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MADRAS RECORD OFFICE.

Government of Madras.

DEPARTMENT.

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185

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*Proceedings of the Madras Government, Public Works Department,
15th October 1867.*

No. 298. Read the following letter from the Consulting Engineer for Irrigation and Canal Company, to the Secretary to Government, Department Public Works, dated Madras, 23rd September 1867, No. 76 :—

1. In their Proceedings of the 17th November last, No. 3,671, the Government declined to sanction the revised estimates of the 2nd Section, Main Canal, pending the submission of a complete estimate, with information as to the necessity for the extra sanction which might then be asked for. I have now the honor to submit, for the consideration of Government, a letter, No. 259 of the 13th instant, from the Agent and Manager, Madras Irrigation and Canal Company, transmitting the documents and estimates, as per margin,* for the completion of the works of the section.

1 Original letter from Agent, No. 259, 13th instant, General No. 416.
1 Copy of do. to do. No. 66, 5th June 1867.
3 Estimates.
73 Plans.

* Chief Engineer's Report, dated 30th August 1867.
Executive Engineer's Report, dated 10th August 1867, with Notes attached.
The above are appended to the Agent's letter.
Revised Estimate.
Abstract do.
Comparative Statement.
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2. The estimate, as now revised, amounts to Rupees 17,91,600, and it includes not only provision for the completion of the earthworks, revetments, and masonry works, but also for those additional works which the Chief Engineer has considered necessary for the stoppage of leakage through the banks of the canal.

3. The previous sanctions given for the works of this section of the canal, which are included in these estimates, are—

As quoted in Proceedings Madras Government,	RS.
17th November 1866, No. 3,671	13,76,415
Proceedings Madras Government, dated 30th October 1866, No. 3,145	4,709
Total ...	13,81,124

The difference, therefore, for which sanction is asked is Rupees 4,10,476.

Besides the above estimates however, Rupees 8,550 were sanctioned in Proceedings Madras Government of the 8th April last, No. 1,078, for minor bridges, so that the actual total estimated cost of the section is at present Rupees 18,00,150, and the length of the section being 14 $\frac{3}{4}$ miles, the average cost per mile comes to Rupees 1,22,044.

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4. The subjoined statement will enable a comparison to be made between the several estimates, which have at different times been sent in for sanction.

Miles.	Original estimate sanctioned, December 1861.	Estimate sanctioned, February 1865.	Estimate dated June 1866.	Present Estimate, dated Aug. 1867.	Estimate of 1867, compared with that of 1866.		Excess of 1867 Estimate over that of 1865, per cent.
					Increase per cent.	Decrease per cent.	
* 18 ...	14,560	70,044	1,01,933	1,03,511	1.54	...	31.00
19 ...	34,402	59,697	74,227	76,607	3.28	...	28.42
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22 ...	26,555	50,241	57,643	51,640	...	1.04	2.78
23 ...	51,171	1,45,522	2,00,915	1,73,456	...	13.65	19.22
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Contingencies ...	25,171	1,02,910	1,99,711	1,37,566	...	31.11	33.67
Plant ...	...	...	...	50,000	...	...	...
Deduct in Stone	5,36,400	...	...	...	...	...	...
	2,400	...	...	...	...	...	...
	5,34,000	13,76,415	17,97,365	17,91,600	...	0.32	30.16

* The part below Hindry aqueduct about three-fourths of a mile.

† Sanctioned March 1865.

The estimate for 1865 was the first which gave evidence of the magnitude of the works required for this section; that of 1866 was prepared on insufficient data as to the extent of work to be done, and it was besides incomplete, as the work provided for would not have made an efficient canal. In preparing the estimate of 1867, the wants of the canal have been more carefully considered, and it will be seen that, while much additional work has been provided for, the total of the estimate is below that of the preceding year.

5. The principal alterations in the last estimate are:—

1st.—Additional work for the stoppage of leakage expected to cost—

	RS.	A.	P.
In the 25th mile...	26,616	12	0
" 26th " ...	13,494	13	0
" 27th " ...	54,225	11	0
" 28th " ...	22,763	7	0
" 32nd " ...	17,104	1	0

2nd.—A provision for the wear and tear of plant used in carrying on the works

Total...	1,34,204	12	0
...	50,000	0	0
Total	1,84,204	12	0

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Deducting this sum from the total excess, Rupees 4,10,476, of the estimate of 1867 above that of 1865, we obtain Rupees 2,26,017, as the cost of all the work remaining to be done, with the exception of the new works for stopping leakage, and the new charge for wear and tear of plant. On the other hand, the estimate of 1866, which the Government declined to sanction, exceeded that of 1865 by Rupees 4,20,950. The difference is very great, and though works on different designs cannot be absolutely compared, it is tolerably clear, I think, that had the estimate of 1866 been sanctioned and carried out, the total cost of completing the section would have been as much as Rupees 4,20,950 × Rs. 1,84,205 = 6,05,155 against the Rupees 4,10,476 of the present estimate, and it is by no means improbable that, with the works on the old design more advanced, the cost of the special works for the stoppage of leakage would have been greater.

6. As already noticed, special works for stopping leakage are provided in five miles, and the lengths in these miles requiring to be reformed are as follow:—

25th mile ...	Yards	966½
26th " ...	"	947½
27th " ...	"	1,500
28th " ...	"	544½
32nd " ...	"	341½
		4,301

Whether or no all considerable leakage will be covered by these works, I cannot say. I was under the impression that in the 24th mile similar works would, to some extent, be needed, but I have been unable to find any Memoranda referring to the banks of this mile in particular. In the 29th and 30th miles also it is not improbable that, where the soil is sandy or otherwise porous, additional works will when the banks shall have been tested by the admission of water, be deemed requisite.

7. In all the miles it is proposed to stop excessive leakage, by constructing masonry revetments on the inside of the present banks, and reforming the embankments against these walls. This plan has been adopted.

1stly.—“Because the cost of finishing over defective banks in this way will not be more than by the other method of puddling them, and will be much more efficient and permanent.”

2ndly.—“Because earth for puddling does not exist near most of the places where it is wanted.

“It should be observed that by using a masonry wall, a great economy can be effected in the earthwork, as a much smaller quantity of embankment is sufficient when in connection with a permanent masonry wall, and this is the main source of economy where earth is so scarce as it generally proves to be on these rocky hill sides.

3rdly.—“Further, it should be observed that whilst contractors will not undertake puddling at the old rates, accepted for repairing the breaches, they willingly tender for masonry at lower rates than those used by Captain Mullins in his comparative Estimate.

4thly.—“In filling the canal rapidly, the relative liability to danger from sudden settlement is vastly less where masonry is employed, and it is worth some expenditure to avoid this risk.”

8. Of these reasons, the first is true, for those parts of the banks which are still far from complete, as, for instance, at Section No. 53, 27th mile, where puddle and revetment wall would cost just about the same. It does not apply, however, to the banks which are more advanced as at the cross Section No. 38 of the 25th mile, where puddle would cost 33 to 36½ Rupees, according as the rate allowed was 8 Annas to 1 Rupee the cubic yard, while the masonry revetment arrangement will cost about 48 Rupees the yard run.

The second reason is similarly applicable to some parts and not to others, and there is in most places some fair soil, and in others good soil within a moderate distance.

The third reason that the contractors who executed puddle at the breaches in the 25th and 27th miles last year are unwilling to accept similar work at the rates then given, is no criterion of the proper cost of such work done in a systematic way. It is a description of work with which the natives of that part of the country are altogether unfamiliar, and it would be necessary to teach them how to do it, and arrangements would be needed to provide for the water required in an economical manner.

