Acres. 480,000	Acres. 294,000	Irre- gular.	4"	18' 0"	This channel is in sections, and falls sections, the fol mate only. 9' 2,100	
Karkarapurru.	6	0	0	...	...	...	400 Sq. M. × 500 = 200,000 acres.	1,21,500	5"	5"	9' 0"	9' 0"	760½
Venkia and Weyairu.	6	0	0	...	...	...	300 Sq. M. × 500 = 150,000 acres.	90,400	...	...	6' 0"	An old channel larger than re tity of water re also Yerraculwa	
Ellore Canal...	6	0	0	...	...	...		...	...	...	...	...	..
I. Gostanaddi and Velpur.	7	2	0	...	...	...	100 Sq. M. × 500 = 50,000 acres.	36,200	...	...	...	...	...
				18	0	0	...	...	...	...	...	...	...
				19	6	0	...	...	...	...	...	...	...
				20	0	0	...	...	...	...	...	...	...
				20	6	0	...	...	...	...	...	...	...
				20	6	0	...	...	...	...	...	...	...
				21	0	0	...	...	...	...	...	...	...
				21	0	0	...	...	...	...	...	...	...
				21	0	0	...	...	...	...	...	...	...
				21	0	0	...	...	...	...	...	...	...
				24	0	0	...	...	...	...	...	...	...
				25	4	0	...	...	...	...	...	...	...
				29	6	110	...	...	...	...	...	...	...
				29	6	0	...	...	...	...	...	...	...
				30	2	0	...	...	...	...	...	...	...
				31	2	0	...	...	...	...	...	...	...
				32	0	0	...	...	...	...	...	...	...
II. Bank Canal	14	6	0	0	2	0	120 Sq. M. × 500 = 60,000 acres.	23,800	5"	5"	6'	6'	204
				0	2	0	...	...	...	...	...	...	...
				4	0	0	...	...	...	...	...	...	...
				5	0	0	...	...	...	...	...	...	...
				6	6	0	...	...	...	...	...	...	...
				8	4	0	...	...	...	...	...	...	...
				9	0	0	...	...	...	...	...	...	...
				9	2	0	...	...	...	...	...	...	...
				9	6	0	...	...	...	...	...	...	...
				10	0	0	...	...	...	...	...	...	...
				11	4	0	...	...	...	...	...	...	...
				12	4	0	...	...	...	...	...	...	...

No. 4.

Western Delta, Godavery.

ARY FULL SUPPLY.			DISTRIBUTION OF WATER TO BRANCHES.		Acreage.	Remarks.
Mean velocity in feet per second.	Discharge in cubic yards per hour.	Discharge in cubic feet per second.	Branches.	Quantity. Cubic yards per hour. Cubic feet per second.		
three branches of varying as shown in the plans and following entries are approximate.			I. Kakarapurru Canal ...	220,000 1,650	122,500	
			II. Venkia and Weyairu ...	150,000 1,125	91,400	
			III. Ellore Canal ...	156,000 1,170	82,400	
1.85 5,26,000 3,825				526,000 3,945	296,300	
2.16 2,19,058 1,642½			I. Gostanaddi and Velpur ...	60,000 450	36,200	
			II. Bank Canal ...	45,000 337½	23,800	
			III. Bhupiah ...	4,000 30	2,500	
			IV. Nursapore Canal ...	102,000 765	54,000	
			V. Minor branches ...	9,000 67½	6,000	
				220,000 1,650	122,500	
of irregular section, much required for carrying the quantity for irrigation. Carries flood water.			I. Minor branches above Peramulla ...	7,000 52½	5,000	
			II. Undi High Level Canal ...	100,000 750	58,900	
			III. Chinakapaverum Channel ...	23,000 172½	16,000	
			IV. Weiyaru ...	20,000 150	11,500	
				150,000 1,125	91,400	
			I. Uttali Channel ...	*60,000 450	34,200	* Should be 65,000
			II. Ellore Canal ...	*96,000 720	48,200	Do. 91,000
				156,000 1,170	82,400	
			Mallipudi ...	700 5½	400	
			China Pydava ...	200 1½	140	
			Poda do. ...	500 3½	300	In first reach above Pennamuntra Lock
			Batlamugutur ...	1,000 7½	600	
			Nelapogula ...	1,350 10½	800	
			Cothulagundam ...	1,350 10½	800	
			New branch to Andalur ...	1,550 11½	960	
			Direct from 14 to 21 miles ...	75 5½	5,800	
			Eastern Velpur or Konitivada Branch ...	10,000 75	5,800	
			Siddirazukodu ...	1,700 12½	1,000	
			Tolair Channel ...	2,000 15	1,200	
			Direct from 21 to 29½ miles ...	1,350 10½	800	
			Viravasaram West Side ...	9,000 67½	5,400	
			Adivicodu ...	82½ 6,600	6,600	
			Thallukodu ...	11,000 7½	600	
			Ferranghykodu ...	1,000 7½	1,800	
			Razukodu ...	3,000 22½	1,800	
			Direct from 29½ to 32 ...	11,800 88½	7,500	
				1,150 8½	700	
				60,000 450	36,200	
			Mukamala Canal ...	5,000 37½	3,000	
			Do. Branch ...	750 5½	600	In first reach.
			Khandavelly Parallel ...	1,250 9½	800	
			Vemavaram ...	1,500 11½	1,000	
			Asanta ...	6,000 45	4,000	In second reach.
			Siddhantam ...	300 2½	200	
			Duvva ...	2,350 17½	2,350	
			Iluparuru ...	3,500 26½	450	
			Parallel Channel ...	700 5½	2,100	
			Jagguraju Channel ...	3,000 22½	2,400	
			Kodamanchilly ...	2,500 18½	3,200	
			Parallel Channel ...	5,000 37½	1,400	
			Direct in 8rd reach ...	2,000 15	600	
			Dodesputtah Channel...	1,000 7½	1,800	
				3,000 22½	1,800	
			Extra to make channel navigable	36,500 268	23,800	
				8,500 64	23,800	
				45,000 337½	23,800	

APPENDIX
Statement of Water Distribution,

Statement of Water Distribution.													
Names of Channels.	POSITIONS.			DISTANCES FROM HEAD OF CHANNEL.			AREA.		FALL OR SLOPE PER MILE.		Maximum depth.	ORDIN	
	M.	F.	Y.	M.	F.	Y.	Commanded.	Supply provided for.	Bed.	Surface.		Depth.	Area of cross section.
III. Nursapore Canal.	16	2	0	1	4	0	160 Sq. M. × 500 = 80,000 acres.	55,000	1"	5"	7½	7½	400
				3	6	0							
				5	2	0							
				6	2	0							
				7	6	0							
				9	2	0							
				9	2	0							
				9	2	0							
				12	3	0							
				12	4	0							
				16	0	0							
				17	1	0							
				17	1	0							
				20	6	0							
				21	2	0							
				23	4	0							

APPENDIX No. 4—
Statement of Water Distribution,

Names of Channels.	POSITIONS.			DISTANCES FROM HEAD OF CHANNEL.			AREA.		FALL OR SLOPE PER MILE.		Maximum depth.	ORDI						
	M.	F.	Y..	M.	F.	Y.	Commanded.	Supply provided for.	Bed.	Surface.		Depth.	Area of cross section.					
Weyairu below Peramulla.	20	6	0	37	0	0	Acres.	Acres.				An old channel of discharging						
				37	6	0		...	...	...								
				41	0	0		...	...	...								
				41	3	0		...	...	...								
				41	4	0		...	...	...								
				42	0	0		...	...	...								
				42	6	0		...	...	...								
				46	0	0		...	...	...								
Uttalli Channel.	6	6	0	0	2	0	90 Sq. M.	3,400	4"	4"	6'	6'	276					
				2	6	0	× 500 =	...	...	...	...							
				4	0	0	45,000 acres.	...	...	...	...							
				7	6	0		...	...	...	...							
				10	4	0		...	...	...	...							
				11	0	0		...	...	...	...							
				11	4	0		...	...	...	...							
				13	4	0		...	...	...	...							
				14	4	0		...	...	...	...							
				15	7	0		...	...	...	...							

