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Public Works DEPARTMENT.

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Not to be folded or roughly handled

Proceedings of the Madras Government, Public Works Department, 15th May 1865.

No. 305. Read the following letter from Captain J. MULLINS, R. E, Consulting Engineer for Irrigation and Canal Company, to Colonel C. A. ORR, R. E, Secretary to Government, Department Public Works, dated Madras, 19th April 1865, No. 243 :—

SIR,

1 Letter in original from the Agent, No. 180, dated 10th April 1865.

1. Having inspected the first eight sections of the Madras Irrigation and Canal Company's main canal, between the 21st and 31st ultimo, I have the honor to report, for the information of Government, the state and progress of the works.

The Soonkasala Anicut.

* Letter No 45, dated 23rd July 1864, and enlorsement No 89, dated 2nd September 1864, to Agent's letter No. 1,083 of the 31st August 1864.

2. The Soonkasala anicut was breached in July*1864, and at the time of my visit the body wall had been re-built to within about five feet of the full height. It is founded on the loose rubble of which the ring bund to cut off the breach was composed, and to strengthen this part of the work, the following arrangements were in progress. Two walls at right angles to the body were being built as retaining walls to a sloping apron. The walls will, at their junction with the body wall of the anicut, be three feet below the crown, and they will slope at one to nine to the rear, and abut against solid rock in the bed of the river. The space between these walls will be filled in with rubble stone, over which one foot of concrete is to be laid, and above this the slope of the apron is to be formed with packed stone of the largest size procurable. As an additional precaution two retaining walls parallel to the body of the anicut, and connecting the side walls of the sloping apron, were to be built. On the rubble ring bund a low wall has been constructed to prevent water in freshes passing over the site of the breach until there is a considerable quantity of water in the river below.

There was a good deal of water passing through the loose rubble under the new body wall, but it was considered that this will be checked by the mass of stone about to be placed in rear, and that puddling between the ring bund and new body wall, and above the former, will so far reduce the leakage as to allow of the bed of the river silting up and so stopping it altogether.

3. The character of the work now under construction for the strengthening of the breach is very different to that which failed last year, and which was noticed in my report as per margin.

No 40, 2nd July, Proceedings Madras Government, 24th August 1864, No 2,438.

I think however that the sloping apron, though well adapted to rivers with sandy beds, is not well adapted to resist the action of the water when it is laid upon rock, and it is difficult so to secure the foot of the slope as to guard against the removal of the stone at that point, and the consequent destruction of the apron. The work in progress is, of its kind, as good as the circumstances of the case would allow, but had not so much of the work been done, and the time before the early freshes been so short, I should have recommended the adoption of measures which would probably have rendered it practicable to found a new body wall on the solid rock. An attempt was made to do this, but on removing the stone from the line of the wall, it was found that the loose stone of the ring bund would not stand, and the intention was therefore abandoned. I think, however, that it would have been quite practicable to cut off the breach entirely by a mud bank formed from the silt in the river bed above the anicut, either by running such an embankment from the wall beyond the breach on either side, or by bunding the open channels at some distance above the anicut.

4. The wish to throw water into the main canal both for irrigation and for the supply of Kurnool has much interfered with the facilities that might otherwise have been obtained for closing the breach. The river for some time past has not contained more water than might readily have been got rid of through the under-sluices, but to maintain the supply in the canal these have of necessity been kept closed. It would have been better had the canal been made to give way to

the very important work at the breach. At most a few hundred Rupees of compensation would have been the only loss, and not only at the anicut itself, but in the main canal, as will be presently noticed, the work would have got on much better in the absence of water.

5. I understood that the outlay on the breach would amount to about 40,000 Rupees. Much of the expense was occasioned by the stone for the ring bund having to be obtained from the revetment of the stop bank on the south side of the river, and carried along the crown of the anicut to the breach. This stone was of small size, and a great deal was carried through the breach, and the wonder is that the formation of the bund with such material proved practicable.

6. The crown of the anicut has, throughout both branches, stood very much better than I anticipated when reporting on it last year. The damage has been very trifling indeed, and it is now in good order.

Paragraph 4 of letter No. 40, 2nd July

7. The rock in rear of the south branch has, in parts, been a great deal worn by the overfall. The worst parts were to the north of the breach, and there repairs have been executed and the hollows at the foot of the body wall have been filled with concrete. The Officiating Chief Engineer considered that experience had shown that this material stood better than stone masonry, I have never seen concrete under an overfall of more than about six feet, while in the present case the anicut is more than double that height. At the same time it is undoubtedly difficult to construct good masonry in such positions unless the rock be first cut out, so as to afford room and holding surface for large block masonry, and perhaps before incurring the expense of such work it will be well to try the concrete. Should this fail it will be necessary wherever the nature of the rock is such as to be incapable of standing the wear and tear, to construct an apron of massive, picked, dressed stone in a bed cut out of the rock.

8. The body wall of the north branch was, in some places, damaged to a small extent by the displacement of the stones at the off-sets on the rear face. The necessary repairs have been executed. The rock in rear of this branch has in some places broken up into large masses, which have been moved a few feet by the water. The process by which this has been accomplished is observable in many rivers. The softer parts of the solid mass are drilled out by the water, these holes at last approach to within a foot or so of each other, and this intermediate neck of rock is then fractured, and what was a continuous mass becomes divided into lumps varying in size from 1 or 1½ cubic yards to a few cubic feet, and the force of the water then removes them from their original position. Except at one spot, where this action has been going on near the foot of the anicut wall, it will take a long while before the rock will have suffered to an extent to occasion any immediate danger to the anicut itself, but in the meantime the action should be watched carefully, and perhaps the detached rocks might be so arranged as to protect the foot of the anicut, either by packing them there, or using them to dam up the water and form a cushion pool to receive the overfall.

Paragraph 6 of letter No. 40, 2nd July.

9. The north wing-wall of the north branch is built on loose rubble. The silting up of the bed of the river has reduced the leakage very considerably, and it may be anticipated that the freshes of another year will deposit sufficient silt to make it altogether water-tight. There was no water near it at the time of my visit.

The Under-sluices.

10. The masonry of the under-sluices has stood very well, and is in good order. The south vent has lost a couple of stones from the rear edge of the flooring, and that is the only damage occasioned by the freshes of the past season. The rock in rear, which is much below the sluice floor, is sufficiently hard to stand the wear without injury. The revolving shutters, which have been fitted to ten out of the twelve vents, require re hanging, as they do not shut properly, and work with difficulty. The shutters themselves are in excellent order. The depth of water on the upper sill was five feet.

The head Sluice

11. The shutters of the vents which have been fitted with gearing are reported to work well. There is a large bank of silt above the sluices, and about one foot of deposit in the canal.

Proceedings of the Madras Government, Public Works Department,
15th May 1865.

The side slope revetment below sluice on the left bank has much of it been displaced.

Stop bank, south side.

12. This bank was complete prior to the removal of its revetment to the anicut breach. The stone will now have to be replaced

Main canal, 1st Section, 1st to 18th mile.

13. *1st to 5th Mile* —The embankments are generally very nearly finished, and in many parts quite complete. The patches of rock in the canal bed still remain. The bund of the small tank in the 4th mile is not quite up to full height at the upper end The black soil, where the canal is in cutting, and consequently unrevetted, has washed down a good deal.

14. *6th Mile.*—The Yeddarúr tank which breached in July 1863 is in this mile. The work here is not yet complete, and it has been much delayed by the presence of water in the canal. Some parts of the revetment are not yet up to water level (about one foot above canal bed). Parties were at work dressing the bank and packing revetment. Calingulah No. 1 in this mile was breached to enable the water to be kept down to a safe level, but the length of body removed was so small as to be practically useless. This surplus work has no apron.

15. *7th to 10th Mile.*—The canal in these miles is approaching completion. The Calingulah No. 2 in the 8th mile is finished, and has a small dry stone apron, which may perhaps stand, but would hardly do so were the calingulah to discharge much water. The revetment in this part of the canal is being done at 8 Annas a cubic yard, a fair rate

The Culvert No. 10 is said to leak less than it did at first, and the paving and revetments connected with it are complete.

In the 10th mile the making up of the banks was in progress up to Calingulah No. 3, which was complete last year.

16. *11th, 12th, and 13th Miles* —In the 11th mile the banks are nearly finished, the revetment is still far from complete. The high banks in the 12th and 13th miles are finished, and in good order. Much revetment still remains to be done, and in the tank in the 13th mile there are parts which are not yet up to the level of bed of canal, and it will be difficult to get on with this work so long as water is being passed down.

17. *14th, 15th, and 16th Miles.*—In the 14th mile a good deal of revetment has been done, and much remains to do. In the upper part of the 15th mile this work is behindhand, but below that the canal works are complete, with the exception of a little earthwork above the revetment. Calingulahs Nos 5 and 6 have been breached purposely, but to a very small extent only.

18. *17th and 18th Miles.*—Some of the revetment in the 17th mile, which was built on a very steep slope, has fallen over, and a good deal more is unsafe. It will be repacked on a proper slope, and this will cost but little. The cutting at the end of this and the beginning of the 18th mile is complete. The Kurnool sluice is a carefully finished work and answers well.

Temporary Bridges.

19. All that were required to be built were constructed last year, and have been in use ever since, and most of them have carried a considerable traffic. It is intended to raise them two feet this year to allow of more water being passed down, but as they have only two vents, or spans, of 12 feet each, I doubt whether the water-way will suffice.

Ferry Boats.

20. Two have been placed on this section of the canal, but they have not yet been brought into use. They are made of wood and are of the ordinary punt form, and will carry two bandies without bullocks, or one cart with bullocks.

Revetments

* Letter No 40, 2nd July 1864, paragraph 27.

21. These would have made much more progress but for the delay occasioned by bringing the canal into use. I do not know why the intention,* to build all the revetments to five feet above bed of canal, before proceeding with the upper part of this work, was not carried out; as

it is, the sooner the water is stopped and the parts, which are below the level of water intended to be admitted this year, are finished, the less the difficulty will be. The anxiety to take water down the canal led to its admission before the works were ready, and although little risk of damage was incurred, the proceeding will add to the cost. The rates for revetment have been revised, and due attention appeared to have been given to economy.

The revetments, where laid on unconsolidated earth, are in many parts displaced, and will need re-packing, but on the whole the damage sustained from this cause is less than might have been expected, and this may be due to a regular settlement over the whole slope.

Earth work.

22 But little remains to be done to the banks. Where the canal is in cutting there is a good deal to be done in the way of clearing and widening, especially just where it passes into and out of tanks, and this should be done as soon as possible, as it may be inconvenient to dry the canal when the lower sections come into use. The removal of the rock, which has remained untouched since last year, should also be attended to.

Irrigation Sluices

23. Several of these have been constructed with their sills considerably above the level of bed of canal, and to afford them a supply, temporary dams have been placed across the channel, and, in one case, water was being lifted at the Company's expense. It is probable that the sills were thus placed intentionally, with reference to the level of the lands to be watered, but at any rate the permanent arrangements should be decided on, and neither dams nor water lifting should be allowed after this season.

Leakage.

24. Except in a few places where the material of which the banks are composed is very porous, the leakage through the banks is not very great, but nearly all along there is more or less leakage through the sub-soil. Where the former occurs and the toe of the rear slope was affected, shingle banks have been laid down which have stopped damage. In the latter case the loss of water is the only evil, as there are abundant facilities for drainage.