9. The fourth reason is an important one, and it will doubtless be much more easy with masonry walls to pass water along the canal rapidly than would be the case with merely revetted banks. It must not, however, be forgotten that a rush of water along the toes of the walls will not be advisable, and that the speed with which the upper forty-three miles of the canal can be filled will still be determined by the character of the works generally, and will not be very much affected by the walls in two miles and 780 yards out of five miles.

10. I do not wish at all to interfere with the Chief Engineer's discretion in this matter, and it will be better to allow him to carry out the works in the way which he has, after due consideration, decided to be best, rather than to lay much stress on a saving of perhaps Rupees 25,000.

11. Looking now to the details of the proposed works as exhibited in the cross sections, it will be noticed that the walls and banks connected with them are to be only two feet above the full canal level. Under no circumstances would this be a safe margin for a wall with a bank in rear, and it would be extremely unwise to run the risk of damage from the spill of canal water cutting away the earth in rear of the walls. I may remark also that it is by no means certain at what exact levels the water will stand in various parts of the canal, for the falls vary very considerably, and adjustments of level will naturally result to render the several parts capable of passing the full discharge. It would seem too that there have been mistakes made regarding the levels in some miles, at least I judge so from the additions proposed to be made to the core section and other walls in the 28th mile, cross sections, Nos. 53 to 57, which seem to have been finished under a mistaken idea as to the actual level of the water in the canal when full. The core sections, as proposed to be completed, would be quite unsafe, for the water can pass freely through the dry wall, and would have to get through

a few inches only of the soil to reach the roadway between the masonry parapets, and then similarly to find its way to the rear. When I proposed to make the top of a masonry revetment two feet above full canal level, it was intended that, leaving a berm for a towing path, the embankment in rear should be made up to the full level, six feet above water. I consider that either the wall should be carried up to 3½ feet above water, or to 1½ feet above the level shewn in the cross sections, or that the earthwork should be carried up at least four feet above that level.

12. In some cases the walls are to have buttresses on the canal side, their tops being on canal bed level. It is nowhere shown or stated how these buttresses are to be arranged, but in the Executive Engineer's Report, 25th mile, it is mentioned that they are to be at close intervals. As far as can be ascertained from checking the quantities of masonry in the 25th mile, these buttresses are to be placed at twice their own thickness apart.

13. The Chief Engineer has furnished such information with regard to the work done as the accounts contain, but he has not ascertained by measurements how much of that work is in existence, and how much of this is efficient. As, however, the demand for supplemental sanction, exclusive of additional work, has been reduced to about one-half of that shown in last year's estimates, and as the Executive Engineer appears to have carefully ascertained what work has to be done to complete the banks, it is not now so necessary for practical purposes, and in order to prevent further irregularities, that the detailed examination should be made. Except, however, where, owing to change of arrangements, the placing of the banks in form for measurement might have entailed a waste of money, I am unable to agree with the Chief Engineer in thinking that the difficulties in the way of a sufficiently approximate measurement of work done were at all serious, or such as to justify the Controlling Officers of the Company from undertaking, or requiring the performance of, the duty.

14. The Government have already been informed of the unfavorable circumstances attending the planning and execution of this section of the canal, and they have expressed their opinion thereupon. I will not, therefore, report what has been said before, or notice the Chief Engineer's remarks in deprecation of the idea that this part of the canal will not be a success on the whole. If it be so, and if in the end it be thoroughly efficient, all that can be said will be that, with better management, equally good results might have been secured at perhaps two-thirds of the cost.

15. A few of the miles call for remark in explanation of the general results shown in the statement contained in paragraph 4 above.

18th Mile.—I gather from the Executive Engineer's remarks that the quantity of work done in this mile agrees tolerably closely with that paid for, if so, this is so far satisfactory, but there is altogether an absence of proof that there was any necessity for exceeding the estimate of 1865 by thirty-four per cent. At that time a large proportion of the work had been done, and had a not excessive, but sufficient, section been given to the bank, there would have been no necessity for bringing soil from a long distance at very high rates. If the banks here were deemed only what they should be, it would be necessary to call upon the Chief Engineer to revise much of the work proposed for the miles lower down.

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20th Mile.—A copy of my letter of the 5th June last, on the subject of the gun-powder supplied to the contractor for the deep cutting, and not paid for by him, is enclosed. If, as would seem to be the case, the accounts had not been so kept as to give the Company a fair chance of recovering from the Contractor in a Court of Law, it would have been useless to institute a suit against him, and be repudiated his liability to pay. He ought certainly to have been regularly charged with the value of the powder supplied to him, and, even if lost sight of in the first instance, the transactions ought to have come under notice long before they did do so, and it would have been easy, when the rate for the cutting was raised in 1865, to have taken care that all demands against the contractor were duly provided for. If the contractor refuses to pay for the powder, he should not again be allowed to contract for work.

The rest of the apparent excess on this mile is due to the bridge, which was sanctioned after February 1865, and which has been completed within the estimate.

23rd Mile.—One-half of the excess over the estimate of 1865 is due to the Kadrabagh aqueduct, and the remainder is distributed over many items, the chief being for embankment. In completing the earthworks, there was great difficulty in obtaining stable banks near the aqueduct, and, though this difficulty was in a great measure due to the way in which the earlier work was executed, it accounts for the excess.

The Executive Engineer refers to the Kadrabagh aqueduct in paragraph 25 of his Report. It is very unsatisfactory to find that the last sanction for this work has been exceeded by 6,700 Rupees, and that it is necessary to spend Rupees 3,235 more upon it, bringing up the total to Rupees 56,303; I believe that it would be much better, now that it is certain that many months will elapse before the 2nd section will be fit to carry water, to pull down all those parts of the aqueduct which have proved to be so unsound, and to re-build them in a substantial manner, with proper foundations, to the upper abutment and pier. There can be no certainty, while the present wretched work is allowed to stand, that a failure may not venience were it to occur after a considerable length of the canal had been opened and cultivation irrigated from it.

24th Mile.—Here the excess is on embankments, and on masonry walls with backing to secure them. In the absence of the original ground surface on the cross sections, it is not practicable to guess even how much of the nearly thirty per cent. additional earthwork was required. In some cases Sections Nos. 8, 10, 46, 47, and 48 the pits were cut within the line of the rear slope of the embankment.

25th Mile.—Of the eighty-five per cent. excess over the estimate of 1865, fifty-six per cent. are due to the additional works for stopping leakage; the most noticeable item among other causes of increase is "excavation rocky soil," of which cubic yards 18,400, Rupees 4,600 were entered in the former estimate, cubic yards 28,914 are shown as executed, and 9,839 to be done. The excess will amount to Rupees 9,030. The cross sections, are by no means such as to make calculation of cutting easy, but according to that made in this Office, after filling in the surface line as nearly as it could be guessed, the amount of work done is cubic yards 17,421.

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26th Mile.—Of the excess 34.46 per cent., thirteen are due to the additional works for preventing leakage, and with one exception every item exhibits some increase. What is called the dry rubble or core wall, was carried out to a much greater extent than was sanctioned, and where the work was well done, this is no doubt an advantage, though the irregularity might easily have been avoided.

27th Mile.—The excess on works, other than the new arrangements for placing the banks of this mile in a safe state, do not need special notice. The new works account for nearly seventy out of the eighty-two per cent. of excess.

28th Mile.—Here also out of a total excess Rupees 26,106, Rupees 22,908 are for stopping leakage.