NURSAPORE,
31st May 1870.

(Concluded.)
Western Delta, Godavery—(Concluded.)

NARY FULL SUPPLY.			DISTRIBUTION OF WATERS TO BRANCHES.		Acreage.	Remarks.
Mean velocity in feet per second.	Dis-charge in cubic yards per hour.	Dis-charge in cubic feet per second.	Branches.	Quantity. Cubic yards per hour. Cubic feet per second.		
of irregular section capable of a large body of water.	...	...	Kollaparru Channel ...	6,000	45	3,600
			Gummular do. ...	1,000	7½	600
			Mathivada do. ...	1,600	12	900
			Ajamur do. ...	2,400	18	1,400
			Akeed do. ...	300	2½	150
			Dampagadapa do. ...	1,000	7½	600
			Cherukumilly do. ...	5,000	37½	2,500
			Yelurpad do. ...	1,700	12½	1,050
			Minor sluices and direct	1,000	7½	700
				20,900		11,500
1.54	60,319	450	West Parallel Channel	3,600	27	1,750
			Satyavadu	1,400	10½	700
			Duvva do.	8,000	60	4,500
			Tetali do.	2,000	15	1,300
			Rameswaram	2,800	17½	1,400
			Relanghy Main Branch	15,000	112½	8,750
			Mayyairu	5,000	37½	3,000
			Vuradalapalem	1,600	12	1,000
			Direct in 4 to 13½ miles	3,100	23½	2,200
			Kesamudram	2,500	18½	1,500
...	...	...	Direct	5,500	41½	2,900
			Manchilly...	4,000	30	2,200
			Comarra Channel	6,000	45	3,000
				60,000		34,200

(Signed) J. W. RUNDALL,
Executive Engineer.
(Signed) J. F. FISCHER, Major, R. E.,
Acting Supp. Engr., 1st Division.

APPENDIX No. 5.

Abstract Statement of Expenditure incurred on the Western Delta Completion Project
Works up to March 1870, forwarded as called for in the Superintending Engineer's
Circular Memorandum, No. 3,652, dated 18th January 1870.

Description of Works.	Amount of Estimate.	Expenditure.	Total expenditure on each Canal.	Remarks of the work done against expenditure.
	RS.	RS. A. P.	RS. A. P.	
<i>Drainage Works under Ellore Canal which belong to this Range.</i>				
Aqueduct under Chinakapaverum Channel near Peramulla.	11,560	10,866 4 10		Completed.
Regulator and Bar across drains.	1,100	972 2 2		Do.
Tail Race Embanking Channel, etc.	9,010	8,911 5 0		Do.
Re-building Peramulla Channel Sluice.	320	278 1 4		Do.
Drains below Peramulla Aqueduct.	9,195	8,886 8 1		Do.
Do. from near Bodapad ...	4,510	4,404 6 1		Do.
Bridge and Drop opposite Chillacampad Ferry.	1,305	887 6 4		Built up to springings, and arch turned; parapet wings and apron to be finished.
Expenditure in No. 4, Range Budget item No. 146.		56,531 0 0		
<i>Nursapore Canal.</i>			91,737 1 10	
Constructing Peravelly Weir.	6,640	5,586 14 0		Completed.
Do. Itempudi do.	5,070	4,889 1 3		Do.
Do. Lock at Peravelly.	21,390	280 1 2		Materials collected.
Do. at Itempudi...	21,640	3,204 10 9		Do.
Manufacture of bricks at Peravelly.		177 8 9		
Sluice at head of Peravelly West Side Channel.		165 3 6		Completed.
Improving Madapad Channel.		772 6 3		Madapad Channel finished.
Do. Gontair Irrigation Channel.		1,098 4 6		Gontair Channel earthwork finished.
Lutchmeswarum Channel and Sluice at its head.		474 3 1		Lutchmeswarum Channel three-fourths done, and sluice built.
<i>Bank Canal.</i>			16,648 5 3	
Bricks collected at Khandavelly.		357 11 6		
Drainage Tunnel under Duvva Channel.	750	811 5 5	1,169 0 11	Completed, except coping. Materials of about Rupees 104 remaining, which can be transferred to other works.
<i>Venkia and Weyairu.</i>				
Escape in Venkia Canal ...	1,500	1,381 3 10	1,381 3 10	Completed.
<i>Uttali Canal.</i>				
Constructing Lock at Godicherla.	16,230	1,443 6 0	1,443 6 0	Materials collected.

Minor improvements to existing channels, Estimate Rupees 26,010.

Abstract Statement of Expenditure incurred on the Western Delta Completion Project
Works up to March 1870, etc.—(Concluded.)

Description of Works.	Amount of Estimate.	Expenditure.	Total expenditure on each Canal.	Remarks of the work done against expenditure.
	RS.	RS. A. P.	RS. A. P.	
<i>Gostanaddi and Velpur.</i>				Completed.
Constructing under-tunnel at Rayacuduru.	750	559 12 10		
Do. do. at Madugupolarem.	750	360 15 0		Materials collected; concrete put in foundations.
Manufacture of bricks at Juttiga and Penmuntra.		279 8 3	1,200 4 1	
<i>Drain west of Nursapore Canal.</i>	18,320	6,047 11 7	6,047 11 7	Earthwork, quarter, done; bridges not commenced.
<i>Minor Drainages.</i>				Outfall improved.
Caza Drain ...	5,760	310 3 2		Do.
Deepening old Drainage Channel from Rayacuduru Tunnel.	430	354 2 7	664 5 9	
Total...			1,20,291 7 3	

NURSAPORE,
17th June 1870.

(Signed) J. W. RUNDALL,
Executive Engineer.

(True Copy.)
(Signed) J. F. FISCHER, Major, R. E.,
Acting Supt. Engr., 1st Division.

APPENDIX No. 6.
GODAVERY DISTRICT—WESTERN DELTA RANGE.
Abstract Estimate for the Western Section of the Godavery Delta.

No.	Names of Canals and Drains.	EARTHWORK.		MASONRY WORKS.		MINOR MASONRY WORKS.		MINOR CHANNELS.		COMPENSATION FOR LAND, ETC.		TOTAL.		DESCRIPTIVE TOTALS FOR NAVIGATION AND IRRIGATION.				Grand Total.
		Canal.	Drain.	Canal.	Drain.	Canal.	Drain.	Canal.	Drain.	Canal.	Drain.	Canal.	Drain.	Canal.	Drain.	Canal.	Drain.	
1	Canals.																	RS.
2	Main Duc: a d Head-slucce ...	49,000	...	19,500	...	...	...	...	...	...	...	...	...	...	...	...	...	68,500
3	Arkarapurru Canal	31,000	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	33,000
4	Nursapure do.	18,500	...	1,61,380	...	12,235	...	13,715	...	3,820	...	2,09,600	...	1,40,490	...	69,110	...	2,09,000
5	Bank do.	22,500	...	74,875	...	1,195	...	4,980	...	2,500	...	1,06,050	...	63,500	...	42,550	...	1,07,900
6	Venkia and Weyyuru Irriga- tion	4,350	...	7,610	...	...	...	...	...	...	...	11,960	...	...	...	...	...	11,960
7	Undi High Level Canal	26,600	...	29,160	...	8,200	...	12,150	...	4,990	...	81,100	...	14,510	...	66,590	...	1,10,700
8	Uruli Canal	23,510	...	42,700	...	8,920	...	6,270	...	4,500	...	86,000	...	31,700	...	54,300	...	86,000
	Gostanaddi and Velpur Chan- nel	64,000	...	68,080	...	3,230	...	...	...	5,750	...	1,41,060	...	32,780	...	1,08,280	...	1,41,060
Drainages.																		
9	Nakala Drain	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	13,200
10	Gostanaddi Outfall and Sluice.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	94,000
11	Yenamadurra Drain Im- provements	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	28,800
12	Bondada and Rudrayacodu ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	11,550
13	Carra Drain	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	5,760
14	Buggeswerum Drain	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	6,050
15	Minor Drainages	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	4,840
16	Drain west of Nursapure Canal	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	18,320
17	Ellore Canal	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1,03,640
18	Navigation Canal by Low Level Channel to Weyyuru.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2,43,700
19	Eight Rest-houses, as per plan already submitted with the Eastern Delta Project, each Rupees 2,900	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	72,500
	Total...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	23,200
		...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	12,90,640