25. On the whole the condition of this section of the canal after having had water in it for nearly eight months is satisfactory, and if an opportunity be made for finishing off the incomplete work on the low levels, it will be quite ready to carry all, and more than all, the water which will be wanted this year.

Hindry Aqueduct.

26. The arches of the Hindry aqueduct had, prior to the inspection made last year, been completed to two-thirds of their width, and when the water was passed over, it was found that the part of the south abutment which was outside the arch showed signs of yielding to the pressure of the water and earth in rear, and there being masons available, it was thought advisable to construct the remaining third of the arches, and at the time of my visit four arches had been completed and two were nearly ready to be keyed, and as the north arch, under which runs the Bellary road, had been completed before, only seven arches remained to be finished. The aqueduct over the sixty feet width has been enclosed by a temporary wall on the west side, and by a part of the permanent parapet on the east. The floor has been plastered. The leakage through the north abutment is now very small. Some of the arches show signs of considerable leakage, but it was at the south abutment that the great leakage occurred. It would appear that the lower courses of the masonry there were laid without mortar, and the water passing through the sandy soil in rear found its way through the masonry in large jets. Through the south arch, the spandril or face wall, and through the wing-walls also, a great deal of water passed, and left on the face of the masonry a coating of lime, which has been removed from the interior of the masonry. The plastering which has since been executed at the backs of the abutment, and over the flooring will no doubt go far to diminish the leakage, and I believe also that it will be found that the joints of the masonry, notwithstanding the amount of mortar removed

are better filled and more water-tight than was the case before. Leakage through the abutment itself will, it is expected, be obviated by the large mass of rammed earth which has been placed there, but until another trial has been made it is not practicable to give an opinion as to whether recourse to asphalte will not be found necessary, though, if the parts which were most leaky should be found to have been so far improved as to leak no more than many other parts, where the masonry joints had been more carefully constructed, I think this expense may be avoided.

Now that the arches are approaching completion, it would be as well to finish the aqueduct altogether, so that the accounts may be closed, as it is not worth while to leave the parapets only incomplete Opinions may differ as to whether it was altogether advisable, at a time when funds were running short, to turn the last third of the arches, but now that this has been done the comparatively small extent of other masonry should be completed.

Second Section, Main Canal, 18th to 32nd mile.

27. *Part of* 18*th mile below the Aqueduct*—The banks below the aqueduct were constructed of black soil, and the surface soil was similar, but at a depth of two or three feet below the surface there was a great bed of sand. Unfortunately, for constructing the banks, the good soil between them was removed, and on the admission of water the leakage through the sub-soil was found to be so great, as to endanger the masonry retaining walls and the embankments behind them. The water was stopped, and that already admitted quickly drained off, and the filling in of the pits with good soil was then commenced. Two estimates* have been framed and sanctioned for this work: the first provided for the filling in near the aqueduct and for some distance down the canal, and this part was almost finished when I saw it, the second continued the filling further down, and also added somewhat to the thickness of the new stratum of non-porous soil, and this work had just been commenced I am of opinion that the measures adopted were the best that were available; that on the next admission of water a great change from the former unsatisfactory state of affairs may be anticipated, and that should it be found that the leakage is still too considerable to make it prudent to leave it to be stopped by deposits from canal water, the best course will be to increase the thickness of the rammed earth. The masonry retaining walls are complete and in good order, as are also the revetments in continuation of these, and the earthworks are finished with the exception of a little top levelling and the dressing of the rear slopes. All the earth required is upon them. It was expected that, in a fortnight after the 23rd March, the canal at this point would be ready for another trial, and the Officiating Chief Engineer promised to report the result, which will be at once communicated for the information of Government

* Rupees 3 700, Proceedings Madras Government, No 246, dated 26th January 1865
„ 3,476 Do. do. No 616, dated 6th March 1865
7,176

28. 19*th Mile*.—Canal is finished up to the commencement of the cutting above the Gooty road bridge, and the cutting was being cleared out The bridge with its approaches has been finished, and the loop drive in connection with the Kúllúr road has been completed, and is in use.

Loop drive

Proceedings Madras Govt No. 1,540, dated 27th May 1864.

To Calingulah No. 10 a well-packed apron has been added with a retaining wall. A floor also has been constructed in rear of the two-sluice vents of the calingulah. Some loose rubble beyond these aprons will probably be required, and there is an abundance of this material on the spot From this calingulah and from Calingulah No. 11 at the beginning of the next mile the surplus water is to be carried by one channel, and the arrangements for effecting this are to be made without delay

The lower part of the cutting in this mile is being cleared out, some of the rock is very hard and is being blasted

The revetment and bank of the rest of this mile are complete.

29. *20th Mile* —To Calingulah No. 11 an apron similar to that at No 10 has been added. A new irrigation sluice has been constructed.

The heavy cutting in this mile has been completed to full width at the lower end, and many other parts are nearly out, but the upper end of the cutting contains a large proportion of very hard rock, and there only one-third of the full width has been excavated down to the proper level, and the other two-thirds are in various stages of progress, and much remains to be done. The character of the rock varies greatly. The hardest description is a basalt, resembling whinstone, and containing veins and dykes of quartz Another hard stone is a conglomerate, containing much quartz. There are numerous shales, some of which are hard but brittle, and separate easily into small rhomboidal crystalline fragments. These shales are in many places covered with slabs of hard rock from one to 2½ feet thick, which once formed a continuous bed, but have been broken up into slabs of various sizes by the movements of the under-lying strata. Above this slab stratum, nearly all over the cutting, a distorted friable shale is found.

* Paragraph 31.

The work is still in the hands of the contractor referred to in my report* of last year. The blasting, however, is managed by the Company, though the cost is defrayed by the contractor. He is losing by the work, I am told, and it would seem that he clings to it only because he hopes for an increase of the rate It cannot be a matter of surprise that the rate is found unremunerative, for the work has been carried out with a careful avoidance of all proper arrangement, and no fair rate could possibly have left a profit The harder rocks when blasted come out in blocks of one to four tons, and these are then reduced by re-blasting, or with hammers and crow-bars, until the pieces become small enough to be carried up out of the cutting by coolies The additional expense thus occasioned has been very great, and by a judicious use of cranes or travellers, and perhaps of a tramway also, the work could have been done in a satisfactory, expeditious, and economical manner. If the Company ultimately reimburse the contractor, as would seem more than possible, they will lose a large amount of money, which they are not, I think, in any way called upon to pay, seeing that after the difficulties of the work had been experienced, and the contractor had found himself unequal to the task of overcoming them, the option of throwing up the contract was afforded him, and he declined to avail himself of the opportunity of cancelling his engagement. The shingling has been finished up to the sluice at 1,700 yards, and below that the revetment is up to full height, and the canal complete. A temporary bridge has been constructed at the lower end of the cutting.

Zorapore Bridge.

Proceedings Madras Govt No 1,540, dated 27th May 1864

30. The bridge for the accommodation. of Zorapore and its neighbourhood is to be built at a favorable site, at the deepest part of the cutting. It has not yet been commenced. but the collection of materials has been begun.

31. *21st Mile.*—The banks and revetment have been completed. The culvert which was found to leak a great deal was being uncovered, with the intention of plastering its exterior surface, but as the culvert will not, now that the Zorapore bridge has been added to the list of crossings, be of necessity used as a passage, and as the work would involve the removal of a great mass of earthwork, with perhaps doubtful results, the Officiating Chief Engineer considered it might be left alone, and I agreed with him.

32. *22nd Mile* —This mile is complete including Calingulah No. 12, to which the wall referred to in paragraph 34 of last year's report has been added, but not in a very satisfactory manner. The site is a rock, the surface of which is the shape of an inverted saucer, and consequently the water has an inclination to run along the rear of the banks both above and below. The wall will stop the discharge in the latter direction only. Below the calingulah a wall which, including a part in the 23rd mile, is 2,000 feet long. takes the place of an embankment, and is complete.

Proceedings of the Madras Government, Public Works Department,
15th May 1865.

33. *23rd Mile* —Below the wall just referred to, the revetment has been completed up to the three-quarter mile, and the banks need only a little trimming and levelling The right or contour bank is likewise, with its revetment, nearly finished up to the same point. Beyond this up to the Kadrabagh aqueduct, and below that to the end of the mile, which is 100 yards further down, a great deal of earthwork remains to be done, and the heavy revetments have yet to be commenced. A short distance above the aqueduct the soil is a porous lime kunkur, and though the banks, and a few inches of the surface soil, are of better material, a great deal of leakage must be anticipated under, but not through the banks. This will, however, only occasion loss of water.

The embankments near the aqueduct will be very lofty, and the admission of water will require to be carefully managed. They are to have interior slopes at two to one, and exterior one-and-a-half to one.

Kadrabagh Aqueduct.

Letter No 230, dated 24th March 1865

34. The condition of this work has already been reported upon in transmitting a revised supplemental estimate for the additional works deemed necessary to render its stability possible. The rammed earth backing to the upper abutment has made considerable progress, the rest of the additional work was not commenced. Concrete for the flooring over arches was being laid. The main wing-walls are much too short to hold the embankments properly, and the masonry of the side walls of the duct is not of a description likely to be water-tight.

35. *24th Mile* — The wall at end of right contour bank, with its irrigation sluice and some revetment, is finished

The bank (single) for a length of 500 yards nearly up to the first ravine is fully finished and revetted ; to the rest of the bank a good deal more work is required to be done.

The wall, 200 yards in length, across the ravine is finished, all but a few feet of coping. It is intended to strengthen the wall by placing a bank of shingle in rear for one-third the height, and at a slope of about one-and-a-half to one. The wall has been well built.

The earthwork below the wall to end of mile rather behind-hand. The shingling, except for 100 or 150 yards near the wall, is nearly finished

36. *25th Mile.*—Calingulah No. 13 finished. The six sluice-vents will want some apron, as the ground, though rocky, is not hard enough to stand wear.

The earthworks are seven-eigths done, and the revetment nearly finished.

37. *26th Mile.*—The upper part of this mile, as far as the first valley, is in much the same state as last year, and a great deal of clearing and banking has to be done.

Across the valley a wall of the new section, *i. e*, a core of rammed earth with dry rubble retaining walls, is being built. The filling in was behind-hand, and it will not be water-tight unless care be taken to water it and to place its base on tolerably solid material. The surface soil is so full of small stone that water would pass through it as readily as through a sieve. It is said that this wall is costing more than the old section of masonry The limestone for rubble costs 12 Annas a cubic yard, the estimate allowing 8 Annas only. The filling was expected to be done at the rate of three yards the Rupee, but this is found insufficient, as the soil is brought about one-fourth of a mile and there is no water near. This wall is about one-third done.

Below the wall there is some very good revetment, which was done at three yards the Rupee, but the stone is now not so easily obtained as was the case at first, and this rate does not pay. A short distance below there was to have been a masonry wall 800 feet in length, of this 400 feet have been built and, in lieu of the remainder, the new section with earthen core has been substituted This was a mistake, for it will be a very difficult matter to make a good junction, and the appearance also will not be satisfactory. Probably the only safe plan will be to carry on the masonry wall double and gradually diverging, at the same time increasing its batter, until the same section as that of

the dry rubble walls is reached, there will then be room for a proper core. This wall is 40 feet high at the nullah; it looks very weak, and its dimensions* are much below those usually allowed. Some soil has been thrown behind it, and it is undoubtedly advisable to continue this backing all across the low ground.