29th Mile.—The excess 16.26 per cent. is not large, comparatively speaking, and more than half of it appears to be due to the cuttings being abandoned by contractors after getting out the easy soil, leaving the harder parts to be done by others at higher rates.

32nd Mile.—The total excess is Rupees 15,862; Rupees 17,104 are the estimated cost of masonry revetments for securing the banks, and there will be a saving on earthworks.

16. In partial explanation of the decrease on the estimate of 1866, it may be remarked that there is no separate item in the present estimate for maintenance; whereas in the former one Rupees 58,180 altogether were allowed. From paragraph 5 of the Chief Engineer's Report, however, it will be seen that such allowance on this account as appeared necessary has been made.

17. As considerable modifications of the banks in some of the miles are intended to be made, and as many of the masonry works also have been modified as, for instance, the calingulabs by the addition of sluices, it will not, I think, be advisable to require the Chief Engineer, on the completion of the section, to forward a statement of the work executed, as this would be very difficult to ascertain. It will, however, be quite practicable to show what the work, forming part of the finally adopted arrangements is, and this should be accurately ascertained and reported before the final passing of the expenditure. Plans of all masonry works, as executed, should accompany the measurements of the work. The Chief Engineer should also price the work of all kinds done, with reference to the rates which have from time to time prevailed, and the fair value of the section, as completed in an efficient manner, will then be known, and can be compared with the actual total expenditure. If this requirement be kept in view during the further progress of the section, I have no doubt a sufficiently close and satisfactory account of the work may be prepared. On this condition, and on the understanding that the Chief Engineer will take care that the level of the revetments and banks, referred to in paragraph 11 above, is modified, so as to afford a sufficient margin for safety, I beg to recommend that supplemental sanction for Rupees 4,10,476 be given for the 2nd Section, Main Canal.

*Proceedings of the Madras Government, Public Works Department,
15th October 1867*

No. 299. ORDER THEREON, 15th October 1867, No. 3,195.

IRRIGATION, No. 12.

1. In Proceedings No. 3,671, dated 17th November 1866, the Government were compelled to withhold sanction to revised estimates of Rupees 17,97,365 for completing the second section of the Madras Irrigation and Canal Company's Canal, as it appeared evident from the Consulting Engineer's scrutiny of them that they were prepared on insufficient data as to the extent of work to be done, and that they did not provide for all that was required to place the section in a secure and satisfactory condition. Captain Mullins now submits modified estimates which have been framed after a more careful consideration of the requirements of the canal, and it is observed that, while much additional work has been provided for, the total, Rupees 17,91,600, is slightly below the estimate which the Government declined to sanction in 1866; but, contrasted with the original* and first† revised estimates, exhibits an excess of 235 per cent. in the former case and 30 per cent. in the latter.

* Rupees 5,34,000.
† „ 13,76,415.

2. Under the circumstances brought to notice in paragraph 17, the Government will not insist on the submission after the completion of the section, of a statement of the work executed; but the final passing of the expenditure will be dependent on the particulars specified by Captain Mullins in the same paragraph being furnished; and on this condition, and on the understanding that the precaution suggested in paragraph 11 for the safety of the revetments and banks is adopted, His Excellency in Council sanctions the revised estimate for the second section of the canal.

(True Extract.)
(Signed) CHARLES A. ORR, Colonel, R. E.,
Secretary to Government.

To the Consulting Engineer, Madras Irrigation and Canal Company,
„ Manager for do. do. With two Estimates, two Statements, and seventy-three Plans.

Ed. S. T. Augustin.

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Whether or no all considerable leakage will be covered by these works, I cannot say. I was under the impression that in the 24th mile similar works would, to some extent, be needed, but I have been unable to find any Memoranda referring to the banks of this mile in particular. In the 29th and 30th miles also it is not improbable that, where the soil is sandy or otherwise porous, additional works will when the banks shall have been tested by the admission of water, be deemed requisite.

7. In all the miles it is proposed to stop excessive leakage, by constructing masonry revetments on the inside of the present banks, and reforming the embankments against these walls. This plan has been adopted.

1stly.—“Because the cost of finishing over defective banks in this way will not be more than by the other method of puddling them, and will be much more efficient and permanent.”

2ndly.—“Because earth for puddling does not exist near most of the places where it is wanted.

“It should be observed that by using a masonry wall, a great economy can be effected in the earthwork, as a much smaller quantity of embankment is sufficient when in connection with a permanent masonry wall, and this is the main source of economy where earth is so scarce as it generally proves to be on these rocky hill sides.

3rdly.—“Further, it should be observed that whilst contractors will not undertake puddling at the old rates, accepted for repairing the breaches, they willingly tender for masonry at lower rates than those used by Captain Mullins in his comparative Estimate.

4thly.—“In filling the canal rapidly, the relative liability to danger from sudden settlement is vastly less where masonry is employed, and it is worth some expenditure to avoid this risk.”

8. Of these reasons, the first is true, for those parts of the banks which are still far from complete, as, for instance, at Section No. 53, 27th mile, where puddle and revetment wall would cost just about the same. It does not apply, however, to the banks which are more advanced as at the cross Section No. 38 of the 25th mile, where puddle would cost 33 to 36½ Rupees, according as the rate allowed was 8 Annas to 1 Rupee the cubic yard, while the masonry revetment arrangement will cost about 48 Rupees the yard run.

The second reason is similarly applicable to some parts and not to others, and there is in most places some fair soil, and in others good soil within a moderate distance.

The third reason that the contractors who executed puddle at the breaches in the 25th and 27th miles last year are unwilling to accept similar work at the rates then given, is no criterion of the proper cost of such work done in a systematic way. It is a description of work with which the natives of that part of the country are altogether unfamiliar, and it would be necessary to teach them how to do it, and arrangements would be needed to provide for the water required in an economical manner.

9. The fourth reason is an important one, and it will doubtless be much more easy with masonry walls to pass water along the canal rapidly than would be the case with merely revetted banks. It must not, however, be forgotten that a rush of water along the toes of the walls will not be advisable, and that the speed with which the upper forty-three miles of the canal can be filled will still be determined by the character of the works generally, and will not be very much affected by the walls in two miles and 780 yards out of five miles.

10. I do not wish at all to interfere with the Chief Engineer's discretion in this matter, and it will be better to allow him to carry out the works in the way which he has, after due consideration, decided to be best, rather than to lay much stress on a saving of perhaps Rupees 25,000.

11. Looking now to the details of the proposed works as exhibited in the cross sections, it will be noticed that the walls and banks connected with them are to be only two feet above the full canal level. Under no circumstances would this be a safe margin for a wall with a bank in rear, and it would be extremely unwise to run the risk of damage from the spill of canal water cutting away the earth in rear of the walls. I may remark also that it is by no means certain at what exact levels the water will stand in various parts of the canal, for the falls vary very considerably, and adjustments of level will naturally result to render the several parts capable of passing the full discharge. It would seem too that there have been mistakes made regarding the levels in some miles, at least I judge so from the additions proposed to be made to the core section and other walls in the 23th mile, cross sections, Nos. 53 to 57, which seem to have been finished under a mistaken idea as to the actual level of the water in the canal when full. The core sections, as proposed to be completed, would be quite unsafe, for the water can pass freely through the dry wall, and would have to get through

a few inches only of the soil to reach the roadway between the masonry parapets, and then similarly to find its way to the rear. When I proposed to make the top of a masonry revetment two feet above full canal level, it was intended that, leaving a berm for a towing path, the embankment in rear should be made up to the full level, six feet above water. I consider that either the wall should be carried up to 3½ feet above water, or to 1½ feet above the level shown in the cross sections, or that the earthwork should be carried up at least four feet above that level.