APPENDIX No. 7.
Statement of Fees collected on Boats, Rafts, etc., passed through the Canal in No. 3 or Western Delta Range, Godavery District,
during the year 1869-70.

Month and Year.	Fee collected on Cargo Boats.	Fee collected on Transit or Passenger Boats.	Fee collected on Teakwood and Bamboo Rafts.	Total.		Amount paid into Treasury.	Balance remain- ing to be paid in on 1st April 1870.
	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.	RS. A. P.
Balance remaining on 1st April 1869, to be paid into Treasury	...	...	...	152	3 6	...	...
April 1869	166 0 0	...	150 8 10	316	8 10	400 0 0	...
May "	287 4 0	114 8 0	279 14 3	681	10 3	700 0 0	...
June "	116 8 0	22 0 0	565 6 6	703	14 6	654 0 0	...
July "	500 8 0	234 4 0	351 0 6	1,085	12 6	1,175 0 0	...
August "	734 0 0	45 2 0	24 4 6	803	6 6	775 0 0	...
September "	274 8 0	37 6 0	4 15 6	316	13 6	350 0 0	...
October "	106 0 0	124 12 0	18 10 6	249	6 6	250 0 0	...
November "	70 8 0	...	90 6 9	160	14 9	140 0 0	...
December "	24 8 0	...	11 1 9	35	9 9	44 4 7	...
January 1870	3,554 0 0	3,985 12 0	104 1 9	7,643	13 9	7,411 0 0	...
February "	1,903 0 0	143 8 0	214 5 0	2,260	13 0	2,199 0 0	...
March "	981 8 0	...	417 2 0	1,398	10 0	1,332 0 0	...
Total...	8,718 4 0	4,707 4 0	2,261 13 10	15,839	9 4	15,830 4 7	50 4 9

NURSAPURE,
12th April 1870.

(Signed) J. P. FISCHER, Major, R. F.,
Acting Supy. Engr., 1st Division.

(Signed) J. W. RUNDALL,
Executive Engineer.

GODAVERY DISTRICT.

STATEMENT OF REMUNERATIVE WORKS IN THE GODAVERY DISTRICT FOR THE YEAR 1868-69.

Name of Work.	CAPITAL.				REVENUE.							
	OUTLAY ON CONSTRUCTION (DEAD STOCK VALUATION.)				CHARGES.				INCOME.			
	Description.	Amount up to the end of the past year.	Amount for the current year.	Total.	Description.	Amount up to the end of the past year.	Amount for the current year.	Total.	Description.	Amount up to the end of the past year.	Amount for the current year.	Total.
Godavery Anicut and its Subsidiary works.	Outlay on Original Works and Re-construction.	RS. 45,97,878	RS. 1,99,624	RS. 47,97,502	Interest on the Capital, 45,97,878, at 4 per cent. Maintenance and Repairs.	RS. 21,71,976	RS. 1,93,915	RS. 23,65,891	Gross proceeds from all sources. Balance of Income.	RS. 2,33,79,381	RS. 17,80,702	RS. 2,51,10,083
	Deduct deterioration by wear and tear, at 1 per cent.	4,96,061	45,978	5,42,639		RS. 32,56,450	RS. 1,13,992	RS. 38,70,442		RS. 1,79,50,955	RS. 14,22,795	RS. 1,93,73,750
	Balance of Capital ...	...	...	42,54,863	Total Charges ...	54,28,426	3,07,907	57,36,333				

DOWLAISHWERAM,
5th June 1869.

(Signed) J. F. FISCHER, Major, R. E.,
Acting Supg. Engr., 1st Division.

	RS.		RS.
* Maintenance and Repairs		Gross collections	34,87,702
		Do. average of five years before commencement of amount	17,57,000
Management and Distribution—		Increase of land revenue	17,80,703
Irrigation	24,000	* Deductions	1,76,993
Navigation	14,000		<hr/> 15,53,710 <hr/>
	38,000	Net decrease of land revenue	41,337
	25,000	Add—Boat license fees	...
		Proceeds of grass sales	17,401
Share of Public Works Establishment	<hr/> 63,000 <hr/>	and avenues	...
			<hr/> 58,733. <hr/>
Total	1,76,992	Total	16,12,448

APPENDIX No. 9.

No. 3 RANGE, GODAVERY DISTRICT.

Statement showing the Number of Boats passed through different Locks.

Years.	NURSAPORE LOCK.						PALKOLI LOCK.						KAVVITAM.						
	Boats.						Boats.						Boats.						
	Up.			Down.			Up.			Down.			Up.			Down.			
	Number.	Tonnage.	Empty Number.	Number.	Tonnage.	Empty Number.	Number.	Tonnage.	Empty Number.	Number.	Tonnage.	Empty Number.	Number.	Tonnage.	Empty Number.	Number.	Tonnage.	Empty Number.	
1866	...	459	6,687	816	297	4,955	808	466	7,438	595	482	8,258	623	626	11,389	429	456	7,740	826
1867	...	814	13,438	444	324	6,600	684	834	14,083	819	708	8,507	791	579	10,528	542	687	12,218	548
1868	...	889	18,125	472	357	7,635	1,003	851	17,804	559	537	10,601½	963	730	15,409	526	586	11,271	611
1869	...	654	12,681	469	374	6,053	780	519	11,360	379	421	7,981	609	595	12,123	300	389	7,668	604

* From March 1866 to December 1866.

Years.	MARTAIR LOCK.				ITEMPUDI LOCK.				PERAVELLY LOCK.									
	Boats.				Boats.				Boats.									
	Up.		Down.		Up.		Down.		Up.		Down.							
	Number.	Tonnage.	Empty Number.	Empty Tonnage.	Number.	Tonnage.	Empty Number.	Empty Tonnage.	Number.	Tonnage.	Empty Number.	Empty Tonnage.						
1866*	639	10,643	285	852	6,953	821	729	13,376	229	441	9,186	666	1,247	22,294½	52	1,286	23,990	813
1867	628	12,822	485	897	7,816	683	714	14,015	443	897	7,913	745	1,247	25,013	115	1,114	21,863	208
1868	864	18,291	350	483	9,638	665	1,051	22,146½	864	1,097	17,364	858	1,205	25,413	821	740	16,008	813
1869	781	14,865	421	642	11,770	626	777	16,404	412	611	13,611	616	1,038	20,815	571	822	19,132	673

* From March 1866 to December 1866.

Statement showing the Number of Boats passed through different Locks—(Continued.)