* 6½ feet top width *plus* height of wall into five inches, being 4 inches per foot batter in front and 1 inch per foot in rear

The next wall is finished; it is of moderate height, and joins on to a low hill at the lower end. Beyond the hill there are a few hundred yards of embankment, which have been carefully revetted, and the mile ends with a masonry wall across the valley, 52 feet high at the ravine, and, like the other walls, constructed with a rubble and sand core. It is 600 feet long, and has cost something over 30,000 Rupees. It is very nearly finished, and will want backing; the masonry is good, but the section is weak.

A good deal of excavation remains to be done to complete the canal across the spurs, but only a little work will be required to pass down a stream 30 feet wide, and 2 feet deep, and that is to be provided for first.

38. 27*th Mile*.—Down to the deep valley the bank and revetment are well advanced, but the cutting is far from complete. The abandoned bank is being run down by railway to the deep valley, and the embankment there is being partially made up also from pits, and is about two-thirds done. It will be finished in two or two and-a-half months. Cost of earth brought by rail is 4 Annas a cubic yard The pit soil is more than half small stone.

Vide paragraph 40 of last year's report

Some cutting at the spurs is required to complete canal.

39. 28*th Mile*.—The long wall in this mile is in much the same state as last year, except that, at the upper end, a short length on an improved section has been added. It requires to be backed with soil. The short masonry wall further down is six feet above bed, and a length of the new section† has just been commenced. It will be better to continue the masonry wall, with however the improved section adopted at the beginning of this mile.

† Earth core and dry stone walls

Beyond this to the end of the mile the core section wall is continuous, and is about half done.

In this mile there are only a few yards of ordinary embankment.

40. 39*th Mile*.—For the first 300 yards the core section wall is continued; it is about one-third done, and the greatest height will be 28 feet. Thence the cutting across the spur is about half done, and below that, down to Calingulah No. 14, the bank is very nearly finished with revetment. The calingulah is in the same state as last year, stone for the sluice vents under preparation. Thence to the end of the mile the high banks are very nearly finished, and the revetments also are not far short of full height.

41. 30*th Mile*.—In the first quarter mile the bank and revetment are very nearly finished. Thence to half mile, bank three-fourths done, and will be shingled. Nearly all the rest of the mile will be a combination of cutting, and single wall with a thin bank in rear, and this part is three-fourths done. The last few yards are formed with a bank, which is nearly complete, and will be shingled.

42. 31*st Mile*.—The mile commences with a length of 200 yards of core section wall, which is about seven-eighths done. After that the single wall has not been touched since last year, and has to be backed. Thence to the end of the mile the bank is complete except trimming, and the revetments, all but 200 yards near the lower end, are finished. These banks are high and their interior slopes are two to one

43. 32*nd Mile*.—A little trimming and levelling are alone required to complete this mile. Revetments complete. There are one or two small gaps, which have been purposely left, one is at the spot where Calingulah No. 15 was to have been built.

Proceedings of the Madras Government, Public Works Department,
15th May 1865.

General state of the 2nd Section

44 The amount of work done in this section during the past nine months, is very satisfactory, and while there is much to do to render the canal complete, there will be no difficulty in getting the section ready to pass down a moderate supply by the end of June. The state of the Kadrabagh aqueduct is, however, far from satisfactory, and until this work has been found capable on trial, and the embankments connected with it have settled, it must be doubtful how soon it will be possible to take down a continuous supply. The great walls of this section have also yet to be tried; that they will leak considerably can hardly be doubted, and their stability is perhaps rather to be hoped for than to be confidently expected. The scouring sluices which it was at one time intended to place in these walls, have been omitted, and this is perhaps an advantage.

As mentioned in last year's report the soil throughout this section is unfavorable for water-tight embankments.

Distribution.

Nothing has as yet been done towards the construction or laying out of irrigation channels, the irrigation however will be very limited, and the land between the canal and the river being but a narrow strip, the arrangements will be very simple.

Railings or parapets to walls.

45. No provision has as yet been made for railings or parapets for the great walls in this section, but some protection of this sort appears to me to be indispensable, and if cattle are to be used in towing, there is not room for anything but a railing. A drop of 30 to 50 feet is not a pleasant contingency, and it is one that should be guarded against before the line of the embankment becomes, as it soon will become, a thoroughfare. I may add that the long calingulah towing-paths stand in need of a similar protection, though their elevation is far less.

3rd Section of Main Canal.
33rd to 43rd miles

46. 33*rd Mile*.—The banks and revetment are very nearly complete throughout. The Sultanpore crossing-culvert wants plaster and puddling over the crown, and the walls and contour banks at the south end are incomplete; the former were commenced of an insufficient thickness, and two feet are about to be added. The main bank over north end of culvert has to be made up.

47. 34*th Mile*.—Calingulah No. 16 is complete except coping, and a one vent sluice at east end. There is no apron; one will be necessary. The earthwork of the banks has been all thrown up, and has to be trimmed and sectioned. The absence of sections for the guidance of the work-people has led to work much in excess in several places. Some shingling has been done. Calingulah No. 17 was complete last year. It has no apron, and perhaps one might be dispensed with by raising the body wall a few inches, as it struck me that all surplus water might be discharged at No. 16 Calingulah.

48. 35*th Mile*.—(About three miles). The cutting at the commencement is very nearly finished. The banks below, down to end of next cutting, are very nearly finished and revetted. The cutting is about half done, the rate is 4 Annas a cubic yard for lime kunkur, which is the soil met with all along here Thenth-ere is along cutting about 3½ feet in depth, which is nearly finished, and the bank across the small valley beyond is complete and revetted. Beyond this there will be a cutting, through side-long ground, nine feet deep at upper edge, and this is hardly commenced. The narrow cut through this will have to be pushed on, if water is to be passed down in June or July. Below this, down to the Ullur aqueduct, the bank is very nearly complete, and much of it revetted, but there is a short length where it is only half done. The rate for revetment here is 2 Annas for the bottom yard, and 1 Anna additional for each successive yard, and this is very cheap.

Below the aqueduct only a very little earth work has been done since last year, and this part is therefore still barely commenced. The last 150 yards up to Calingulah No. 18 will be core section wall, and this is half finished. Calingulah still wants a coping to complete. No apron has been yet given.

Allur Aqueduct

49 This aqueduct has its arches turned, and the spandrils and wings partly built. The materials used are dark limestone for the arch faces and cut waters, and a lighter variety for the rest of the work, both these stones make excellent masonry. The arches and especially the thirds last turned are by no means as carefully built as they should have been: irregularities and open joints are far too numerous, and even the faces are not true, and it will not be surprising should work so constructed leak. A large quantity* of tough kunkur has to be excavated above and below the aqueduct, which at present stands in a rectangular pit, and the road approaches will necessitate much excavation The circumstances of the place rendered such a work quite unnecessary, and many thousands of Rupees might have been saved, but for the Chief Engineer's objection to bridges.

* Not provided for in the estimate, so far as I can judge from the plan

50. *36th and 37th Miles*—In the former nearly all the revetment, which was incomplete last year, has been finished, and some earthwork has been done, but the bank is not yet quite complete. The cutting at the end of the mile is very nearly finished. In the 37th mile a little more earthwork is still required, and some small amount of revetment. The irrigation sluice for which a gap was left is not yet built.

51. *38th Mile.*—Up to the wall, banking and revetment nearly finished Wall complete except at upper end, where a gap for a passage has been left; most of the earthwork backing thrown up. Bank below this up to double wall very nearly finished The double wall is now 15 feet high, it will be 17 feet. To the end of the mile revetment finished, and only a few cubic yards of earthwork remain to be done. The irrigation sluice here has not been commenced, and the gap for it remains unclosed.

52 *39th Mile.*—Down to Calingulah No. 19, bank finished all but a little dressing, and revetment complete. The average rate for this latter has been 4 Annas, and much of it is very good. Calingulah in the same state as last year. Bank and revetment below calingulah complete, down to the cutting near the end of the mile; rate for revetment 6 Annas a cubic yard. A great deal of the cutting has been done, and on the whole it has turned out to be easier work than was expected, but at the lower part the surface is composed of hard limestone and conglomerate rock which, though in detached pieces, is difficult to get out, and as the rate allowed for the cutting, 4 Annas a cubic yard, is too low for this work, it would be better to raise it to 6 or 7 Annas for the rock, which will probably be found to extend to a small depth only, and afterwards to fix another rate for the sub-soil, when its nature has been ascertained. The sluice in the wall immediately below the cutting has not yet been built: the wall is nearly up to full height.

Paragraph 56 of last year's report.

53. *40th Mile*—The wall in continuation of that in the preceding mile is very nearly finished, and part of it is being coped. Thence to the double masonry wall, the main mass of earthwork has been done, and the revetment has made some progress The wall is very nearly finished, and it looks far from safe It might have been left out with advantage. For 150 yards below wall, the earth work is two-thirds done, revetment not commenced. The inner toe of the bank here is a good deal out of line Thence down to the cutting at Malayála the banks and revetment are approaching completion. The cutting is much behind-hand, and it is tough work. Thence down to scouring sluice the works are in much the same state as last year. The sluice is in progress, the entrance and exit tunnels are complete, and the vents nearly up to the level of covering stones. The cut stones for the shutter grooves are very fine blocks. Below this to the end of the mile the banks and revetments are complete.

54. *41st and 42nd Miles.*—The banks and revetments of both these miles are, for the most part, finished, and the remainder are approaching completion. One gap remains to be filled in in the 41st mile. The proposed scouring sluice near Madigutla in the 42nd mile has been omitted, and this is an improvement. Calingulah No. 20 at the end of the mile was complete last year

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55 *43rd Mile*—The cutting at the upper end of the mile is almost finished, the bank below this was complete last year. The irrigation sluice, for which a gap has been left a little below the middle of the mile, has not yet been commenced. Some little making up of the banks in this mile is required where the settlements have been considerable. The junction with the Nagatore tank has not yet been completed.

General state of the 3rd Section.

56. If attention be paid to the few parts which are rather behind hand this section should be ready to pass water down by the 1st July

Several irrigation sluices have yet to be built, they are small works and could be finished in a few weeks Nothing has yet been done to the distribution channels. There are some seven or eight thousand acres of land available for irrigation probably, under this section of the main canal, but in the absence of irrigation channels but a small part of the area is likely to be watered this season, and it is to be regretted therefore that arrangements have not been made for laying out and pushing forward these works. The Ryots cannot wait until the close of the season before determining what the crops of the year are to be, and if they were to turn dry lands into paddy fields this year, the channels ought to have been ready by the end of March at latest, so as to give them an opportunity of ascertaining what the arrangements would be.

Additional funds will be required for the Hindry Division

57. The above three sections form the Hindry Division. The Executive Engineer at present in charge has not, as yet, had time to compare the work in all the miles with the balance of the sanctioned estimates available for its completion, but he considers that to finish the Division altogether, according to the arrangements which have been sanctioned, an additional supplemental grant of between two and three lacs will be needed.

4th Section or Nagatore Division

58. *44th Mile*—The gap left for an irrigation sluice has been partially closed, but the sluice has not yet been built. Up to the end of the Nagatore tank bund, the work is in much the same state as last year, but it has recently been recommenced. Below this, to sluice at 39 chains, banks complete, and patches of revetment done. The sluice has been built of good stone. Distribution channel is being laid out. Thence to end of mile, banks complete and revetted.

59. *45th Mile.*—As far as the Nagatore bridge, the banks are nearly complete, and revetted as far as intended and required, and the earthwork of the entire mile is approaching completion. Approaches of bridge nearly finished; the pits have been cut to a depth of nearly three yards on ground required for the slopes of the approaches, and these latter will have either to be carried down into the pits, or retaining walls must be built.