12. In some cases the walls are to have buttresses on the canal side, their tops being on canal bed level. It is nowhere shown or stated how these buttresses are to be arranged, but in the Executive Engineer's Report, 25th mile, it is mentioned that they are to be at close intervals. As far as can be ascertained from checking the quantities of masonry in the 25th mile, these buttresses are to be placed at twice their own thickness apart.

13. The Chief Engineer has furnished such information with regard to the work done as the accounts contain, but he has not ascertained by measurements how much of that work is in existence, and how much of this is efficient. As, however, the demand for supplemental sanction, exclusive of additional work, has been reduced to about one-half of that shown in last year's estimates, and as the Executive Engineer appears to have carefully ascertained what work has to be done to complete the banks, it is not now so necessary for practical purposes, and in order to prevent further irregularities, that the detailed examination should be made. Except, however, where, owing to change of arrangements, the placing of the banks in form for measurement might have entailed a waste of money, I am unable to agree with the Chief Engineer in thinking that the difficulties in the way of a sufficiently approximate measurement of work done were at all serious, or such as to justify the Controlling Officers of the Company from undertaking, or requiring the performance of, the duty.

14. The Government have already been informed of the unfavorable circumstances attending the planning and execution of this section of the canal, and they have expressed their opinion thereupon. I will not, therefore, report what has been said before, or notice the Chief Engineer's remarks in deprecation of the idea that this part of the canal will not be a success on the whole. If it be so, and if in the end it be thoroughly efficient, all that can be said will be that, with better management, equally good results might have been secured at perhaps two-thirds of the cost.

15. A few of the miles call for remark in explanation of the general results shown in the statement contained in paragraph 4 above.

18th Mile.—I gather from the Executive Engineer's remarks that the quantity of work done in this mile agrees tolerably closely with that paid for, if so, this is so far satisfactory, but there is altogether an absence of proof that there was any necessity for exceeding the estimate of 1865 by thirty-four per cent. At that time a large proportion of the work had been done, and had a not excessive, but sufficient, section been given to the bank, there would have been no necessity for bringing soil from a long distance at very high rates. If the banks here were deemed only what they should be, it would be necessary to call upon the Chief Engineer to revise much of the work proposed for the miles lower down.

20th Mile.—A copy of my letter of the 5th June last, on the subject of the gunpowder supplied to the contractor for the deep cutting, and not paid for by him, is enclosed. If, as would seem to be the case, the accounts had not been so kept as to give the Company a fair chance of recovering from the Contractor in a Court of Law, it would have been useless to institute a suit against him, and be repudiated his liability to pay. He ought certainly to have been regularly charged with the value of the powder supplied to him, and, even if lost sight of in the first instance, the transactions ought to have come under notice long before they did do so, and it would have been easy, when the rate for the cutting was raised in 1865, to have taken care that all demands against the contractor were duly provided for. If the contractor refuses to pay for the powder, he should not again be allowed to contract for work.

The rest of the apparent excess on this mile is due to the bridge, which was sanctioned after February 1865, and which has been completed within the estimate.

23rd Mile.—One-half of the excess over the estimate of 1865 is due to the Kadrabagh aqueduct, and the remainder is distributed over many items, the chief being for embankment. In completing the earthworks, there was great difficulty in obtaining stable banks near the aqueduct, and, though this difficulty was in a great measure due to the way in which the earlier work was executed, it accounts for the excess.

The Executive Engineer refers to the Kadrabagh aqueduct in paragraph 25 of his Report. It is very unsatisfactory to find that the last sanction for this work has been exceeded by 6,700 Rupees, and that it is necessary to spend Rupees 3,235 more upon it, bringing up the total to Rupees 56,303; I believe that it would be much better, now that it is certain that many months will elapse before the 2nd section will be fit to carry water, to pull down all those parts of the aqueduct which have proved to be so unsound, and to re-build them in a substantial manner, with proper foundations, to the upper abutment and pier. There can be no certainty, while the present wretched work is allowed to stand, that a failure may not take place at any time, and such failure would occasion serious loss and inconvenience were it to occur after a considerable length of the canal had been opened and cultivation irrigated from it.

24th Mile.—Here the excess is on embankments, and on masonry walls with backing to secure them. In the absence of the original ground surface on the cross sections, it is not practicable to guess even how much of the nearly thirty per cent. additional earthwork was required. In some cases Sections Nos. 8, 10, 46, 47, and 48 the pits were cut within the line of the rear slope of the embankment.

25th Mile.—Of the eighty-five per cent. excess over the estimate of 1865, fifty-six per cent. are due to the additional works for stopping leakage; the most noticeable item among other causes of increase is "excavation rocky soil," of which cubic yards 18,400, Rupees 4,600 were entered in the former estimate, cubic yards 28,914 are shown as executed, and 9,839 to be done. The excess will amount to Rupees 9,030. The cross sections, are by no means such as to make calculation of cutting easy, but according to that made in this Office, after filling in the surface line as nearly as it could be guessed, the amount of work done is cubic yards 17,421.

26th Mile.—Of the excess 34.46 per cent., thirteen are due to the additional works for preventing leakage, and with one exception every item exhibits some increase. What is called the dry rubble or core wall, was carried out to a much greater extent than was sanctioned, and where the work was well done, this is no doubt an advantage, though the irregularity might easily have been avoided.

27th Mile.—The excess on works, other than the new arrangements for placing the banks of this mile in a safe state, do not need special notice. The new works account for nearly seventy out of the eighty-two per cent. of excess.

28th Mile.—Here also out of a total excess Rupees 26,106, Rupees 22,908 are for stopping leakage.

29th Mile.—The excess 16.26 per cent. is not large, comparatively speaking, and more than half of it appears to be due to the cuttings being abandoned by contractors after getting out the easy soil, leaving the harder parts to be done by others at higher rates.

32nd Mile.—The total excess is Rupees 15,862; Rupees 17,104 are the estimated cost of masonry revetments for securing the banks, and there will be a saving on earthworks.

16. In partial explanation of the decrease on the estimate of 1866, it may be remarked that there is no separate item in the present estimate for maintenance; whereas in the former one Rupees 58,180 altogether were allowed. From paragraph 5 of the Chief Engineer's Report, however, it will be seen that such allowance on this account as appeared necessary has been made.

17. As considerable modifications of the banks in some of the miles are intended to be made, and as many of the masonry works also have been modified as, for instance, the calingulabs by the addition of sluices, it will not, I think, be advisable to require the Chief Engineer, on the completion of the section, to forward a statement of the work executed, as this would be very difficult to ascertain. It will, however, be quite practicable to show what the work, forming part of the finally adopted arrangements is, and this should be accurately ascertained and reported before the final passing of the expenditure. Plans of all masonry works, as executed, should accompany the measurements of the work. The Chief Engineer should also price the work of all kinds done, with reference to the rates which have from time to time prevailed, and the fair value of the section, as completed in an efficient manner, will then be known, and can be compared with the actual total expenditure. If this requirement be kept in view during the further progress of the section, I have no doubt a sufficiently close and satisfactory account of the work may be prepared. On this condition, and on the understanding that the Chief Engineer will take care that the level of the revetments and banks, referred to in paragraph 11 above, is modified, so as to afford a sufficient margin for safety, I beg to recommend that supplemental sanction for Rupees 4,10,476 be given for the 2nd Section, Main Canal.

Consulting Engineers Office
Irrigation & Canal Company
Madras, September 1867.

N^o 76.

From,

Captain, J. Mullins R.E.
Cons Engineer for I.C.C.