Years.	MUKAMALA LOCK.						KHANDAVELLY LOCK.						SIDDHANTUM LOCK.					
	Boats.						Boats.						Boats.					
	Up.			Down.			Up.			Down.			Up.			Down.		
	Number.	Tonnage.	Empty Number.	Number.	Tonnage.	Empty Number.	Number.	Tonnage.	Empty Number.	Number.	Tonnage.	Empty Number.	Number.	Tonnage.	Empty Number.	Number.	Tonnage.	Empty Number.
1866*	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1867	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1868	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1869	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	8	15	15	28	459	21	171	4,367	40	68	1,676	202	33	581	19	16	402	30

* From March 1866 to December 1866.

Years.	GOSTANADDI LOCK.						NUNDAMOOR LOCK.						PERAMULLA LOCK.					
	Boats.						Boats.						Boats.					
	Up.			Down.			Up.			Down.			Up.			Down.		
	Number.	Tonnage.	Empty Number.	Number.	Tonnage.	Empty Number.	Number.	Tonnage.	Empty Number.	Number.	Tonnage.	Empty Number.	Number.	Tonnage.	Empty Number.	Number.	Tonnage.	Empty Number.
1866*	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1867	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1868	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1869	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	83	1,668	76	95	2,217	167	915	23,776	179	550	12,271	485	766	16,834	123	414	10,389	433

* From March 1866 to December 1866.

Statement showing the Number of Boats passed through different Locks—(Concluded.)

Years.	CHINAKAPAVARUM LOCK.						YELURPAD.						GRAND TOTAL.					
	Boats.						Boats.						Boats.					
	Up.			Down.			Up.			Down.			Up.			Down.		
	Number.	Tonnage.	Empty Number.	Number.	Tonnage.	Empty Number.	Number.	Tonnage.	Empty Number.	Number.	Tonnage.	Empty Number.	Number.	Tonnage.	Empty Number.	Number.	Tonnage.	Empty Number.
1866*	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1867	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1868	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1869	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	116	2,795	...	111	2,723	...	210	4,437	...	200	3,788	...	6,761	144,720	3,009	4,721	100,040	5,245

* From March 1866 to December 1866.

DOWLAISHWEAM,
19th September 1870.

(Signed) J. F. FISCHER, Major, R. E.,
Acting Suptg. Engr., 1st Division.

No. 4 RANGE, GODAVERY DISTRICT.

Statement showing the Number of Boats passed through the Locks, etc., on the Ellore Canal.

Years.	NUNDAMOR AQUEDUCT.						ELLORE LOCK.					
	BOATS.						BOATS.					
	Up.			Down.			Up.			Down.		
	Number.	Tonnage.	Empty Number.	Number.	Tonnage.	Empty Number.	Number.	Tonnage.	Empty Number.	Number.	Tonnage.	Empty Number.
1866...	1,033	11,539	489	744	7,622	487	485	6,245½	222	575	8,650½	254
1867...	1,305	29,203	1,884	2,167	51,028	527	567	13,815	1,669	2,293	51,136	84
1868...	1,044	25,105	452	1,445	31,764	261	912	21,493	851	1,834	38,811	178
1869...	665	16,387	463	738	16,250	276	543	12,438	617	1,017	21,205	116

Years.	ELLORE AQUEDUCT.						GRAND TOTAL.					
	BOATS.						BOATS.					
	Up.			Down.			Up.			Down.		
	Number.	Tonnage.	Empty Number.	Number.	Tonnage.	Empty Number.	Number.	Tonnage.	Empty Number.	Number.	Tonnage.	Empty Number.
1866...	140	2,474	26	190	3,205½	53	1,658	20,258½	737	1,509	19,484½	794
1867...	225	5,492	731	839	17,584	40	2,097	48,510	3,784	5,299	1,19,748	651
1868...	368	9,040	408	799	17,411	112	2,324	55,637	1,711	4,078	87,986	551
1869...	232	5,811	227	437	10,080	89	1,440	34,136	1,307	2,192	47,535	481

DOWLAISHWERAM,
19th September 1870.

(Signed)

J. F. FISCHER, Major, R. E.,
Acting. Suptg. Engr., 1st Division.

APPENDIX No. 10.

WESTERN DELTA No. 1.

Statement showing the actual Expenditure incurred on Delta Works up to 1869-70.

Western Delta general charges	TOTAL EXPENDITURE FROM 1847 TO 1866-67, AS PER STATEMENT No. 1 EMBODIED IN G. O., No. 93, DATED 13TH JANUARY 1869.		EXPENDITURE IN 1867-68.		EXPENDITURE IN 1868-69.		EXPENDITURE IN 1869-70.		Grand Total.	
	Main and Distribution Channels.		Main and Distribution Channels.		Main and Distribution Channels.		Main and Distribution Channels.		Main and Distribution Channels.	
	Original Works.	Repairs.	Original Works.	Repairs.	Original Works.	Repairs.	Original Works.	Repairs.	Original Works.	Repairs.
1. Main Canal	RS. 25,209	RS. 54,736	RS. 377	RS. 187	RS. 377	RS. 187	RS. 256	RS. 103	RS. 26,113	RS. 55,107
2. Ellore Canal	26,807	47,108	5,632	3,316	5,632	3,316	2,396	2,396	32,439	53,304
3. Weyaru	6,21,063	1,30,971	28,488	5,060	37,794	6,045	27,979	5,772	7,15,324	1,47,848
Undi Channel	1,39,657	58,382	272	2,842	1,437	1,381	1,381	677	1,41,310	63,338
Chinakapaverum Channel	15,534	8,200	1,454	3,510	656	3,662		569	17,664	15,941
Rudrayacodu		362		619		7		302	203	1,290
4. Uttali Canal	31	1,412	17,046	210	52,116	47	7,735	511	76,928	2,180
5. Nursapore Canal	6,147	30,640	368	2,403	219	1,651	1,443	1,072	8,207	35,766
6. Bhupiah Channel	2,51,061	76,068	2,227	5,165	4,727	4,766	14,220	13,082	2,72,235	99,081
Rapaka Channel	6,684	7,432	335	2,260	119	1,011	1,056	339	8,194	11,892
Chinchinada Channel	6,495	1,002		2,097		876		327	6,495	4,814
Jinnur Channel	9,949	4,237				201		55	9,949	4,785
Gostanaddi Channel	12,287	3,239				682		275	15,937	7,227
6. Bank Canal	12,588	4,170		1,601	3,600	229		1,167	15,937	7,227
7. Drainage	91,492	16,239	2	9,751	1,616	6,116	1,266	4,126	15,472	36,232
Mukamala		38,392	1,212	7,575	13,502	2,713	28,380	2,385	1,34,586	51,065
Total...	12,25,004	4,82,610	57,638	47,082	1,14,650	30,646	83,969	877	14,81,311	5,95,287
										20,76,598

DOWLAISHWERAM,
19th September 1870.

(Signed) J. F. FISCHER, Major, R. E.,
Acting Suptg. Engr., 1st Division.

APPENDIX No. 11.

GODAVERY DISTRICT—WESTERN DELTA RANGE.

General Abstract Estimate of the Western Section of the Godavery Delta.