60 *46th Mile*—An eight feet culvert has been completed at six chains. It was intended to be a crossing, but its floor is about 13 feet below the level of the country, a large outlay would be required for approaches, and the head way is insufficient. The masonry of the arches is very remarkable.

The canal in this mile is very nearly finished, a little rock clearing remains to be done. Some revetment has been built with stone out of the cutting.

61. *47th Mile*—Calingulah No. 1 has some very carefully packed rubble apron partly done Cost 5 Rupees a cubic yard. The sluice apron well built, and if carried out to the end of the wings with packed rubble, it will do very well Calingulah otherwise complete, canal down to this nearly finished, below that incomplete. At 59 chains a gap has been left for a road; bank here will be 20 feet high. The single bank requires a good deal more earth. It has been revetted to a height of several yards with a rotten slate, which will melt away in a short time. The Culvert No. 2, eight feet span, in this mile is proposed* to be omitted. It was intended partly for drainage and partly for a crossing, but it would be very badly adapted for the latter, and at this point perhaps a crossing is not absolutely necessary for a communication between villages, though that between the fields must not be lost sight of. The omission of the culvert and its connected contour bank

* *Vide* Acting Chief Engineer's letter, No 1,799, 31st ultimo, with tracing attached

would add 7·70 acres to the water-spread of the tank, and this is not of very great consequence as the land is red soil of poor quality. The next crossing will be at a little more than 1½ miles lower down, and this latter culvert also will make a very indifferent passage, as its floor will be ten feet below the level of the country. I would recommend that the omission of Culvert No 2 be left to the Chief Engineer's discretion, it being understood that the question of the provision of a suitable number of crossings will be decided separately, with reference to the orders passed on that subject.

Proceedings Madras Government, No 2,438, 24th August 1864, paragraph 4

62. 48*th and* 49*th Miles.*—In the former mile the cutting is nearly complete; the banks require a good deal more earth. In the 49th mile both the cutting and the banks are not nearly finished, except in the last ten chains of the mile. At fifty chains the excavation for the eight-feet Culvert No. 3 is ready, floor will be about 13 feet below the level of the ground. It will not make a good crossing, the inlet excavation has not been commenced.

63. 50*th and* 51*st Miles.*—At the upper end of the 50th mile the earthworks are behind hand. The masonry of the three-feet culvert at 42 chains not yet commenced. The earthworks of the last three-fourths of the mile nearly finished. The first half of the 51st mile has its earth-work nearly complete, and the revetment is several yards in height. The nullah is still open. The remains of the open wall sluice are to be cleared away. Thence to end of mile three-fourths of earth-work done, and revetment commenced at one part.

64. 52*nd Mile.*—The three-feet culvert is in progress, side walls and part of arch done, and part of the out-fall channel. Thence to Calingulah No. 2 the cutting wants a little clearing only Calingulah sluices not completed, apron not commenced. Canal completed below this, all but a little clearing and filling up gaps left for crossings.

65. 53*rd Mile* —Down to the fourteen-feet culvert at 31 chains, the canal nearly finished. Below this contour bank approaching completion and partly revetted, and the single bank is in some parts nearly full height, but elsewhere three to four yards below the proper level. Revetment has made good progress, but much of the stone is very bad, and will have to be re-placed. This error ought to have been avoided as it was well known (*vide* paragraph 75 of last year's report) that some of the slate in this Division would not stand exposure. The rate varies from 6 to 10 Annas. In the last few chains of this mile, the earth-work is much behind-hand and the revetment has not been commenced. The fourteen-feet culvert has had the excavation completed, and the one abutment, which was constructed for a six-feet culvert, remains in the state in which it was six months ago. New work not commenced.

66 54*th Mile.*—As far as the gap at 15 chains, a few yards of revetment done, stone pretty good, slope rather steep. The banks on the two sides of the gap are in a different alignment. Thence to 25 chains revetment about three yards high, and it averages two feet above the bed of canal, the bank is one and a half to two yards higher than the revetment. From 25 to 40 chains, revetment not commenced. From the half mile down to the end, the revetment is in various stages of progress.

The nullah is at 51 chains, and there one bit of a front wing of the open wall sluice remains; the rest was carried away last year. At 73 chains there is a road-way gap.

The embankment is generally high enough for the level of the water which it is desired to carry this year, but the low parts want pushing forward, and there is not too much time for the careful filling in of the gaps.

67. 55*th Mile.*—In the upper part of this mile the bank has yet to be raised four to six yards; in the lower part it is nearly full height. Revetments just commenced. There are several gaps to be closed.

68. 56*th Mile.*—The banks in this mile are nearly finished. Revetment stone is being collected for parts where such a protection is not required. The construction of revetment not commenced. Calingulah No. 3 is in much the same state as last year. The sluice vents were built up some four or four-and-a-half feet, but so badly that this work is being taken down. The rate, 2½ Rupees a cubic yard, is said to be too low.

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15th May 1865.

69. 57*th and* 58*th Miles.*—In the 57th mile the bank is in much the same state as last year. The completion of the earth-work has just been taken up. Revetments not commenced. At 42 chains there is a gap at which an embankment 25 feet high has to be formed. From the commencement at the 58th mile to the 35th chain the revetment has been built one foot above bed, work not very good. Below this the revetting is going on fast, but its cost is said to be not less than 5 Rupees a cubic yard, and the estimate allows Rupees 1½ The quarries are 5 miles distant, the bandies are paid 11¾ Annas a trip, and they bring about one-fourth cubic yard. The quarrying is not a separate charge. The proper rate would be about 3½ Rupees a cubic yard. The slope is 1½ to 1, average thickness 2½ feet. Some parts are up to full height. In some places the thickness of the revetment is greatly in excess of both the intended and estimate allowance, and this will occasion further excess. The Executive Engineer promised to see to this at once. The earthwork for the top of these high banks costs 3 to 4 Annas a cubic yard according to the lead. In the last one-fourth mile about six chains of bank, averaging 36 feet in height, have just been commenced

70. 59*th and* 60*th Miles.*—Up to the end of the tank in the former mile a great deal of earthwork remains to be done. At 35 chains the excavation only for an eight-feet culvert has been got out. Contour bank three-fourths done. Thence to site for Calingulah at 51 chains, little or nothing done since last year. A little more excavation executed at calingulah No. 4. No masonry commenced. Thence to end of mile very little done. In the 60th mile a little earthwork had been done within the last few days, but otherwise the works had been at a stand still since last year. The foundations of the Júpád bridge were just being put in, so that here too little or no progress has been made.

Júpád Office

71. The walls are about six feet above basement, work good. The amount of the estimate is Rupees 2,444, the expenditure Rupees 3,777. The Executive Engineer will be prepared to report shortly upon this work, but he had not, at the time of my visit, the details necessary to show the cause of the great excess.

General state of the works of the section.

72. The progress made during the nine months since my last inspection is very far from satisfactory. The quantity of masonry work executed is very insignificant, and where the heavy embankments were behind-hand last year, they are still very far, not only from completion, but much below the level which they must reach before water can be admitted. The Acting Chief Engineer, who had inspected the works of the section shortly before my visit, expressed a doubt as to whether water could be taken below Puggydial this year, and certainly it will require great exertions to get the section ready, and should sickness occur, as is frequently the case in June it will not be possible to get the arrears of work brought up in time to make any use of the water for cultivation. Nothing has yet been done, beyond commencing the laying out of one channel in the forty-fourth mile, towards providing for the distribution of water.

The state of the masonry works is as follows:—

COMPLETED.

One bridge, five irrigation sluices, one eight-feet culvert, four three-feet culverts, one calingulah.

PARTIALLY BUILT.

Two calingulahs, one three-feet culvert, one bridge.

NOT COMMENCED.

Three irrigation sluices, three eight-feet culverts, one three-feet culvert, one fourteen-feet culvert, one six-feet culvert, one calingulah. The Executive Engineer thinks that three-fourths of the earthwork of the section have been completed.

Revetments.

73. A revised estimate, Rupees 92,545, for revetments was sanctioned in Proceedings of the Madras Government, No 2,871 of the 5th October last, after the Chief Engineer had been afforded an opportunity of ascertaining what the proper rates should be, and what quantities were required. It would seem, however, that the same Officer who entered in the estimate 10 Annas a cubic yard for the 54th mile, 1 Rupee for the 55th and 56th miles, and 1½ Rupees, for the 57th mile, gave the revetment, in the last three miles, and in the latter half of the 54th mile, out on contract at 3¼ Rupees a cubic yard. The estimate allowance, as compared with the cost of the work of this portion, stands approximately thus:—

Proceedings Madras Government, No, 2,394, 20th August.

	Estimate.	*Contract.*
	Rs.	
Half of 54th mile	832	
55th „	13,486	
56th „	6,715	
57th „	20,904	
Up to 6 feet above bed		85,855
To comple to 2 feet above water level		15,570
Rupees ...	41,937	1,01,425

In the 58th and 59th miles the cost will probably exceed the allowance by 2 Rupees a cubic yard, and there are 23,500 cubic yards, so that the excess in these two miles will be about 47,000 Rupees. It is clear, therefore, that the estimate was framed without proper information as to the distance of the quarries, &c, and it may be expected that the actual cost of the revetments of the section will not be less than 3½ times the amount of the estimate said to be sufficient, so late as last September

Rate for earthwork in 54th to 57th miles.

74. I was informed also that a considerable quantity of earthwork in the 3½ miles above referred to, had been let to the same contractor at six Annas a cubic yard, the original rate being 2¼ Annas, and the revised rate 3 Annas.

75. This section has been unfortunately circumstanced during the past year, and though this does not excuse the want of care in preparing estimates, or account for much of the shortcoming in the way of progress, it no doubt has had a considerable effect upon the state of the section. Soon after my last visit the Assistant in charge of the Júpád range was laid up with cholera. In December the Executive Engineer and an Assistant were severely injured by a tiger, and the Assistant died shortly afterwards The result is that, with the exception of one subordinate, there is no one in the section at present who has any knowledge of the works or the accounts, beyond what has been gathered during the last two or three months, and I understood that there was great difficulty in ascertaining what work had been paid for, and what not.

Probable amount of supplemental sanction, which will be required for the section, not known.

76 The present Executive Engineer could not tell me what amount of further sanction will be required to complete the works, and he is at present so much occupied in putting arrangements into proper order, and investigating the accounts, that it will be some time before he will be able to set to work on the preparation of revised estimates.

Proceedings of the Madras Government, Public Works Department,
15th May 1865.

5th Section, Main Canal. 61 to 72 Miles.

77. 61*st Mile.*—Down to the 8-feet culvert much earthwork remains to be done. Culvert completed except inlet. Masonry indifferent. Below this to the end of the mile the earthworks are behind-hand, and in parts the banks have not yet been commenced.

78. 62*nd Mile.*—The inlets to the two 8-feet culverts in this mile remain to be excavated. The earthworks throughout are incomplete, but the amount of work to be done is not large.

79. 63*rd Mile.*—Down to the aqueduct, near the village of Terugopila, both banks have made good progress, and though much work has to be done to complete those banks, not much more need be done before passing water down. Thence to the end of the mile the right bank is behind-hand, the left bank is nearly complete. Below the aqueduct there is to be a revetment, with pointed joints, to either bank, for a length of four chains, and a similar revetment for two chains above the aqueduct and, beyond these revetments, ordinary dry stone revetments are to be given up, and down, to the point where the ground surface is on a level with the canal bed. The pointing is, I think, an additional expense, without any corresponding advantage, and as, where it is given, the slope is to be 1 to 1, and elsewhere 1½ to 1, I should say the latter description of work will be the more substantial of the two.