To,
The Secretary to Government
Department of Pub. Works.

Sir,

In their Proceedings of the 17th November last N^o 3671, the Government declines to sanction the revised estimates of the 2nd Section Main Canal, pending the submission of a complete estimate with information as to the necessity for the extra sanction which might then be asked for - I have now the honor to submit for the consideration of Government a letter N^o 259 of the 13th instant from the

Chief Engineer's report dated 30 August 1867
Executive Engineer's report dated 30 August 1867
with notes attached
The above are appended to the Agent's letter
Revised Estimate Abstract - 2
Comparative Statement 2
75 Plans - 2
Agent and Manager, Madras Irrigation and Canal Company, transmitting the documents and estimates as per margin for the completion of the works of the Section -
The estimate as now revised amounts to Rupees 1,79,16,000, and it includes not only provision

provision for the completion of the earthworks, rearmments, and masonry works, but also for those additional works which the Chief Engineer has considered necessary for the stoppage of leakage through the banks of the Canal.

3. The previous sanctions given for the works of this Section of the Canal, which are included in these estimates, are:

As quoted in Proceedings Madras — Rs.
Government 17th Nov 66 N^o 3671 } 1376415
Proceedings Madras Govt. dated 30th Oct 66 } 4709
N^o 3145 } Rupers 138124

The difference therefore for which sanction is asked is Rupers 4,10,476.—

Besides the above estimates however, Rupers 8,550 were sanctioned in Proceedings Madras Government of the 8th April last, N^o 1073, for minor bridges, so that the actual total estimate cost of the Section is at present Rupers 18,00,150, and the length of the Section being 14 3/4 miles, the average cost per mile comes to Rupers 122,044.—

4. The subjoined statement will enable a comparison to be made between the several estimates, which have at different times been sent in for sanction.—

Miles

Miles	Original Estimate sanctioned December 1861	Estimate sanctioned July 65	Estimate dated June 1866	Present Estimate dated August 1867	Present Estimate compared with that of 1866		Increase or Decrease	Percent	Remarks
	1861	1865	1866	1867	Percent	Percent			
18 ^x	14,560	70,044	101,933	103,511	1.54	"	34.88	"	The part below Hindry Ague duct about 3/4 of a mile. Sanctioned March 1865.
		7176							
19	34,402	59,697	74,227	76,667	3.28	"	28.42		
20	45,298	127,393	124,823	141,205	13.12	"	10.84		
21	20,554	67,273	74,115	67,923	"	8.35	0.96		
22	26,555	50,241	57,643	51,640	"	1.04	2.78		
23	51,171	145,522	200,915	173,486	"	13.65	19.22		
24	57,438	131,454	184,105	174,075	"	5.44	32.42		
25	28,041	47,406	68,633	87,884	28.04	"	85.38		
26	30,983	103,858	135,728	139,656	2.89	"	34.46		
27	37,551	78,868	104,748	143,393	36.89	"	81.87		
28	39,520	91,249	126,148	117,355	"	6.97	28.60		
29	20,288	54,081	68,761	62,875	"	8.57	16.26		
30	48,442	87,621	105,062	93,723	"	10.79	6.96		
31	23,762	88,657	95,956	89,206	"	7.03	0.61		
32	21,407	45,105	51,835	60,967	17.61	"	55.16		
Booby & Land-mudrig Roads	7,657	16,060	20,822	18,668	10.24	"	16.36		
Terry boats	3600	1800	2200	1800	"	18.18	"		
Contingencies	25,171	102,910	89,971	1,37,566	"	31.11	33.67		
Plant				50,000	"	"	"		
	536,400								
Grand Total	2400	137,6415	179,7365	179,600	"	0.32	30.16		
	534,000								

The estimate for 1865 was the first which gave evidence of the magnitude of the works required for this Section; that of 1866 was prepared on insufficient data as to the extent of work to be done, and it was besides incomplete

plate

incomplete, as the work provided for would not have made an efficient canal. In preparing the estimate of 1867 the wants of the canal have been more carefully considered, and it will be seen that, while much additional work has been provided for, the total of the estimate is below that of the preceding year.

5. The principal alterations in the last estimate are:

1 st . Additional work for the stoppage of leakage expected to cost	
in the 25 th mile	Ruppes 26,616.12.0
26 th "	13,494.13.0
27 th "	51,225.11.0
28 th "	22,763.7.0
32 nd "	17,104.1.0
	1,34,204.12.0

2nd. A provision for the wear and tear of Plant used in carrying on the works 50,000.00

Total Rs. 1,34,204.12.0

Deducting this sum from the total excess Ruppes 4,10,476 of the estimate of 1867 above that of 1865. We obtain Ruppes 22,6,017 as the cost of all the work remaining to be done with the exception of the new works for stopping leakage and the new charge for wear and tear of plant. On the other hand the estimate of 1866, which the Government declines to sanction, exceeded that of

of 1865 by Ruppes 4,20,950. The difference is very great, and though the works on different designs cannot be absolutely compared, it is tolerably clear, I think, that had the estimate of 1866 been sanctioned and carried out, the total cost of completing the Section would have been as much as Ruppes 4,20,950 + Ruppes 1,84,205 = 6,05,155 against the Ruppes 4,10,476 of the present estimate, and it is by no means improbable that, with the works on the old design more advanced, the cost of the special works for the stoppage of leakage would have been greater.

6. As already noticed special works for stopping leakage are provided in 5 miles, and the lengths of these miles requiring to be reformed are as follows:

25 th mile	Yards 966 ² / ₃
26 th "	947 ¹ / ₃
27 th "	1500
28 th "	544 ² / ₃
32 nd "	341 ² / ₃
	4,301

Whether or no all considerable leakage will be covered by these works I cannot say. I was under the impression that in the 25th mile similar works would to some extent be needed, but I have been unable to find any memoranda referring to the banks of this mile in particular. In the 29th and 30th miles also it is not improbable that, where the soil is sandy or otherwise porous

porous, additional works will, when the banks shall have been tested by the admission of water, be deemed requisite.

7. In all the miles it is proposed to stop excessive leakage by constructing masonry revetments on the inside of the present banks, and re-forming the embankments against these walls. - This plan has been adopted.

1st. Because the cost of finishing over defect. vide Ex. Engrs Report. 25th mile.

"Five banks in this way will not be more than by the other method of puddling - them and will be much more efficient and permanent."

2nd. Because earth for puddling does not exist near most of the places where it is wanted.

"It should be observed that by using a masonry wall a great economy can be effected in the earthwork, as a much smaller quantity of embankment is sufficient when in connection with a permanent masonry wall, and this is the main source of economy where earth is so scarce as it generally proves to be on these Rocky hill sides."

3rd. Further it should be observed that whilst Contractors will not undertake puddling at the old rates, accepted for repairing the breaches, they willingly tender for masonry

"masonry at lower rates than those used by Captain Mullins in his Comparative estimate."

4th. "In filling the canal rapidly the relative liability to danger from sudden settlement is vastly less where masonry is employed and it is worth some expenditure to avoid this risk."

8. Of these reasons the first is true for those parts of the banks ^{which} are still far from complete, as, for instance, at Section N^o 53 - 27th mile - where puddle and revetment wall would cost just about the same. - It does not apply however to the banks which are more advanced, as at the Cross Section N^o 38 of the 25th mile, where puddle would cost 33 Rs 36¹/₂ Rupees, according as the rate allowed ^were 8 annas for 1 Rupee the cubit yard, while the masonry revetment arrangement will cost about 48 Rupees the yard run.