Description of Work.	Amount.	Total.	Grand Total.
CANALS.	RS.	RS.	RS.
Main Duct.			
Earthwork, 8 miles ...		49,000	
Head-sluice shutters ...		19,500	
Total for the above duct...			68,500
Karkarapurru Canal.			
Earthwork ...		31,000	
Compensation for land ...		2,000	
Total for the above canal...			33,000
Nursapore Canal.			
Earthwork ...		18,500	
Masonry Works.			
Peravelly Lock with bridge over tail bay	21,390		
Itempudi do. do. over do.	21,640		
Martair do. without do. over do.	21,400		
Kavittam do. with do. do. do.	24,160		
Palkoli do. without do. do. do.	22,570		
Tidal do. into Uputair at Mogultur	29,330		
Peravelly weir of 6 spans of 9 feet each	6,640		
Itempudi do. of 4 do. of 9 do.	5,070		
Alterations of Martair weir of 3 spans of 9 feet each	1,310		
Do. of Kavittam do. of 2 do. of 8, 10½ inches each	1,070		
Palkoli weir of 2 spans of 9 feet each	4,370		
Weir into Uputair at Mogultur	2,330		
		1,61,330	
Minor Channels and Masonries.			
Earthwork ...		13,715	
Masonries ...		12,235	
Compensation for land, etc.		3,820	
Total for the above canal...			2,09,600
Bank Canal.			
Earthwork ...		22,500	
Masonry Works.			
Lock at 5th mile near Khandavelly...	14,400		
Do. at 10th „ do. Siddhantam...	17,720		
Do. at 16th „ do. Kodair	18,570		
Double lock at 22¼ mile near Dodeputtah	34,370		
Surplus weir into Nakala at 2nd mile	4,310		
Alterations to Siddhantam weir	35		
Weir at 16th mile near Kodair	3,260		
Surplus weir above Dodeputtah Lock at 22¼ mile	2,340		
Improvements to Mukamala weir at 27¼ mile from the head of Bank Canal	600		
Drop in rear of sluice aqueduct in Kodamanchilly Channel	830		
		96,435	

General Abstract Estimate of the Western Section of the Godavery Delta—(Continued.)

Description of Work.	Amount.	Total.	Grand Total.
	RS.	RS.	RS.
Minor Channels and Masonries.			
Earthwork ...	175		
Head-sluice to Mukamala Channel ...	250		
Do. to Kodamanchilly do. ...	200		
Do. to new Parallel do. ...	320		
Sluices to Illapacurru and Vadilunka Channels, at 160 Rupees each	250		
Dam at 22nd mile below bridge		1,195	
Masonries above Drains.			
Drainage tunnel under Duvva Channel	750		
Do. do. Illaparu do.	600		
Sluice at end of Vallur Drain	500		
Compensation for land ...		1,850	
		2,500	
Total for the above canal...			1,29,460
Venkia and Weyairu Irrigation.			
Earthwork ...		4,350	
Masonry Works.			
Kalaparru Sluice ...	900		
7-feet dam below Kalaparru Sluice	210		
5- do. do.	190		
Madivada Channel Sluice	430		
Azzamur Sluice	470		
Akced do.	250		
Two sluices, one to Gummaloar Channel and the other to Dampagadapa Channel, at 410 Rupees each	820		
Cherukunilly Channel Sluice	660		
Yalurpand Sluice	430		
Chillacampad Escape	1,500		
Seven masonry sluices to Venkia Canal above Peramulla Lock.	1,750		
		7,610	
Total for the above irrigation...			11,960
Undi High Level Canal.			
Earthwork ...		26,600	
Masonry Works.			
Lock at head	14,510		
Calingulah or weir at head	4,060		
Surplusing do. at 7½ mile	4,910		
Do. do. at 15½ do. above the Undi Aqueduct	3,550		
Drop below aqueduct	1,480		
Dam at the end of channel	650		
		29,160	
Drain.			
Earthwork ...	22,890		
Lock at 11½ mile into Yennamadurru Drain	5,110		
Surplus weir at 11½ mile		1,600	
		28,000	
Minor Channels and Masonry Works.			
Earthwork ...	400		
Drainage tunnel for Annacodair		12,150	

General Abstract Estimate of the Western Section of the Godavery Delta—(Continued.)

Description of Work.	Amount.	Total.	Grand Total.
	RS.	RS.	RS.
<i>Minor Channels and Masonry Works—(Concluded.)</i>			
Two dividing dams, one to Comara and the other to Annacodair Channel, at 250 Rupees each	500		
18 sluices, at 250 Rupees each	4,500		
7 do. at 150 „ „ „ „ „ „ ..	1,050		
50 minor new sluices for direct irrigation, at 35 Rupees each...	1,750		
		8,200	
Compensation for land		4,990	
Total for the above canal...			1,10,700
<i>Uttali Canal.</i>			
Earthwork		23,610	
<i>Masonry Works.</i>			
Lock at 4th mile near Godicherla	16,230		
Do. at 13½ „ „ „ „ „ „ ..	8,270		
Weir at 4th „ „ „ „ „ „ ..	4,090		
Surplus weir at 10½ mile	2,550		
Sluice at the head of Ralinghy Main Branch	1,110		
Weir at 13½ miles	1,580		
Do., or dividing dam at 16th mile	850		
Do. or do. at „ „ „ „ „ „ ..	820		
		35,500	
<i>Minor Channels and Masonries.</i>			
Earthwork		6,270	
11 Sluices to Main Channel, at 320 Rupees each	3,520		
10 dividing dams, at 150 Rupees each	1,500		
100 minor sluices, at 24 „ „ „ „ „ „ ..	2,400		
2 under-tunnels, at 750 „ „ „ „ „ „ ..	1,500		
		8,920	
Compensation for land		4,500	
Total for the above canal...			78,800
<i>Gostanaddi and Velpur Channel.</i>			
Earthwork		64,000	
Lock at head	17,780		
Do. at Penumuntra	15,000		
Calingulah at head of Gostanaddi	4,670		
Do. across Gostanaddi at 14th mile	6,230		
Head-sluice to eastern branch	1,020		
Calingulah at Penumuntra	3,700		
Aqueduct over Buswarowkodu	11,270		
Surplus below aqueduct	1,480		
Drop do.	1,470		
Head-sluice to Viravasaram Channel	1,270		
Do. to Adivikodu do.	1,270		
Do. to Razikodu do.	1,270		
Surplus weir into Gostanaddi near Razikodu	1,650		
		68,080	
<i>Minor Masonries.</i>			
Two drops to Bhupiah Channel	700		
Seven sluices to minor branches above Penumuntra	1,680		
Two do. below Penumuntra Lock and Buswarowkodu Aqueduct	400		
Two minor sluices below aqueduct	450		
		3,230	
Compensation for land		5,750	
Total for the above channel...			1,41,060

General Abstract Estimate of the Western Section of the Godavery Delta—(Concluded.)

Description of Work.	Amount.	Total.	Grand Total.
	RS.	RS.	RS.
DRAINAGES.			
NAKALA DRAIN.			
<i>Masonry work.</i>			11,000
Sluice Aqueduct	...	...	
<i>Gostanaddi Outfall and Sluice.</i>		78,500	
Earthwork	...		
<i>Masonry work.</i>		7,900	
Drainage sluice at the junction of Gostanaddi with Yennamadruru Drain	...		
<i>Minor Masonry works.</i>		3,000	
Masonry inlets	...	2,500	
Compensation for land	...		91,900
Total for the above drain...	...	...	
<i>Yennamadruru Drain Improvements.</i>		20,130	
Earthwork	...	8,670	
Masonry inlets	...		28,800
Total for the above drain ..	...	...	
<i>Bondada and Rudrayacodu.</i>		...	11,550
Earthwork	...		
<i>Caza Drain.</i>		...	5,760
Earthwork	...		
<i>Buggeswerum Drain.</i>		...	6,050
Earthwork	...		
<i>Minor Drainages.</i>		...	4,840
Earthwork	...		
<i>Drain west of Nursapore Canal.</i>		14,300	
Earthwork	...		
<i>Masonries.</i>	930		
12-feet Bridge at 3 miles and 1 furlong	1,440		
16-feet do. across drain at 4½ mile		2,370	
<i>Minor Masonries.</i>		1,650	
Minor in-fall drainages	...		18,320
Total for the above drain...	...	...	
<i>Overseers' Sheds.</i>			
10 sheds, at Rupees 2,900 each, as per separate estimate attached and as per plan already submitted with the Eastern Delta Project	...	...	29,000
Total estimated ...	...	...	9,90,300

DOWLAISHWERAM,
13th September 1870.