Teragopila Aqueduct.

80 On excavating for the foundations of this work the rock was found to be at a much greater depth below the surface than had been anticipated, and the foundations are being laid at 37 feet below canal bed, instead of 30½ feet, as shown in the sanctioned plan. Some of the details of this plan have been altered, but the general arrangement remains the same. The two piers were 4½ and 6 feet high, the foundation of the upper abutment was being laid, and the excavation for the lower abutment was not quite out. The stone used for the face work is very good, it costs 2 Rupees* delivered at the work. Stone obtained on the spot is being used for the hearting, and the Engineer employed on the work expressed a doubt as to whether it was sufficiently good, as it is said to deteriorate rapidly on exposure to either air or water. This question should be looked into before it is too late.

* A cubic yard.

Proposed alteration of the Aqueduct—*vide* latter part of the Acting Chief Engineer's letter No 1,799 of the 31st March 1865.

81 The Acting Chief Engineer mentioned to me, when I was at Kurnool, that he wished to reduce the width of this aqueduct so as to hasten its completion and reduce the cost. He hoped to have visited the work with me, but was prevented by the arrival of the Officiating Chief Engineer appointed by the Board. However, on hearing the particulars of the proposed alteration from the Executive Engineer, I informed† the Acting Chief Engineer, demi-officially, that I would forward his proposition for the consideration of Government, and that I should not offer any objection to its adoption, but at the same time I pointed out what the effect would be as regards increase of velocity, and left him to decide whether it would be advisable on a line of navigation to make the change It will be observed that the Acting Chief Engineer, in his letter quoted marginally above, and which appears to have been written after the receipt of my note, says that the change proposed by him will not alter the velocity or discharge. The discharge will of course remain the same, but I think there can be no doubt whatever that the Acting Chief Engineer is mistaken in supposing that the velocity will not be increased. The sanctioned aqueduct has a clear width of 89 feet, and a depth of 9 feet, and its floor was to be on a level with the canal bed. The Acting Chief Engineer's proposition is to place the floor 3 feet below the level of the canal bed, and to make the width 66½ or properly 66¾ feet, this arrangement being based on the fact that $89 \times 9 = 801 = (9+3) \times 66\frac{3}{4}$, and supposing that the three feet of depth below canal bed is equivalent to, and equally effective with, a similar depth above the canal bed.

† On the 25th March.

The marginal diagram will make the case perhaps more clear. A B is the canal bed, A K B the surface of the ground, C D the floor of aqueduct as sanctioned, E F that proposed, G H the surface of the canal water 4,00,000 cubic yards an hour are the maximum quantity of water to be carried, but probably the discharge will seldom exceed 3,00,000, as the difference will be absorbed by irrigation above this point. Taking the latter quantity, the mean velocity with the 89 feet width would be $\frac{300000}{89}$ = 3,370 yards, or 1·91 miles an hour, and with the 66¾ feet width it would be something less than $\frac{300000}{66\frac{3}{4}}$ = 4,494 yards, or 2·55 miles an hour.

The lower level of the aqueduct floor would, it appears to me, be effective only in one way, it would give the moving water a surface of water instead of a masonry surface to run on, and consequently the lower strata of the water would be less impeded, and the average velocity of the whole square section would be increased without increasing the surface velocity in proportion. If this view be correct, I should anticipate that there would be a deposit of silt on the low level floor, and that, at most, the water cushion would have a practical effect equivalent to an additional six inches of depth, and then the mean velocity would be $\frac{300000}{70\frac{1}{2}}$ = 4,255 yards or 2·41 miles an hour.

In these calculations it has been supposed that the canal, with 3,00,000 yards an hour, will run nine feet deep. I do not know whether it has been arranged to do so, but if either this depth represents a greater discharge, or the 3,00,000 cubic yards would be passed with a less depth, the results would be in proportion, and the principle involved the same, and still the only point requiring consideration would be whether an increase of velocity would be advisable, though, as in either of the above cases, the velocity with the 89 feet width would be much higher, and the increased velocity with the reduced width much greater, this one point would perhaps be of greater importance, as involving what might prove to be a current highly obstructive toup-stream navigation.

82. The alteration of the aqueduct would not involve an alteration of the banks, as the head of water required to give the increase of velocity would be but a few inches, neither would it add to the cost of the works, and as the choice between the two aqueducts rests upon considerations which may properly be left to the decision of the responsible officers of the Company, I would recommend that the Chief Engineer be allowed, with the concurrence of the Agent and Manager, to adopt whichever design may be thought most suitable

Main Canal

83. *64th Mile.*—The right bank for the first five chains is behind-hand, below that both banks are nearly finished. There is a good deal of cutting to be done in this mile to complete. The culvert, 8 feet, at 70 chains is complete, with the exception of the inlet channel.

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84. *65th Mile.*—The body of the partly built calingulah now forms the lower part of the left bank. The sluices at 22 chains just finished. The irrigation channel from the sluices not yet commenced, and it will involve a good deal of work, as the cutting will be deep for a considerable distance. The cutting in this mile could be finished in 10 to 15 days, and there is not much other work to be done.

85 *66th to 70th Miles.*—In the 66th mile the work is rather behind-hand, though nearly enough has been done to carry a yard of water. Below the culvert, work only just re-commenced since last year. The first 30 chains of the 67th mile are much as they were last year, lower down considerable progress has been made during the last two months. The construction of the 8-feet culvert near the end of the mile has not yet been commenced In the 68th and 69th miles work has only recently been re-commenced after a long cessation. It is now making good progress, and will, at the present rate, be finished in about two months. The irrigation sluice at the 77th chain of the 68th mile is being partially rebuilt, the crack noticed last year having been found to extend further than was supposed. The earthworks of the upper part of the 70th mile are nearly finished At the village of Pumbalpad a ramp for a crossing has been nearly completed. There will be a ford here when the water is low, and a ferry at other times. The surplus sluice of six vents finished all but two or three courses · all the work, except the old wings, built of very good limestone, which was lately found in the bed of the canal in the 71st mile. The culvert a few yards below will be finished in a few days. At the lower part of this mile no earthwork has been done lately, but there is not much required to complete. A coping has been added to the sluice at end of mile, and it looks well.

86 *71st and 72nd Miles.*—From the quarry in the 71st mile stone is being taken for Lock No. 1 in the 73rd mile. It is a sound laminated limestone, obtainable in blocks of large size and easily worked. The 8-feet culvert is three-fourths finished It is intended for a passage and will be very dark. It is proposed to extend it for a few yards in rear of the bank, to admit of a roadway being taken over it; probably this arrangement would, if the road diversion be taken into account, save but little, and the darkness of the culvert would be increased by the extra length. A great deal of excavation to be done for the outlet and inlet channels of this culvert. The earthwork of this mile is complete, with the exception of a little clearing In the 72nd mile the heavy cutting (Metaconlal) has been finished, except a little clearing and trimming

General state of the 5th Section.
* 63rd Mile.

87. It will require very hard work to get the Terogapila aqueduct* completed in time to pass water down for this season's irrigation, still it may be accomplished, and as with stone masonry the work soon dries, it may be safe to submerge it within a short time after the completion of the masonry, if care be taken to puddle all the surface exposed to the water. The banks and revetments near the aqueduct will also need pushing on. Elsewhere in this section there is no heavy work to be done, and there will probably be no difficulty in finishing some miles entirely, and the rest sufficiently, to carry as much water as can be utilized, before the 1st August next Some of the contractors in this section have been extremely dilatory in the execution of their contracts. The Executive Engineer holds security balances, and the defaulters should be required to complete by a date sufficiently early to allow of the work being taken out of their hands and finished at their expense, if they neglect any longer to do what remains to be done.

Distribution works.

Beyond the construction of sluices in the bank of the main canal, nothing has yet been done towards providing means of distributing irrigation water. The area of land commanded by this section is very considerable, and its breadth measured from the canal is great. It lies on both sides of the Bowanassy river, and a large channel will be taken across that river by an aqueduct, within a short distance of the Bowanassy station buildings.

Funds

88. The Executive Engineer considers that the funds already sanctioned for earth-works will suffice. Supplemental sanction will be required for the masonry works, and for the revetments in the 63rd mile in connection with the aqueduct.

Bowanassy Workshops.

89. These shops have been completed for some time, and there is an abundance of work. There are two circular saw tables, a lathe, &c., and these find full employment for the engine.

Surplus works.

90. The calingulah, which is to discharge 3,00,000 cubic yards of water into the Caulee, has not yet been commenced. The channel in connection therewith has made good progress, and will be finished at an early date, it is partly revetted, and the arrangements appeared good, and likely to be efficient.

Main Canal, 6th Section, 73 to 91 miles

91. *73rd Mile* The earthworks and revetments above Lock No. 1, and in connection with the scouring and head sluices, have made considerable progress. The scouring sluice is within three feet of full height The embankment between the head sluice and lock, and the channel from the sluice to the canal below the lock, have not been commenced. The lock valves are lying near the lock; their workmanship is not as good as it might be, but as these are the first of this pattern that have been constructed; probably future valves will be better than these. The frames of the lock gates are at Bowanassy: they were made at Kurnool The work for the seating of the valves and for hanging the lock gates is in progress. Below the lock to the end of mile, the earthworks are half done except for 15 chains.

92. *74th and 75th Miles.* The work in the 74th mile has been recently commenced, a large party of coolies is at work upon it. In the 75th mile very little earthwork has been done. At the 55th chain the two-arch bridge has been completed, and the approaches are nearly finished. Almost all the surface of the bridge is plastered, and it would have been better, I think, with excellent stone obtainable within a moderate distance, had the pier and the abutments been stone faced, as the plaster will soon be damaged by boats. The wings and superstructure of the bridge are rough cast, and in appearance it falls short of what one would except to see on a project of this magnitude.

93. *76th Mile.* There are no masonry works. The banks and cutting very nearly finished, soil, laterite with purple shale below, or black cotton. The estimate rates have been found very insufficient.

94. *77th Mile.* Earthworks nearly complete. The masonry of the culvert, ten feet, at 61 chains finished. It will make a good passage, but the headway seven feet, is rather small. Outlet and inlet have yet to be done

95. *78th Mile.*—Upper part easy soil, in the lower part there is a good deal of shale and limestone. excavation and banks one-third done. The off take of the irrigation channel will be at 70 chains.

96. *79th Mile.*—Lock No. 2. This will be a treble lift; seven-eighths of the masonry of the first chamber done. Stone and work very good. This lock has the large openings between the culvert and chamber. Lock No. 3.-Masonry complete except that dependent upon the valves, and the double culvert at the upper end. Stone good, masonry passable rubble, but very different to that at Lock No. 2. A good deal of excavation done between Locks Nos 2 and 3.

97. *80th, 81st, and 82nd Miles* —Very little done since last year, as the canal from the 79th mile to the 91st is one of navigation only, and the works have been stopped.

98. *83rd Mile.*—Lock No. 7. Right wall of both chambers, two retaining walls, left wall to springing of culvert, and abutment of under bridge, ready Work stopped.

99. *84th to 91st Miles* —In these miles only a little work was done, after the inspection made last year, before the work was stopped.

General state of 6th Section

100. From the 73rd to the 78th miles the works are now making good progress, and they may be expected to be ready to carry water by the 1st August next, should such be necessary; but in the absence of distribution works, but little if any irrigation will be possible this year. There are no sluices in the banks of the main canal, and several will be required

Funds.