The second reason is similarly applicable to some parts and not to others, and there is in most places some fair soil, and in others good soil within a moderate distance.

The third reason that the Contractors who executed puddle at the breaches in the 25th and 27th miles last year, are unwilling to accept similar work at the rates then given is no criterion

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9. The fourth reason is an important one, and it will doubtless be much more easy with masonry walls to pass water along the canal rapidly than would be the case with merely rammed banks. - It must not however be forgotten that a rush of water along the toes of the walls will not be advisable, and that the speed with which the upper 43 miles of the canal can be filled will still be determined by the character of the works generally and will not be very much affected by the walls in 2 miles 4780 yards out of 5 miles. -

10. I do not wish at all to interfere with the Chief Engineer's discretion in this matter, and it will be better to allow him to carry out the works in the way which he has, after due consideration, decided to be best, rather than to lay much stress on a saving of perhaps Rupees 25,000.

11. Looking now to the details of the proposed works as exhibited in the Cross Sections, it will be noticed that the walls and the banks connected with them are to be only 2 feet above the full canal level. - Under

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no circumstances would this be a safe margin for a wall with a bank in rear, and it would be extremely unwise to run the risk of damage from the spill of canal water cutting away the earth in rear of the walls. - I may remark also that it is by no means certain at what exact levels the water will stand in various parts of the canal, for the falls vary very considerably, and adjustments of level will naturally result to render the several parts capable of passing the full discharge. It would seem too that there have been mistakes made regarding the levels in some miles, at least I judge so from the additions proposed to be made to the cross section and other walls in the 28th mile, cross sections Nos 53 to 57, which seem to have been finished under a mistaken idea as to the actual level of the water in the canal when full. The cross sections as proposed to be completed would be quite unsafe for the water can pass freely through the dry wall, and would have to get through a few inches only of soil to reach the roadway between the masonry parapets and then similarly to find its way to the rear. - When I proposed to make the top of a masonry revetment 2 feet above full canal level, it was intended that, leaving a berm for a towing path, the embankment in rear should be made up to the full level - 6 feet above water - I consider that either the wall should be carried

carried up to $3\frac{1}{2}$ feet above water or to $1\frac{1}{2}$ feet above the level shown in the Cross Sections, or that the earthwork should be carried up to at least 4 feet above that level. —

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13. The Chief Engineer has furnished such information with regard to the work done, as the accounts contain, but he has not ascertained by measurements how much of that work is in existence and how much of this is efficient. — As however, the demand for supplemental execution, &c. of additional work, has been reduced to about one half of that shown in last year's estimates, and as the Executive Engineer appears to have carefully ascertained what work has to be done to complete the banks, it is not now so necessary for practical purposes, and in order to prevent further irregularities, that the detailed examination should be made. — Except however where, owing to change of arrangements, the

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21st 4. 15th Feb. 1861. 14. The Government have already been informed of the unfavorable circumstances attending the planning and execution of this Section of the Canal, and they have expressed their opinion thereupon. I will not therefore report what has been said before, or notice the Chief Engineer's remarks in deprecation of the idea that this part of the Canal will not be a success on the whole. — If it be so, and if in the end it be thoroughly efficient, all that can be said will be that, with better management, equally good results might have been secured at perhaps two thirds of the cost. —

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18th mile. I gather from the Executive Engineer's remarks that the quantity of work done in this mile agrees tolerably closely with that paid for if so this is so far satisfactory, but there is altogether an

an absence of proof that there was any necessity for exceeding the estimate of 1865 by 34 per cent. At that time a large proportion of the work had been done, and had a not excessive, but sufficient, section been given to the bank, there would have been no necessity for bringing soil from a long distance at very high rates. - If the banks here were deemed only what they should be, it would be necessary to call upon the Chief Engineer to revise much of the work proposed for the miles lower down. -

20th mile - A copy of my letter of the 5th June last, on the subject of the Gunpowder supplied to the contractor for the deep cutting, and not paid for by him, is enclosed - If, as would seem to be the case, the accounts had not been so kept as to give the Company a fair chance of recovering from the Contractor in a Court of law, it would have been useless to institute a suit against him and he repudiated his liability to pay. - He ought certainly to have been regularly charged with the value of the powder supplied to him and, even if lost sight of in the first instance, the transactions ought to have come under notice long before they did do so, and it would have been easy, when the rate for the cutting was raised in 1865, ~~to have taken~~ ^{care}

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The rest of the apparent excess on this mile is due to the Bridge, which was sanctioned after February 1865, and which has been completed within the estimate. -

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The Executive Engineer refers to the Kadrabagh Aqueduct in para. 25 of his report. It is very unsatisfactory to find that the last sanction for this work has been exceeded by 6,700 Rupees, and that it is necessary to spend Rupees 3,235 more upon it bringing up the total to Rupees 56,303. I believe that it would be much better, now that it is certain that many months will elapse before the 2nd Section will be fit to carry water, to pull down all those parts of the Aqueduct which have proved to be so unsound, and to rebuild them in a substantial manner with proper

proper foundations to the upper abutment and pier. - There can be no certainty, while the present wretched work is allowed to stand, that a failure may not take place at any time, - and such failure would occasion serious loss and inconvenience were it to occur after a considerable length of the canal had been opened and cultivation irrigated from it. -

24th mile. - Here the excess is on embankments and on Masonry walls with backing to secure them. - In the absence of the original ground surface on the Cross Sections it is not practicable to guess even how much of the nearly 30 per cent additional earthwork was required. - In some cases - Sections Nos 8-10-46-47 and 48 the pits were cut within the line of the rear slope of the embankment. -

25th mile. - Of the 85 per cent excess over the estimate of 1865 - 56 per cent are due to the additional works for stopping leakage; the most noticeable item among other causes of increase is "excavation rocky soil" of which cubic yards 18,400 Rupees 4,600 were entered in the former estimate, cubic yards 28,914 are shown as executed, and 9,039 to be done. - The excess will amount to Rupees 9,030. - The Cross Sections are by no means such as to

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make calculation of cutting easy, but according to that made in this office, after filling in the surface line as nearly as it could be guessed, the amount of work done is cubic yards 17,421. -

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27th mile. - The excess on works, other than the new arrangements for placing the banks of this mile in a safe state, do not need special notice. - The new works account for nearly 70 out of the 82 per cent of excess. -

28th mile. - Here also out of a total excess Rupees 26,106, Rupees 22,908 are for stopping leakage. -

29th mile. - The excess 16.26 per cent is not large comparatively speaking and more than half of it appears to be due to the cuttings being abandoned by Contractors after getting out the easy soil, leaving the harder parts to be done by

by others at higher rates.—

32nd mile.—The total excess is Rupees 15,362; Rupees 17,104 are the estimated cost of Masonry reinforcements for securing the banks, and there will be a saving on earthworks.—