(Signed) J. F. FISCHER, Major, R. E.,
Acting. Suptg. Engr., 1st Division.

N.B.—The differences between these estimates and those recommended for sanction are explained
in paragraph 22 of the Note by the Chief Engineer for Irrigation.

24

GODAVERY DISTRICT.

WESTERN DELTA RANGE.

General Abstract Estimate for the Ellore Canal included in the Western Section of the Godavery Delta.

Description of Work.	Amount.	Total.	Grand Total.
	RS.	RS.	RS.
CANALS.			
<i>Main Canal.</i>			
Earthwork	...	31,580	
<i>Masonry works.</i>			
26 Sluices	12,590		
Minor Channels	7,560		
20 Dams	3,270		
Total for the above Canal...	...	23,420	55,000
<i>Mid Level Channel.</i>			
Earthwork	20,280		
Do. (Branch Channels)	3,520		
<i>Masonry Works.</i>			
Head-sluice	1,480		
Bridge at 1½ mile	980		
Do. at 3½ do.	980		
Do. at 4th do.	1,930		
Do. at 5½ do.	980		
Under-tunnel at 7th mile	4,330		
Bridge at 7½ mile	980		
Drop at 7½ do.	700		
Bridge at 8½ do.	1,930		
Drop at 9½ do.	700		
Escape and regulating bridge at 9½ mile	2,840		
Drop at 10th mile	700		
Do. at 11½ do.	700		
Do. and regulating bridge at 11½ mile	3,600		
Do. at 12½ mile	1,530		
Do. at 14th do.	550		
Do. at 14½ do.	530		
Do. at 15½ do.	500		
12 Village sluices at 420 each	5,040		
6 Metalled crosses at 160 do.	960		
<i>Compensation.</i>			
166 Acres of land under Main Canal at 40 Rupees per acre... ..	6,640		
45 Do. do. under side channels at do. do.	1,800		
Total for the above Canal...	...	8,440	64,180
<i>Low Level Channel.</i>			
Earthwork	...	6,150	
<i>Masonry Works.</i>			
Head-sluice	1,140		
Bridge and Drop at Madapuram	1,430		
Drop at 2½ mile	560		
Escape at do.	1,000		
Bridge over Doovah Road	1,100		
Drop at 3½ mile	520		
Do. at 7½ do.	520		
Do. at 8½ do.	470		

General Abstract Estimate for the Ellore Canal included in the Western Section of the Godavery Delta.—(Concluded.)

Description of Work.	Amount.	Total.	Grand Total.
	RS.	RS.	RS.
<i>Masonry Works.—(Concluded.)</i>			
6 Village sluices at 420 each	2,520		
7 Metalled Cattle crossings at 160 each	1,120	10,380	
Compensation	...	2,760	19,290
Total for the above Channel...	...	...	
DRAINAGES.			
<i>Pundikodu Drain.</i>			
Earthwork	...	34,600	
<i>Masonry Works.</i>			
Aqueduct over Chinakapaverum Channel	18,240		
Bridge over drain near Chilakumpaud	1,305	19,545	
Compensation	...	5,385	59,530
Total for the above Drain...	...	...	
<i>Drain from 9½ miles of Mid Level Channel to Pundikodu and Sundry Drains.</i>			
Earthwork	...	17,730	
<i>Masonry Works.</i>			
Drop at ½ mile	620		
Do. at 1st mile	620		
Do. at 2nd do.	650		
Do. at 2½ do.	720		
Do. at 2½ do.	760		
Do. at 2½ do.	800	4,170	
Escape at 12½ do.	...	2,100	24,000
Compensation	...	...	
Total for the above Drain...	...	...	
<i>Drainage Diversion.</i>			
Earthwork	650		
Drop at 2½ mile	900		
Do. at 3½ do.	1,220		
Sluice to Chinanindrakollu Channel	380	3,150	
Bar across Drain at 5½ mile	...	...	21,700
Total for the above Diversion ...	...	...	
<i>Overseers' Sheds.</i>			
2 Sheds at 2,900 each as per separate estimate attached and as per plan already submitted with the Eastern Delta Project	...	...	5,800
Total Estimated...	...	...	2,49,500

(Signed) J. F. FISCHER, Major, R.E.,
Actg. Supg. Engr., 1st Division.
DOWLAISHWERAM,
13th September 1870.

N.B.—The differences between these estimates and those recommended for sanction are explained in paragraph 22 of the Note by the Chief Engineer for Irrigation.

APPENDIX No. 12.

Godavery District.

WESTERN DELTA RANGE.

List of papers accompanying the letter of 19th September 1870, No. 2,104, from the Acting Superintending Engineer, 1st Division, to the Secretary to Government, Public Works Department.

Main Duct.

- 1 Book of longitudinal and cross sections.
- 1 Tabulated Statement and Estimate.

Vijaiswarum Head-sluiice Shutters.

- 1 Plan of head-sluiice.
- 1 Do. of do. section.
- 1 Do. of do. iron shutter.
- 1 Detailed Estimate.
- 1 Abstract do.

Karkarapurru Canal.

- 1 Book of longitudinal and cross sections.
- 1 Tabulated Statement and Estimate.

Nursapore Canal.

- 1 Book of longitudinal and cross sections of Mogultur Canal.
- 1 Plan of Lock with bridge at Peravelly, Itempudy, and Kavitam.
- 1 Do. of do. without do. at Martair and Palkoli.
- 1 Do. of weir at Mogultur.
- 1 Detailed Estimate of masonry works.
- 1 Abstract do. of do.
- 1 Statement showing the proposed water-supply and distribution to branches of the Nursapore Canal.

Bank Canal.

- 1 Book of longitudinal and cross sections.
- 1 Plan of Lock at 5th mile near Kandavilly.
- 1 Do. of do. at 10th and 16th miles near Siddhantam and Koderu respectively.
- 1 Do. of weir at 16th mile near Koderu.
- 1 Do. of surplus weir at 22½ mile above Doddipatla Lock.
- 1 Do. of double Lock at 22½ mile near Doddipatla.
- 1 Do. of Drop in rear of sluice aqueduct.
- 1 Do. showing the improvements to Mukamala Weir.
- 1 Detailed Estimate of masonry works.
- 1 Abstract do. of do. do.
- 1 Tabulated Statement and Estimate.

Venkia and Weyairu Irrigation.

- 1 Plan of Chilacumpaud Escape.
- 1 Do. of sluice and dams.
- 1 Detailed Estimate of masonry and earthworks.

Undi High Level Canal.

- 1 Book of longitudinal and cross sections.
- 1 Plan of Head Lock at Chilacumpaud.
- 1 Do. of do. weir at do.
- 1 Do. for dams and weirs.
- 1 Do. of Tidal Lock into Yennamadurru Drain at 11½ miles near Gollalakoderu.
- 1 Detailed Estimate of masonry works.
- 1 Abstract do. of do.
- 1 Tabulated Statement and Estimate.

Uttali Canal.