101. For the six miles which will carry irrigation water, supplemental estimates will shortly be ready. The canal being here on a small scale (carrying only 45,000 cubic yards an hour) the amount of supplemental sanction required will not be large, though its proportion to the original sanction will be considerable.

Proceedings of the Madras Government, Public Works Department,
15th May 1865.

7th Section, miles 92 to 114. Jootoor Anicut and Head works.

102. The anicut across the Caulee at Jootoor is to throw into the 7th Section 1,00,000 cubic yards of the water brought by the main canal, as far as the end of the 72nd mile, and then carried by the surplus works (paragraph 90 above) into the Caulee. It is proposed, this year, to complete the anicut to 5 feet above the sill of the under-sluices, or one-half of the full height. The under-sluices are already completed to the 5 feet level, and the body of the anicut also for a length of 70 feet in continuation. On the west side, beyond or behind the present line of the river bank, the anicut and wings have been completed to full height. It will take but a short time to complete the anicut to the 5 feet level. Rock has generally been found about 3 feet below the surface; at the under-sluices it was, however, at a depth of 4 feet. This year the overfall will not be very great, and perhaps it may be the cheaper plan to let the river clear the bed below the dam, but until the rock has been exposed it cannot be determined what work, in the way of aprons, will be needed. The wall between the under and head sluices is full height. The head sluice is complete with the exception of the cross stones and coping: water wings have been added on the lower side. This sluice, as originally designed, was a very thin work, and to increase its depth from front to rear, an arch 18 inches wide has been turned over each pair of the old vents, and in rear of the alternate piers a battered buttress, square on plan, has been added. The alteration was made when the old work had been nearly completed, and the addition has been well executed. A plan of the work, as built, has been called for

The Engineer in charge of these works informed me that the cost of the best work, a rusticated masonry, has been about 4½ Rupees a cubic yard, and that of the plain and rather rough rubble masonry Rupees 3-12-0 to Rupees 4. The estimate allowed Rupees 2-8-0 a cubic yard, but I think the actual rates are reasonable, as the stone is brought a distance of about five miles. The arch work is very good, and the cost is said not to have exceeded 8 Rupees a cubic yard The regulating lock has not been commenced, the work having been stopped after the excavation had been nearly completed, on the suspension of all navigation works.

Bridge over Nullah.

103. This bridge is complete with the exception of a few courses of the parapets and the approaches. The stone is good, the masonry sufficiently good, and the bridge will look very well.

Main Canal.

104. *92nd Mile.*—Down to the 12th chain, where the ground has only recently been broken, the cutting is being taken out to a width of 15 feet. The cutting is 14 feet deep, the rate allowed was 1⅛ Annas. The upper part has cost 1⅛ Annas, the lower, which is purple slate shale, 4 Annas a cubic yard. Culvert No. 3 at 67 chains not commenced. Down to this from 12 chains, excavation nearly out except side slopes, and for the rest of the mile earthwork more than half finished.

105. *93rd Mile.*—Culverts Nos. 4 and 5, at 10, and 72 chains respectively, not commenced but the excavation for the former is one-third done. Bridge No. 2 for the Nundial road not commenced. Very little done to the canal in this mile, except for a 15 feet channel which has recently been commenced.

106. *94th Mile.*—First half of mile the same as last year. In lower part of mile the 15 feet channel has been begun for a few chains, and below that ground has been broken to full width and various depths.

107. *95th, 96th, and 97th Miles* —In the first 54 chains of the 95th mile earthworks about half done. Here the excavation for Calingulah No. 1 is nearly finished, and a few yards of stone have been collected. Below this to end of mile earthworks about one-third done.

Culverts Nos. 6 and 7 have not been commenced In the 96th mile down to Culvert No. 8, earthworks well advanced. For the culvert excavation partly made, and foundations also for the length deemed requisite for a 15 feet channel. The calingulah at the 65th chain of the 97th

mile has its upper wing 2 feet short of full height, the lower wing complete, and the body 2 feet above canal bed, six sluice vents have been inserted in the body, and this is an improvement A large mass of earth has to be removed for the surplus channel This might be done by making a few cuts, and allowing the water to clear away the rest. It is proposed to cut a small channel from the sluices. As the nullah, the water of which this calingulah is to pass, is some 10 feet below level of canal bed, proper aprons will, as mentioned in my report of last year, be required, and the excavations should be made the whole length of the calingulah to a sufficient width to allow of this work being done, and then the rest of the earthwork can be cleared away by the water The stone used for this surplus work is an excellent blue limestone, and the work is good The nullah being dammed by the canal, banks are required along its two sides to prevent inundation, and these have not been commenced, and Culverts Nos 9 and 10, which are to prevent accumulation of surface drainage behind these banks, have not been begun. Below this to the end of the mile earthworks five-eighths done.

Paragraph 111.

108. 98*th Mile* —Earthworks very nearly finished. Rates in this part are from 1½ to 2 Annas a cubic yard.

109. 99*th and* 100*th Miles*.—There was to have been a treble vent culvert, No. 11, near the commencement of the 99th mile, but this has been altered to two spans of 20 feet each, the excavation is partly out. The limestone collected for this work is good For Culvert No 12, a short distance below, the excavations have been commenced. Earthwork nearly complete for a few chains below Culvert No. 11; thence to the north bund of the Byap Gúdur Tank very little done. In bed of tank to end of mile, 15 feet channel partly excavated, and the same to the south bund of the tank in the 100th mile. Number 13 Culvert, which was intended to pass the tank water under the canal has not been commenced It is now proposed to obtain a transfer of the tank to the Company and the correspondence on this subject was submitted for the consideration of Government with the letter as per margin.* Below the tank to the end of the mile the earthworks are well advanced.

* No 241, dated 12th April 1865

110. 101*st Mile* —Of the culverts allowed for this mile it is now proposed to omit Nos. 14 and 15 For Culvert No 16 a little excavation has been done, and some materials are ready. Culvert No. 17 not commenced. The rock excavation for No. 18 Culvert has but made little progress since last year. The earthworks throughout the mile are behind-hand.

111 102*nd and* 103*rd Miles* —The earthworks in the 102nd mile are in much the same state as last year, except that, for 15 feet in width, the cutting has been carried to the full depth. Down to the 38th chain of the 103rd mile earthworks two-thirds done. The excavations for No. 20 Culvert not yet ready.

112. 104*th Mile*.—From this mile to the present end of the section, the canal was originally intended to form part of the lower section, but was afterwards added to section No. 7. The excavation for Culvert No. 1 is partly out, and materials for the masonry have been collected. For Culvert No. 19, which was transferred from the preceding mile to a site near the end of this mile, the excavations have been commenced, and now again it is proposed to omit this culvert, and turn the water into No 1 Culvert above. Whether these alterations were well advised or not I can hardly judge, but they tend to delay the works, and to interfere, pending the repeated references, with the arrangements for carrying them on. The earthworks in this mile are a little more than half done

113. 105*th Mile* —Down to Culvert No 2, at 31 chains, earthwork about half done, and the cutting for 15 feet channel is out to full depth. The excavations for the culvert have not been touched since last year. Thence to the end of the mile nothing done to earthworks since last year, except the 15 feet channel, which has recently been commenced. The calingulah, which will be required in connection with the Nundial tank supply channel, has not yet been designed.

114 106*th Mile*.—Down to Culvert No 3, at 30 chains, nothing done since last year, except 15 feet cut in part. Excavation for culvert well advanced, masonry not commenced. Thence down to end of mile, 15 feet channel nearly completed.

115. 107*th Mile*.—The excavation for Culvert No. 4 at 20 chains not touched since last year. The earthworks in the upper half of the mile in the same state as last year, except that the 15 feet channel is nearly complete In the lower half mile a good deal of work has been done, and the earthworks there are about two-thirds done. The bridge at 40 chains for the Cuddapah and Cumbum roads has its left abutment 6 feet high, the right 7 feet, and the piers the same height. Some of the masonry rough, but the later work is better than the earlier. The progress of this bridge in the last nine months has been very slow, and it was proposed to defer turning the arches until next year. Cost of rubble masonry Rupees 3 to 3-4-0, and of the face work Rupees 5-12-0. The limestone comes from Chembáram, and the slate from Sitarámpúram; some of the latter is too nearly allied to the purple shale, and it would be better not to use it, if the supply of limestone can be increased.

116. 108*th Mile* —Culvert No. 5 at 42 chains, excavation partly out, masonry not commenced. Earthwork in the upper half mile one-third, and in the lower half done.

117. 109*th Mile*.—Down to about the 30th chain excavation out to full width for half depth, and to full depth for the 15 feet channel. Below this, 15 feet channel only taken out. The excavation for Culvert No. 6 is partly out, masonry not commenced.

118 110*th* to 114*th Miles*.—At Culvert No. 7 in the 110th mile nothing done yet. At 6 chains, in the 111th mile, Culvert No. 8, will be built, work not commenced. In the 112th mile the excavations for the bridge in the same state as last year, and it is now proposed to move the bridge a few yards lower down, so as to avoid running the west approach through a plantation of young trees, and as the cost of the change would not perhaps exceed 5 Rupees, there can be no objection to this alteration. In these three miles the earthwork executed is confined to the 15 feet channel, which will soon be completed In the 113th mile ground has just been broken for the 15 feet channel. Work has not yet been commenced in the 114th mile. The rates now allowed for the small channel, which is being taken out in the above 5 miles, are 1 Rupee for 10 yards in cotton soil, top yard, 1 Rupee for 9 yards below this, and 1 Rupee for 8, 7 or 6 yards for gravel, according to the degree of hardness.

General state of the 7th Section
* June 1864.

119. This section has made but small progress since the date* of my last inspection. In most of the miles the earthworks appear to have been at a stand-still until quite recently, and with the exception of the head works, the quantity of masonry done is next to nothing. Out of some 25 culverts required for the section, the construction of only one has been commenced, and there but a portion of the foundation has been laid. Difficulty in obtaining carriage for materials is stated to have occasioned the delay in commencing these works. At the time of my visit I found that the works were being pushed on with a view to get a 15 feet channel completed from end to end of the section, and it was proposed also to build only such a length of the culverts as would suffice for such a channel. At Iyalur, 107th mile, it was intended to make a temporary bridge and to postpone the completion of the permanent structure, and similarly in the 93rd and 112th miles temporary bridges were to be put up. It appeared to me, however, that no exertions would suffice to make even the reduced width of canal fit to carry even the two feet of water, which was all that was proposed, and that, consequently, while there would be no difficulty in completing a 15 feet ditch, it would not be a canal; besides this consideration, it was certain that to admit water would greatly interfere with the completion both of earth and masonry works and, where the former were down to nearly full depth, there would be other inconveniences, such as difficulty in verifying measurements, &c, the building of the culverts in part would render them when completed less serviceable, added to which, when the surrounding soil had become saturated with water, the difficulty and cost of completing the foundations would be much increased. In the next place, it was uncertain whether Toombuddra water would be available, and Caulee water alone could not suffice for direct irrigation

with no reserve of water to fall back upon, and as not a single irrigation sluice has been built or even estimated, and not a channel planned, it seemed impossible that any returns could be obtained; and consequently the only possible advantage that would arise, to balance the many disadvantages above glanced at, and to which may be added the inconvenience to the neighbouring villages, of having the arrangements throughout, and especially in the 95th and 97th miles, where drainage has to be received into and passed across the canal incomplete, would be the being able to say that water had been carried to such and such a mile. Such being the case, after-inspecting the 8th Section, and finding that there also water could not be utilized this year, it seemed to me that the best arrangement would be to transfer to the 4th Section a considerable portion of the imported labor, which had just been obtained to the number of about 800 coolies for the section under notice, as by this means it might be practicable to render certain the completion of the works from the 53rd to the 60th miles, without which water could not be conveyed to the 5th Section. There was only one objection to this plan, and that was that it was, at the first glance, extremely hard to take away from the Executive Engineer of the Bowanassy Division the labor which he had, with so much difficulty, obtained for his works, but as undoubtedly the results from irrigation under the fifth Section, the first of that Division, would, were water conveyed to it, vastly exceed any that could be derived from the seventh Section, it appeared that he too would directly benefit by the transfer. I therefore wrote to the Acting Chief Engineer, stating what the opinion formed by me, and which would be given in this report, was, in order that valuable time might be saved, should he think fit to adopt the suggestion of the transfer of labor, and I have since heard that he has arranged to bring up the coolies, though it was feared that perhaps a large number would have to be put upon the works near the Terogapila aqueduct in the sixty-third mile, owing to the failure of the contractor there to get on with his work properly.