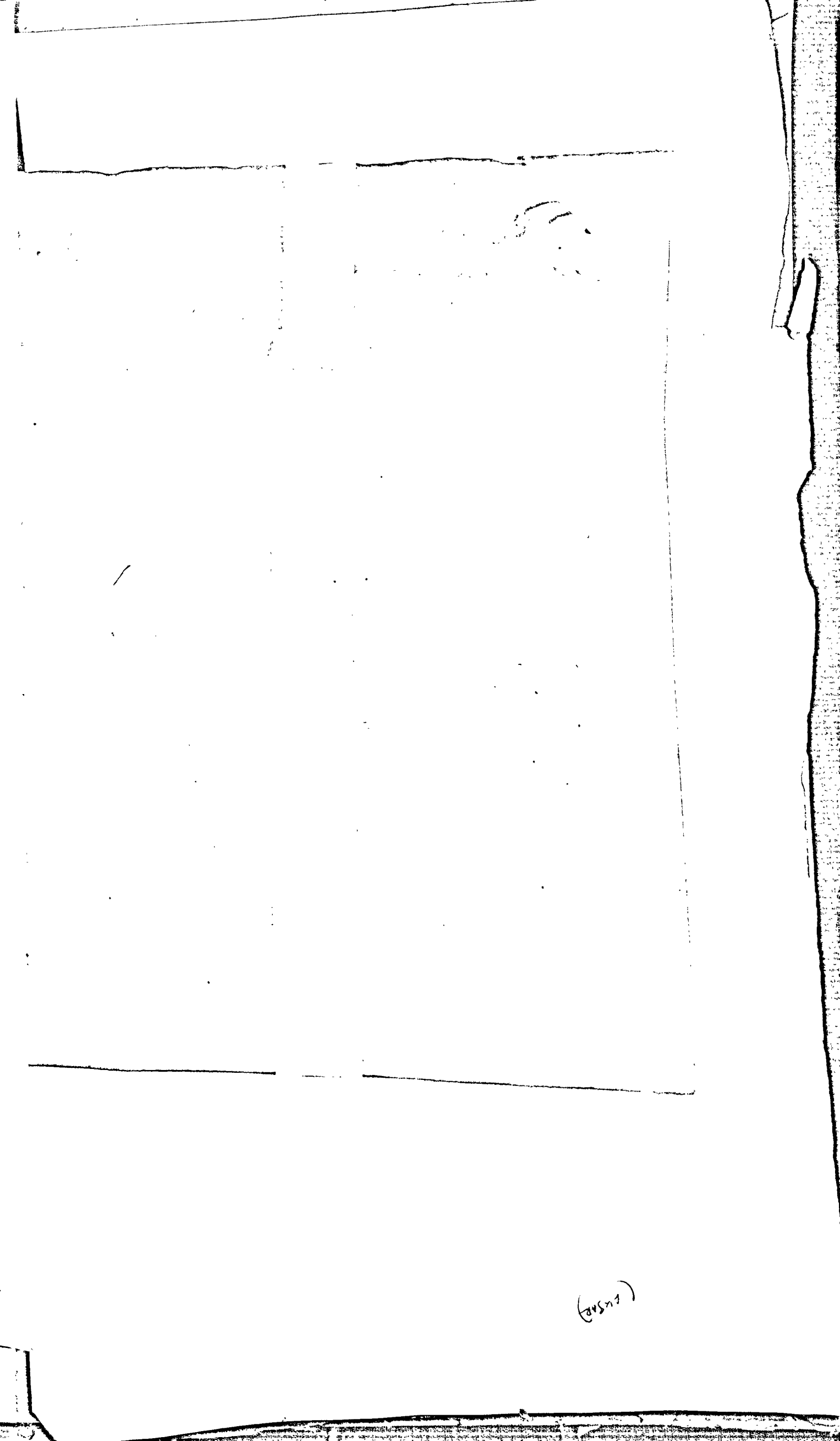
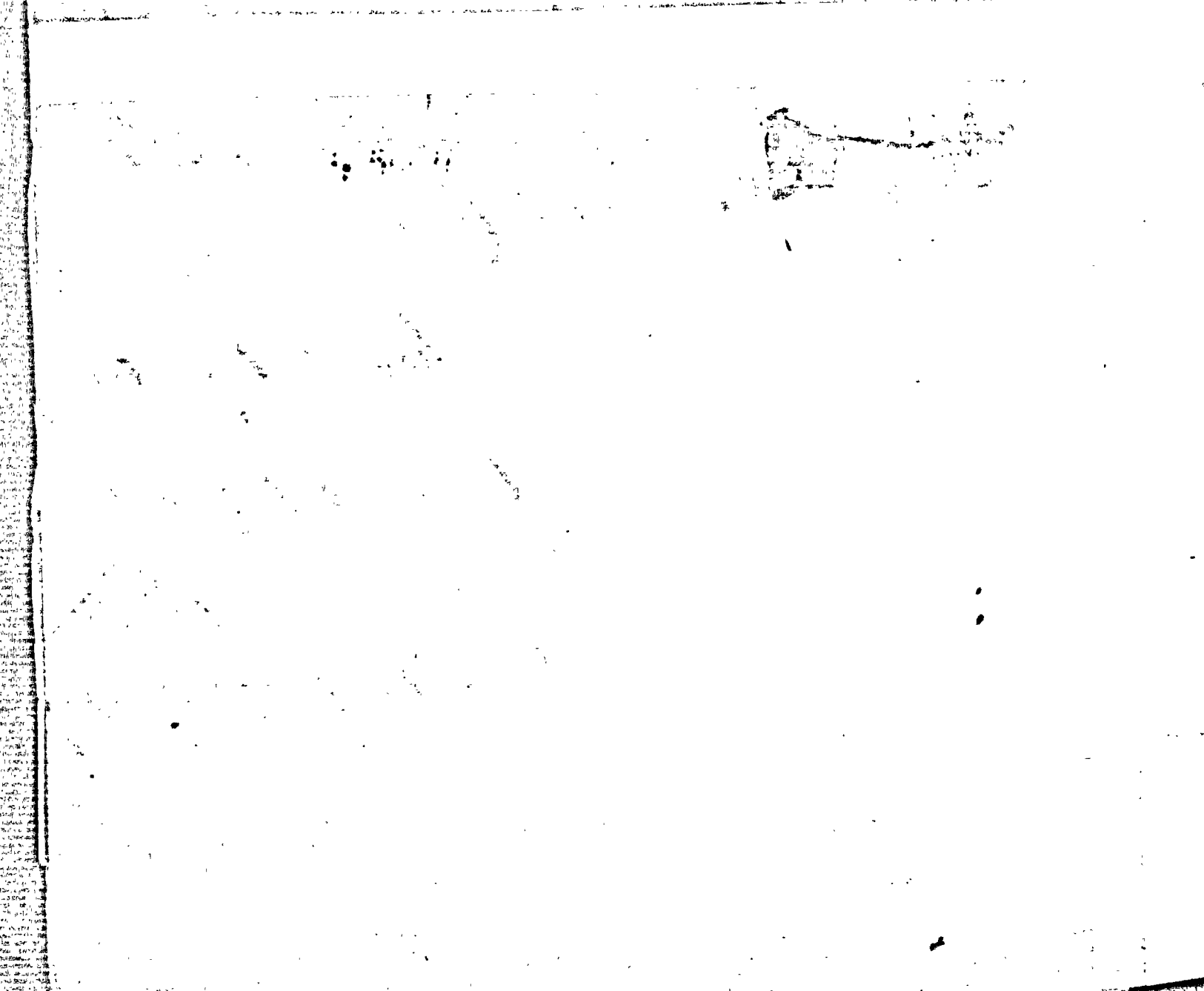
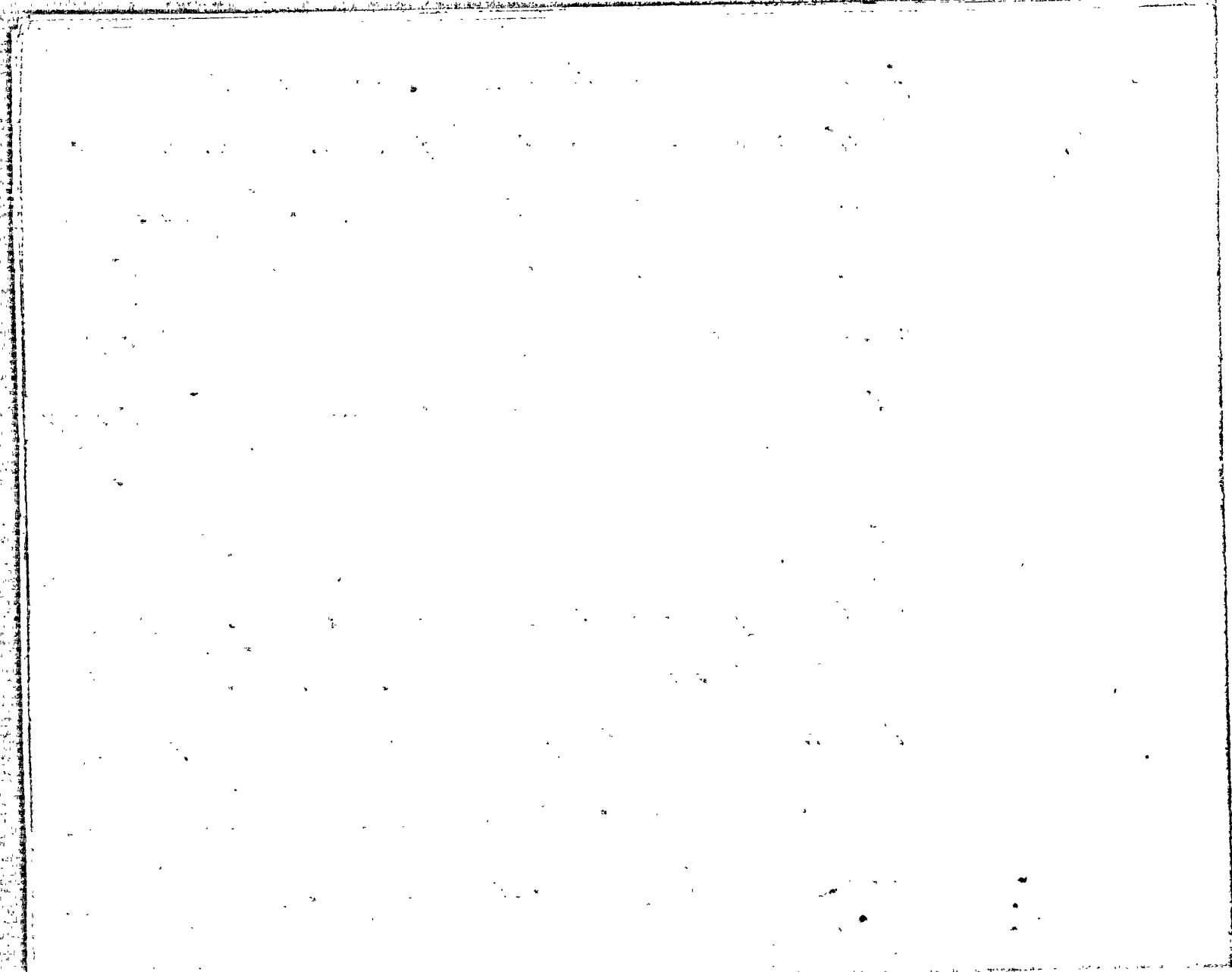
16. In partial explanation of the decrease on the estimate of 1866 it may be remarked that there is no separate item in the present estimate for Maintenance—whereas in the former one Rupees 58,180 altogether were allowed.—From para: 5 of the Chief Engineer's Report, however, it will be seen that such allowance on this account as appeared necessary has been made.—