- 1 Book of longitudinal and cross sections.
- 1 Plan of Head Lock at 4th mile.
- 1 Do. of weir at do.
- 1 Do. of do. at 10½ do.
- 1 Head-sluiice at 11½ do.
- 1 Plan of Lock at 13½ do.
- 1 Do. of weir at 13½ do.
- 1 Do. of dividing dam or weir at 16th mile.
- 1 Detailed Estimate of masonry works.
- 1 Abstract do. of do.
- 1 Tabulated Statement and Estimate.
- 2 Specifications.
- 1 Statement of water distribution.

Gostanaddi and Velpur Channel.

- 1 Book of longitudinal and cross section.
- 1 Head Lock into Gostanaddi at 1½ mile of Karkarapurru Canal near Chettypet.
- 1 Plan of weir at the head of Gostanaddi at 1½ mile of Karkarapurru Canal near Chettypet.
- 1 Do. of do. across Gostanaddi at 14th mile.
- 1 Do. of Head-sluiices to Velpur Eastern Branch Channel, Adivikodu and Viravasaram West Side Channels.
- 1 Do. of Aqueduct over Bisawarowkodu
- 1 Do. of Surplus Weir into do. and Gostanaddi at 29½ and 31½ miles respectively.
- 1 Detailed Estimate for masonry works.
- 1 Abstract do. for do.
- 1 Tabulated Statement and Estimate.

Nakala Drain.

- 1 Plan of Sluice Aqueduct across the drain near Kattupalem.
- 1 Detailed Estimate of the sluice.
- 1 Abstract do. of do.

Gostanaddi Out-fall and Sluice.

- 1 Book of longitudinal and cross sections.
- 1 Drainage sluice at the junction of Gostanaddi with Yennamadurru Drain.
- 1 Detailed Estimate of the sluice.
- 1 Abstract do. of do.
- 1 Tabulated Statement and Estimate.

Drain west of Nursapore Canal.

- 1 Plan of levels and masonry bridges.
- 1 Detailed and Abstract Estimates of masonry and earthworks and Abstract Estimate.

2

- 1 Lump sum estimate for drainages.

1

Overseers' sheds.

- 2 Detailed Estimates.
- 1 Comparative Statement.

3

Miscellaneous.

- 1 General Abstract Estimate.
- 1 Statement or Detailed Abstract Estimate.
- 1 Estimate for "Tools and Plant."
- 1 Statement of present estimate compared with Captain Ryves' estimate.
- 1 General Specification.
- 1 Statement of distribution of water.
- 1 Do. of the area irrigated for first crop from Fusly 1275 to 1279.
- 1 Statement of expenditure on Delta Completion Project Works.
- 1 Copy of Mr. Rundall's report, No. 189, dated 31st May 1870.
- 1 Do. of Mr. Sage's letter, No. 550, dated 3rd February 1870.
- 1 Sketch Map of Western Delta with proposed discharges.
- 1 Map of Western Delta Range showing all works.

12

Ellore Canal.

- 1 Plan of country lying between 8th and 29th miles of Ellore High Level Canal showing proposed irrigation and drainage channels
- 1 Do. from Kykarem to Ellore showing country below it.
- 1 Do. of longitudinal and cross sections of Ellore Canal. (Book).
- 1 Do. of do. do. of drainages. (Po).
- 1 Do. of sluices at head of Mid and Low Level Channel.
- 1 Do. of drop and bridge at Muddapurem.
- 1 Do. of bridge over Duvva Road.
- 1 Do. of Dursaparru under tunnel.
- 1 Do. of bridge and village sluice.
- 1 Do. of sluice to China Nindrakollu Channel and bar below it.
- 1 Do. of drop near Dursaparru.
- 1 General plan of drops in Ellore Canal drainage.
- 1 Plan of Aqueduct under Chinakapaveram Channel and regulator behind Chinakapaveram Head-sluice.
- 1 General plan of sluices in Ellore Main Canal.
- 1 Plan of escape and regulator bridge in Mid Level Channel.
- 1 Bridge near Chilacumpaud ferry over Bodipaud Drain.
- 1 Detailed and Abstract Estimate of Ellore Mid Level Channel.
- 1 Do. do. do. of Low Level do.
- 1 Do. do. do. of drops in Ellore Canal drainages.
- 1 Do. do. do. of sluice to Chinakindrakollu Channel and bar below it.
- 1 Detailed and Abstract Estimate of bridge near Chilacumpaud ferry.
- 1 Do. do. do. of Aqueduct under Chinakapaveram Channel.

- 1 Tabulated statement of Ellore Canal drainage from 9½ miles of Mid Level Channel to Pundikodu Drain.

- 1 Do. do. of Parimella and Pundikodu Drain.

- 1 Do. do. of Mid Level Channel.

- 1 Do. do. of Low do. do.

- 1 Do. do. of Ellore Canal.

- 1 Do. do. of drainage diversion from Badumpoody tail race.

- 1 Statement of water distribution.

- 1 Copy of Mr. Rundall's report of Ellore Canal, No. 482, dated 5th September 1870.

- 1 General Abstract.

- 1 Statement or Detailed Abstract Estimate.

32

120 Plans, etc.

DOWLAISHWERAM,
13th September 1870.

(Signed) J. F. FISCHER, Major, R. E.,
Actg. Supg. Engr., 1st Division.

Public Works 1871 Department
Pr. of Govt for Mmch
(2) 280-561

From
The Chief Engr
for Irrigation

To the Secretary
P.W. Dept

Dated 22nd November 70
Recd 5 Feb 171
Recd 5th 171

N^o 240

Note on the revised
estimates for the im-
provement & completion
of the system of irriga-
tion in the Western sec-
tion of the Godavary Delta.

N^o 768/769-14th March 1871

M367

28 Feb 1871

PUBLIC WORKS DEPARTMENT,
FORT ST. GEORGE, 14th March 1871.

No. 369.

No. 769.

To

THE SECRETARY TO THE GOVERNMENT OF INDIA,
PUBLIC WORKS DEPARTMENT.

IRRIGATION, No. 29.

SIR,—With my letter of the 28th September last, No. 2,336, estimates amounting to Rupees 9,45,400 for the improvement and completion of the system of irrigation and navigation in the Eastern Section of the Godavary Delta were submitted for the sanction of the Government of India, and I am now directed to transmit, for the information and the consideration of His Excellency the Governor-General in Council, similar estimates, amounting to Rupees 12,90,640, for the Western Section of this delta, together with a copy of the Proceedings of this Government thereupon.

G. O., No. 768, dated 14th March 1871.

2. The enclosures of this letter contain full particulars of the contemplated improvements, and I am now therefore briefly to state that the estimates provide—

1st.—For the extension of the area of irrigation from 202,000 to 296,000 acres, being an increase of 94,000 acres.

2nd.—For a complete system of drainage.

3rd.—For materially improving and extending the system of navigation.

3. I am instructed to point out that the revenue derivable from the first or principal crop alone will it is anticipated ultimately yield a return on the outlay of upwards of 20 per cent., and that the results obtained from past expenditure are to a great extent a guarantee of the correctness of the calculations on which this conclusion has been based. This section of the delta is undoubtedly urgently in need of improvement, many of the original works are worn out, others need to be superseded by more efficient structures, and almost everywhere the experience gained during the last twenty-three years of the wants and requirements of this important tract of country requires to be made use of.