Funds

120. The supplemental estimates for the seventh Section are under preparation, but they were not sufficiently advanced to enable the Executive Engineer to name the amount which would be necessary. It is certain, however, that on both earth and masonry works the rates have been, and will be, largely exceeded.

Embankments too near the cuttings

121. In many of the miles of this section the embankments have been placed much too near the cuttings. In some places there is no room for a berm at all, and in others the top line of the cutting will fall within the base of the banks, and the latter will consequently have to be turned over. Had sections for the guidance of the work-people been put up, these mistakes would have been avoided, and the rule should be so to lay out the work, that it may be impossible for the workmen to go wrong, except as a result of such gross and manifest negligence as will justify the re-doing of the work at their expense.

Ferries

122 Provision has to be made for ferry boat recesses, cattle ramps, &c, and these arrangements could be more economically made before the banks occupy the ground required for these purposes.

Distribution works

123. Nothing whatever has been done, towards the provision of distribution works; surveys, levels, plans, and estimates have all to be prepared, and as there should be no doubt of the completion of the main canal in time for the irrigation season of 1866, there is no time to lose, if advantage is to be taken of the power to irrigate even such an extent of land as the Ryots may be prepared to water in the first year.

8th Section, Main Canal, 115th to 143rd miles.

124. 115*th Mile*. Upper half-mile nearly-and lower half not nearly, complete. Just at the half mile a good deal of purple shale and hard kunkur has to be removed. A quantity of excellent limestone has been prepared for Lock No. 1 at lower end of mile. This being a navigation work, will not now be gone on with, but the calingulah in connection therewith has to be built,

125. 116*th and* 117*th Miles*. The 116th mile is in heavy cutting throughout, a large amount of work has been done, but much remains to do. There is a great deal of shale and lime kunkur, and these make the work difficult. The upper part of the 117th mile is nearly complete, and the banks are in fair section. Calingulah No. 2, at fifty chains, has been built, according to the plan, of good stone, with the exception of the sloping apron, for which there was no item in the estimate. Wings want additions. It is proposed to open vents in the body, (an absolute necessity, as without these the canal could not be emptied,) and to alter the wings. Weir channel not commenced. Calingulah No. 3, at about 75 chains, has its wings built, but not the body, which is said to be too short to discharge the water; this can be remedied by the insertion of sluice vents. Wings far too short. Between the above two calingulahs the cutting is in very hard lime kunkur, or conglomerate, and the revised rates here have proved insufficient.

126. 118*th and* 119*th Miles*.—Down to 22 chains in the 118th mile but little work remains to be done. Thence to end of the mile earthworks three-fourths done. About one-sixth of the masonry of Lock No. 3 at 22 chains done before the work was stopped. The first 25 chains of the 119th mile are two-thirds done, below that work very nearly completed. The lower part of this mile has silted up a good deal.

127. 120*th and* 121*st Miles*.—In the former mile, for some distance, a drain was cut last year, and the canal excavation has just been commenced. Some materials have been collected for Calingula No. 4 at 38 chains, and the trial pit shows that the foundations of this work will have to be laid not less than 9 feet below the surface. Thence to end of mile, ground not broken. Some stone has been collected for Calingulah No 5 in the 121st mile of which, in the first 20 chains, and the last 10 chains, the earthworks are nearly finished, and in the remainder the cuttings are in parts nearly out to full depth, and elsewhere the ground has only just been broken.

128. 122*nd and* 123*rd Miles*.—For the first 10 chains, the banks are partly thrown up, and in the last 10 chains they are nearly complete; the intermediate three-fourths mile not commenced. The work at Calingulah No. 6 has not been started. In the 123rd mile, the banks and cuttings are complete. The canal has silted up a alingulah No. 7 at 25 chains finished except apron. Work and stone good. The cost has exceeded the estimate by about 300 Rupees, owing to the distance of the quarries. Excavation for lock nearly out, and for bridge, and waste weir culvert, in progress. This is one of the places where, instead of a separate bridge, the tail bay of the lock will be bridged.

129. 124*th and* 125*th Miles*.—The first half of the 124th mile and Lock and Calingulah No. 8 at 23 chains, not commenced. Earthworks of lower half mile complete. In the 125th mile the earthworks for the upper 45 chains about two-thirds done, and below that, except for a few chains where ground is not broken, most of the work is done. Lock and Calingulah No. 9 not commenced except excavation for the latter.

130. 126*th and* 127*th Miles*.—Down to the 40 chain of 126th mile a good deal done, beyond that ground broken only here and there. Lock and Calingulah No 10 will be at the end of this mile and are not commenced. In the last 10 chains of the 127th mile one-third of the earthwork done, elsewhere ground unbroken.

131. 128*th and* 129*th Miles*.—In the former mile down to 37 chains nothing done, thence for 20 chains approaching completion, and about half done below this. No. 10A Lock and calingulah will be at 60 chains, and are not yet commenced. In the 129th mile Culvert No. 1, of 4 feet at 64 chains, nearly completed to springing. Stone very good, and is obtained from the lock quarry in the 132nd mile. The earthwork of the first 70 chains not commenced, and that of the last 10 chains is nearly finished.

132. 130*th and* 131*st Miles*.—The first 37 chains of the former, and the last 48 chains of the latter mile, have the earthworks nearly complete, elsewhere ground not broken.

133. 132*nd Mile*.—At 10 chains Calingulah No. 11 built according to plan, but without apron, it will require several additions. Work and stone good. At lock site, just below calingu-

lah, a great deal of excellent dark lime stone has been quarried; banks above calingulah nearly finished. Cutting below lock site for a few chains half done, and below that nearly complete to end of mile.

134. 133*rd*, 134*th, and* 135*th Miles.*—The earthworks in the 133rd mile are very nearly finished, and the banks all the way along are in very good section. In the next mile to the 43rd or 44th chain the work has made good progress, and some chains are almost finished. Below this ground not broken. The first half of the 135th mile not commenced, the remainder well advanced.

135. 136*th and* 137*th Miles.*—At the 27th chain of the 136th mile the excavation for Calingulah No 12 has just been commenced, and that for the lock was partly done last year. The earthworks of this mile are very nearly finished In the 137th mile the excavation for Calingulah No. 13 is nearly ready. The earthworks of the first 20 chains and of the last 30 chains of this mile half done, the remainder not commenced.

136 138*th and* 139*th Miles* —The former mile is finished all but a little trimming, and the latter is quite complete.

137. 140*th Mile.*—Complete down to 25th chain, where Calingulah No. 14 is about half built. Excellent slate stone is obtained from a quarry on the lock site, at a cost of 4 to 5½ Annas the cubic yard The culvert over weir channel is to have three vents of 3½ feet span each, and is in progress. Down to the three-fourth mile, cutting commenced and part of it nearly complete, below that ground not broken.

138. 141*st and* 142*nd Miles.*—From the 12th to the 18th chain in the former mile earthworks just commenced, beyond this ground not broken. The first 12 chains of the 142nd mile are complete Calingulah No. 15 will be at 8 chains, and for it a little stone has been collected. At 36 chains for a double 4½ feet culvert the excavations are nearly out; most of the stone required has been collected and much of it is dressed. It is a first rate limestone, is obtained from Upalur, and cost, in the rough, 14 Annas a cubic yard. Earthworks not commenced below the 12th chain.

139. 143*rd Mile, and a small part of the* 144*th Mile.*—Work not commenced. Lock No 16 will be the tail lock, and I understood from the Assistant Engineer that it has no bridge over the tail bay; this was noticed in submitting the revised estimate for this section for sanction,* and as the sketch plan of the head works of the 9th section showed† a road way leading to a bridge at the lock, and as some passage is here required, it will be necessary that some explanation of the intended arrangements should be afforded by the Chief Engineer.

* P M G. No 514 dated 22nd February 1865.

† P M G No 2,807, dated 28th September 1864. Paragraph 5 of my letter No 93, dated 9th September 1864.

General state of the 8th Section.

140. The progress made since my inspection last year in this section is satisfactory. Nine months ago very little had been done, whereas now, in many miles, the earthworks are either finished or approaching completion, and with the working parties now available, the incomplete portions will soon be ready. The embankments are every where in good section where finished, and this is the only part of the canal where sections for the guidance of the workpeople have been used, and the results are just what might have been expected. A good deal has been done to the calingulahs, though not as much as would have been accomplished had the designs for these been in all respects suitable. No navigation sluices or channels have as yet been planned or estimated

Slopes of embankments

141. All the canal banks in this section, whether high or low, have interior slopes of 1½ to 1. Where the soil is good such slopes will stand very well, but generally in this section good soil is not obtainable for the high banks, and is found only where the canal is in deep cutting immediately below the locks, and the highly soluble dark clay, called black cotton soil, must, where under water, assume much flatter slopes. There are only one or two places where soil of this description uncovered by revetments has been subjected to the action of water: these are in the first section, and the flattening out of the side slopes, and the washing down of the soil have occurred to a great extent. This point was noticed in paragraph 146 of last year's report, but it does not appear to have received consideration, as the new banks are being thrown up on the original alignment, whereas if the requisite square section of canal is to be maintained with the flat slopes, which will form themselves, it is evident that the embankments require to be placed further apart, and as this could have been done without any increase of expense, it is a pity that some attention has not been paid to the requirements in this respect. It may be added that, where the banks were approaching completion prior to the rains of the last season, their slopes have already assumed a lower incline than 1 in 1½.

Ferries.

142. No arrangements have yet been made either for recesses for ferry boats or for cattle ramps.

Funds

143. It is expected that the rates allowed in the revised estimates for earthworks will suffice, except where lime kunkur or slate shale occur in the cuttings, and these rocks are of so hard a description that the cost of getting them out will largely exceed the estimated amount. The Executive Engineer considers that the further sanction required on this account will be in the—

115th Mile...	Rupees	3,080
116th do.	,,	7,200
117th do	,,	2,900
119th do.	,,	2,250
120th do	,,	2,000
121st do.	,,	700
122nd do.	,,	1,200
137th do.	,,	900
141st to 143rd Miles	,,	1,500
	Rupees	21,730

Revised plan and estimates for the calingulahs are under preparation. Where these works have been partly built, they must receive such alterations and additions as will render them secure and efficient, but I suggested to the Executive Engineer that where no commencement has been made, he had better obtain the Chief Engineer's sanction to an entirely new arrangement. In several cases these calingulahs are entirely inadequate to discharge the water carried by the canal; their wing-walls are of inefficient length, they require sluice vents to empty the canal and to prevent the silting up of the bed; their aprons, where any have been allowed for, are unsuitable and insufficient; the weir channels require the protection of revetments, and in fact the sum* entered for these works in the sanctioned estimates represents but a small part of the necessary cost of transferring the water from the upper to the lower reaches. The Executive Engineer estimates the additional outlay required to be—

* Rupees 34,418 for 17 calingulahs

10 Calingulahs, at Rupees	2,500 =	25,000
7 Do. at ,, ...	2,000 =	14,000
17 Double revetments of 5 chains each at Rupees	800 =	13,600
		52,600

9th Section, Main Canal, 144th to 178th Miles.