17. As considerable modifications of the banks in some of the miles are intended to be made, and as many of the Masonry works also have been modified as, for instance, the Calingulaks by the addition of sluices, it will not, I think, be advisable to require the Chief Engineer on the completion of the Section to forward a Statement of the work executed, as this would be very difficult to ascertain.—It will however be quite practicable to show what the work, forming part of the finally adopted arrangements, is, and this should be accurately ascertained and reported before the final passing of the expenditure—Plans of all Masonry works, as executed, should accompany the measurements of the work.—The Chief Engineer should also

price the work of all kinds done, with reference³³ to the rates which have from time to time prevailed, and the fair value of the Section, as completed in an efficient manner, will then be known and can be compared with the actual total expenditure.—If this requirement be kept in view during the further progress of the Section, I have no doubt a sufficiently close and satisfactory account of the work may be prepared.—On this condition and on the understanding that the Chief Engineer will take care that the level of the reinforcements and banks referred to in para: 11 above is modified so as to afford a sufficient margin for safety, they do recommend that supplemental sanction for Rupees 4,10,476 be given for the 2nd Section Main Canal.—

I have the honor to be,
Sir,
Your most obedient servant,
Wm. Lindsay Captain R.E.
Cous. Engr for S.H. Company

Edw. M. B. S.



(15/5/57)

Copy in a Letter to England
of 23rd November 1867

From
The Secretary to Govt. D. W.
37/2

Dated 23rd }
Recd 24. } Sept 1867

73 plans in separate
parcels
Submitted for the consideration of Govt. a letter No. 259 dated 13th instant from the Agent transmitting the documents & Estimates with-in mentioned for the completion of the works of the 2nd Section -

No. 3195. 15 Oct 1867

No 298
e 11x Oct 1867 or 14th

Public Works Department.

No 3195

PROCEEDINGS of the MADRAS GOVERNMENT.

Under date the 15 Oct 1867

Read the following

From the (m) J. S. S. Co.

(Here enter No. 76 dated 23rd Sept 1867.)

In Pro. No. 367, dated 17th November 1866, the Govt. were compelled to withhold sanction to revised estimates of Rs. 17,97,365 for completing the second section of the Madras Irrigation and Canal Company's Canal, as it appeared evident from the Consulting Engineer's scrutiny of them that they were prepared on insufficient data as to the extent of work to be done, and that they did not provide for all that was required.

N. S. S. Co.

required to place the
section in a secure and
satisfactory condition.

Capt. Mullins now sub-
mits modified estimates
which have been framed
after a more careful
consideration of the re-
quirements of the Canal,
and it is observed that
while much additional
work has been pro-
vided for, the total,
Rs: 17,91,600, is slightly
below the estimate which
the Govt. declined to
sanction in 1866, but,
contrasted with the
original and first re-
vised estimates, exhibits
an excess of 23.5 per cent
in the former case and
30 per cent in the latter.

Under the circum-
stances brought to notice
in Para 17, the Govt
will

+ Rs: 5,34,000
x " 13,76,415.

will not insist on the
submission after the
completion of the section,
of a statement of the
work executed; but
the final passing of the
expenditure will be de-
pendent on the particu-
lars specified by Capt.
Mullins in the same
Para being furnished;
and on this condition, and
on the understanding that
the precaution suggested
in Para 11 for the safety
of the revetments and
banks is adopted, His
Excellency in Council sanc-
tions the revised estimate
for the second section
of the canal.

To the Comdg. Engr. Mr. J. V. C. with two letters, two
statutes & seventy three plans
Manager. do. do. with two letters

Recd 16/10/67

Copy in a Letter to England
Dy 23rd November 1867.

P. W. 1867. Department.
Proc: of Govt for October
No. 3195

PROCEEDINGS OF GOVERNMENT of Madras

Dated 15th October 1867

Further Order 1089 D/15-4-71

Sanctioning with
remarks the revised estimate
of Rs. 17,91,600 for the second
section of the Madras
Irrigation Canal
Company's Canal.

No 298-299

2.11.67/67 Da 14*