4. Under either the special authority of the Government of India, or on the sanction of this Government given with reference to the general authorization contained in your letter, No. 185-A. I., dated 19th August 1869, Rupees 1,20,291-7-3 had been expended from Loan Funds, up to the end of the past official year, on works which are included in the estimates now submitted, and the particulars of that outlay will be found in Appendix 5 to the papers printed in the enclosed Proceedings. Those works, which were commenced prior to the 31st March last, and which have not been completed, are now in progress, in accordance with the instructions conveyed in your letter, No. 282-I., dated 2nd July 1870, and expenditure is likewise being incurred in connection with another item of these estimates—

the restoration of the navigation with the Weyairu—as authorized in a telegram dated 14th October 1870. Under these circumstances, I am to express the hope of His Excellency the Governor in Council that early sanction to the estimates, and to the execution of the works from Loan Funds, will be accorded, as at present it is not practicable for the local officers to arrange for carrying them on in that regular manner which is desirable, both to make the improvements fully useful, and to secure an early return for the expenditure incurred.

I have the honour to be,

Sir,

Your most obedient servant,

(Signed) J. G. RYVES, Captain, R.E.,
Acting Joint-Secretary to Government.

Govt. of [1871] Madras

PUBLIC WORKS.

To

THE SECRETARY TO THE GOVERNMENT

OF INDIA.

Dated March, 1871.

And

To

G. O., 14th March 1871, No. 769

MARCH

No. 369

SUBMITTING with explanations estimates, amounting to Rupees 12,90,640, for the improvement and completion of the system of irrigation in the Western Section of the Godavery Delta.

MEMORANDUM

Supplied - 8-11-71

Referred for reference the under-mentioned papers

38 estimates & one plan connected with the Western Delta Project

Red D.M.

OFFICE OF THE CHIEF
ENGR. FOR IRRIGATION,
P. W. Department,
To 100 1871.

G. H. Williams

Head Clerk.

The Registrar of the

Public Works Department

Public Works Department
No 980 of 1870

Proceedings of the Madras Government
Under date the 14th February 1870
in which read the following

From the Chief Engineer }
for Irrigation } No 240 of 22nd Nov 70

With his Honor
Collected 22nd November
the Chief Engineer sub-
mitted a statement amount-
ing after multiplication
to Rs. 1290. 64. 0 for
the improvement and
completion of the works
in the Kottai section
of the Coleroon Delta
under the present area
of irrigation in the
vicinity of the Delta is
Rs. 202,000 and it
is intended to provide

N.
A.A.
I.D.S.

water for 296,000 also
to greatly increase the
facilities for navigation,
and to afford proper
drainage to the whole
of the lands.

The Chief Engineer's
note and the papers
accompanying it contain
full information regarding
the scheme. It is now worked
out, and the Excellency
the Governor in Council
is glad to find that
there is strong evidence
of the proposed project
being highly remunerative.
The works of the Western
Delta through roughly

laid out and constructed
and though defective in
some essential parts
it will have added
largely to the Revenue.
The proposed project
is to provide a
system of irrigation, and to
return about 25
per cent on the amount
of the estimate and if
to these 15 per cent is
added for establishment
of the project, the per centage
would still be more
than 22. It will
take time to develop
to its full extent the
irrigation for which
water will be provided
by the Chief Engineer.

if to these estimates

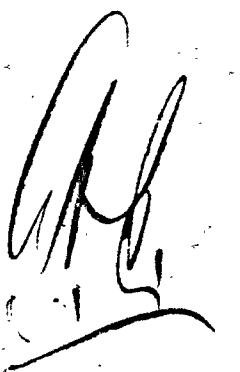
Stephen has been
has been asked, some
thing better, than the
interest in the bill
will be all at once
very soon be covered,
while it is not improbable
that, as the carrying out
of the improvements will
occupy several years, it
will be practicable by
judicious arrangements
to provide the interest
on the bill, being for
ever a single season
a burden on the Revenue.
Admiral the year of
will be for 3 years, &c.,
it would need a yearly
extension of irrigation to
6,500 acres only to return

3
7½ per cent. net, and
this would cover the
interest, and all in-
cidental charges. The
Government will look
to the Superintendent
and Executive Officers
to take care that the
work to be executed
at each successive
period is laid out
as far as possible, the best results
and the Chief Engineer
for irrigation should
review the works year
by year and bring them
before Government.
The attention of the
Superintendent will be called
to

to the particulars of the
details of nature of the
work contemplated in
the Chief Engineer's
Note, in those points
which may need any
further discussion it
will be communicated with the
Chief Engineer. Having
drawing should be
prepared while no further
instructions may be
needed; in accordance
with the estimate
and the Note 5
the estimates will
be submitted to the

Government of India
for sanction, and it
will be pointed out
that some of the im-
provements provided
for in these estimates
have been completed,
and that others are in
various stages of pro-
gress: it is desirable
therefore that permission
to proceed with them
in a regular and sys-
tematic manner should
be given as early as
possible.

To
The Chief Engineer
Irrigation
L. P. Engr. 1st Div
L. P. Engr. 2nd Div
L. P. Engr. 3rd Div
Dec 17/3/71



Aug 69

L.

The Secy: to the Govt.
of India P. W. D.

Per

With my letter of the
28th September last No. 2336
estimated amounting to Rs.
9,45,400 for the improvement
and completion of the system
of irrigation and navigation
in the eastern section of
the Godavary Delta were
submitted for the sanction
of the Govt. of India and
I am now directed to trans-
mit for the information
and consideration of His
Excellency the Governor
General in Council.

similar

similar estimates, amounting
to Rs 12,90,640, for the western
section of this Delta, together
with a copy of the Proceedings
of this Govt. thereupon.

L. A. S.

dated

2. The enclosures of this
letter contain full particu-
lars of the contemplated
improvements and I am
now therefore briefly to state
that the estimates provide-

1st for the extension of the area of
irrigation from 20,20,000 to 29,60,000 acres
being an increase of 94,000 acres.

2nd for a complete system of drainage.

3rd for materially improving and
extending the system of navigation.

3. I am instructed to
point out that the Revenue
derivable from the fruit or
principal crops alone will
it is anticipated ultimately
yield a return on the outlay
of

119 6
of upwards of 20 per cent, and
that the results obtained
from past expenditure
are to a great extent a
guarantee of the correctness
of the calculations on which
this conclusion has been
based. This section of the
Delta is undoubtedly ^{urgently} in
need of improvement.
many of the original works
are worn out others need
to be superseded by more
efficient structures and
almost everywhere the
experience gained during
the last 23 years of the
wants and requirements
of this important tract
of country requires to be
made use of.

4. Under either the
special

special authority of the
Govt. of India or on the
sanction of this Govt. given
with reference to the general
authorization contained
in your letter No. 185. P. I.
dated 17 August 1867. Rs 120291-7-3
had been expended from
Loan Funds up to the
end of the past official
year, on works which
are included in the esti-
-mate now submitted
and the particulars of that
outlay will be found in
appendix B to the papers
printed in the enclosed
Proceedings. Those works
which were commenced
prior to the 31st March
last and which have
not been completed, are
now

G. O. No. 2480 D/15th
October 1870.

now in progress in accordance
with the instructions con-
-veyed in your letter
No. 282 dated 2nd July 1870,
and expenditure is like-
-wise being incurred
in connection with another
item of these estimates, the
restoration of the navigation
with the Veyraux, as
authorized in a telegram
dated 14. Oct. 70. Under
these circumstances I am
to express the hope of His
Excellency the Governor
in Council that early
sanction to the estimates
and to the execution of
the works from Loan
Funds, will be accorded,
as at present it is not
practicable for the local
officers

officers to arrange for car-
-rying them on in that
regular manner which
is desirable both to make
the improvements fully
useful, and to secure
an early return for the
expenditure incurred.

W. H.

Despatch 17/3/71 with 25 copies
of Gen 768 of 1871/72

Naval Estimates despatch
28/3/71 in a box

Enclosures others 1 in three
which were sent to Gen 768 of 1871/72 in the same despatch
14/4/71.

20-12-22 ✓

(2)

768-1500

14-3-71