144. The estimates for this section were sanctioned in Proceedings of the Madras Government No. 2,807 of the 28th September 1864. The works have not as yet been started.

Kurnool Workshops and Office.

145. The accommodation afforded by the buildings at present in use is quite insufficient and very unsuitable. The buildings belong partly to the Company and partly to the landlord of the adjoining house, which has hitherto been rented by the Chief Engineer as a dwelling

house. I was shown when at Kurnool the plan and estimates* of the proposed new buildings, and since my return to Madras, these have been forwarded to me by the Agent, but I cannot dispose of them until the block plan of the present site, and a similar plan of the site for the new buildings, which has been selected on the right bank of the canal, a little above the Hindry aqueduct, are received. The subject will therefore require a separate report, and I will only mention here that while suitable permanent buildings for offices and workshops are undoubtedly required at Kurnool, the accommodation to be provided should be confined to the wants of that neighbourhood, and the idea which I believe Colonel Cotton entertained, of making Kurnool a Central Station and depôt in connection not only with the works from Soonkasala downwards, but with the Bellary and Doab works also, should be abandoned. I am very glad to say that the Agent, in his letter transmitting the estimates, concurs in this opinion. In passing the accounts from time to time, I have found it necessary to notice the heavy expenses incurred for transporting stores from Kurnool to the lower sections, and not only might this outlay have in most cases been entirely avoided, but in many instances much of the previously incurred expense of sending the stores from Madras to Kurnool could have been saved.

* Rupees 50,650

Contract work

146. An observation made by the Executive Engineer of one of the Divisions, that some contractors borrow money at 5 per cent. per month to enable them to carry on their works, and the difficulties which have arisen from the employment of incompetent, dishonest, or pauper contractors in several of the sections, renders it desirable that one or two remarks should be made on this subject. In the first place, it cannot be advantageous to the Company that any contractor without capital, and obliged therefore to borrow money at rates even approximating to those above-mentioned, should be employed. It is evident that if the rates be not higher than is fair the contractor must fail in completing his work, and if, on the other hand, he be able to carry out his contract, it can only be because the rates are far in excess of what the work could be done for. The contract system is an excellent one if only the requisite conditions be observed, and these are, first, that the contractor should be conversant with work of the description of that to be done; secondly, that he should be a respectable man; and thirdly, that he should have the means requisite for the purpose. It is, however, not possible always for an Executive Engineer to ascertain these particulars reliably, and the precautionary measures, which will do to a great extent instead of such knowledge, are a proper agreement and tangible security. The agreement should be precise, and the penalties moderate yet sufficient, and they should be strictly enforced. Heavy penalties which could not be inflicted without injustice are worse than useless, because a contractor makes up his mind from the commencement that they are only nominal. For earthworks very generally the petty contract entered into with the gangs of workmen is, on the whole, the best and the most economical plan, and I have noticed that, where this arrangement prevails, the rates are relatively much lower than where the work has been let on regular contract. In this case also the rates can be more easily regulated, with reference to the soil actually met with, and with good management work can be done in this way with but very little trouble.

For masonry works very much greater care is requisite in entering into contracts. It must be unwise to give such work to any one but a man of approved character and qualifications, and though it may save trouble in the first instance to hand over the execution of masonry works to any contractors who may offer to execute them, the trouble usually comes afterwards in augmented proportions, and considerable losses may be sustained as well It is of course an excellent plan to get all the materials on contract, but here again in most cases it will be better to get each material from the persons accustomed to make or collect it, and not through a middle man.

Distribution works

147. It will have been observed from the remarks on the general state of each section that, with the exception of a few yards of irrigation channel in the first section of the canal, nothing has been done since last year towards the provision of distribution works. Without

Proceedings of the Madras Government, Public Works Department,
15th May 1865.

irrigation channels any returns worth mentioning cannot be obtained, and it seems probable therefore, that the area which will be brought under cultivation this year will be extremely limited. It would have been practicable, I think, to have arranged for the estimates for such works under the 4th and 5th sections being prepared, in time to admit of considerable progress being made by the commencement of the approaching irrigation season, but as yet for only one, section, the 6th, have any estimates of this kind been received, and they were considered to require revision. Some additional Surveyors will be required for these works, and the Agent on the 21st ultimo applied for sanction for four of them, and so soon as I hear from him what their salaries are to be, his letter will be submitted for the favorable consideration of Government.

Proceedings of the Madras Government, No 800, dated 23rd March 1865

Consolidation of earthworks.

148. In the report made after last year's inspection, notice had to be taken of the entire absence of any means of consolidating earthworks, whether in rear of revetments and masonry works, or in other situations where such consolidation was essential to sound work. Since then some improvement has taken place, but the rammers used are of the flat light kind, commonly used for surfacing, and they have but little effect on earthwork. Some heavy rammers were being made up at the Kurnool workshops, and these will no doubt be an improvement, but in every section or sub-section numbers are required, and should be made up by common village carpenters, at a cost of a few Annas. Perhaps the best of the simple forms of rammer is the Pasley muster, a truncated hexagonal, or octagonal pyramid, 7 to 8 inches diameter at the lower, and 5 inches at the upper end, 1¼ to 1⅓ feet high, and weighing about 15 lbs. These can be made out of any branches of trees of sufficient size, at a very small expenditure of labor, and by any one who can handle an adze, and common chisel.

No. 306. ORDER THEREON, 15th May 1865, No. 1,317.

CIVIL WORKS, No. 43.

1. The foregoing report will be communicated to the Chief Engineer of the Madras Irrigation and Canal Company, through the Manager of the Company, with a request that the suggestions therein made may receive consideration.

2. The Government approve of the proposal made at the conclusion of paragraph 81, regarding the alteration of the Teragopila aqueduct.

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

To the Consulting Engineer for Irrigation and Canal Company.
,, Manager for do. do.

Exd S T. Augustin

Ap 6402

12214

To the Deputy Superintendent
Sultan Islands —

Sir, With reference to Your letter of 4th Nº 474 dated 2nd March 1863, I have the honor to obtain the under the orders of the Governor published in the Departmental Circular Book, Page 129, the articles required by Captain Friendly at Wellington must be obtained through the Secretary of State. In admitting of their being done the Secretary of State should obtain and distribute in accordance with the instructions contained in the Proclamation Nº 2701 of 10th November 1862 an indent in duplicate in the prescribed printed

Indemnities — /
2/12214/63.
Letter Nº 200 of 19 Dec/62

forms, and I have to request that you will inform me accordingly —

2. In the comparative statement of the cost of the Bricks prepared by hand or by Machinery Captain Trimble has omitted several items chargeable against the Machine, while he has included the whole cost of the Machine itself. This matter should therefore be carefully inquired into —

3. The charge against the Bricks should be

Interest upon & Sinking Fund to provide for Cost
Depreciation Repairs — &c — &c —
Cost of Superintendence —
Engineer and Firemen —
Oil Grease &c — — —
Fuel &c — — —
Buildings for Engine Sheds &c —
Conveyance of Engine & Machine
Stamp Duty for Engineer including carriage

4. It should be well also that the Estimate should include the whole cost of drying and burning, and in framing it a Statement should be submitted of the actual and not the Estimated cost of 1000 Bricks of an equivalent size made by the Machine

5. The Granting of Bricks requested for the Lawrence Asylum is stated for 60 Lacs and the cost to be supplied at the Rate and in per 1000. which is considered somewhat high —

6. When the Drying Chambers have been filled from England it is believed that they should be set up in the Country

2° April 1863
C. C. R.

Signed / W. D. Birkmyre Chief Engr & Secy

No 708

Executive Engineer's Office
Neilgherries
Wellington 19th December 1862.

33.

From

Captain R Farewell
Executive Engineer

To

Lieut Colonel J Ouchterlony RE
Deputy Chief Engineer SC
Madras

Sir,

With reference to Extract from the Proceedings Madras Government No 397 under date the 18th November 1862 and your order thereon of the 20th idem No 2795, referring the sanctioning of the entry of the Estimates, for the Lawrence Asylum to be built at Ootacamund, in the Extract for 1863, and calling for further plans and Estimates, which are under preparation, as it is not that no time should be lost, I have the honor to bring the following to your notice, with the view that when the time comes we may push on quickly with the work and complete it in such time as will be satisfactory both to Government and the public at large, who are happily much interested in the Institution; & that that the plans adopted will meet with your approbation and cordial support, and that you will remember that having had the sole planning of the buildings required for the Institutions I hold a very responsible position in regard to the whole of the operations necessary for their successful construction, which I understand are to be entrusted to myself.

2. Having now been employed for some years on the Neilgherries you will I hope allow that I have at all events gained some experience in the different climates it is, & a little in building in such

No 6402
Copy forwarded
to the Deputy Chaplain
with Estimates

Ootacamund 23 Nov 1863

Sir

Please find under, the Home Estimate, the detail Estimate & Plans & Specification for the Lawrence Asylum Ootacamund, which I have the honor to forward for the information of Government, & to request that you will be pleased to move Government to sanction the same.

I have the honor to be
Sir
Your most obedient
Servant
[illegible]

a climate, the Badeghars inhabitants of the Neilgherries are so few in number and are so entirely dependant on there labor for cultivating there lands, that we cannot expect much help from them in the way of labor, other native residents on the hills (emigrants from the plains) almost all obtain employment from the European residents, we are therefore obliged to depend upon laborers induced by high pay to come to us from the low Country, these fearing the ill-effects they are likely to suffer from the great change of climate are difficult to obtain, and when obtained do not do half the work they should do, without a great deal of expensive superintendence; I have had great difficulty in procuring laborers for the works at Wellington, as I know what to expect when I want them for Ootacamund, which is at least seven or ten degrees colder in temperature

3 do. give an illustration of the price of labor here at Wellington, which though rather a lonely one is true, I have to pay a Common Coverlet per Eight Rupees per mensem a Grass Cutter five rupees and provide them with clothing into the bargain, I have no doubt that when the Asylum works are known to be commenced, a rise in the price of labor will immediately take place, I bring this very important question into Consideration, I am induced to solicit your attention to any proposition to allow me to use as many labor saving machines as possible and thus insure success and economy in the work contemplated

4 All these Machines when the works are completed can be used under competent direction by the Asylum Boys, and the male asylum be thus turned into a grand and most useful school of Instruction, affording to many of the boys a ready made profession to commence life with on leaving the Establishment, besides supplying both the Government and the public with the building and other materials of the very best description at much less cost than obtainable from manual & native labor, tending to make the Institution self supporting, and relieving the greatest want of the Neilgherries, which from their accessibility will doubtless eventually become the most extensive and important Sanatarium of India.

5 I will now proceed to show the primary wants we shall experience with reference to the buildings in question and prove by figures which are facts, the savings it will be to employ automatic Machines in preference to mere manual labor, the quantity of bricks that will be required to erect the buildings and outhouses to the extent proposed for four hundred boys and two hundred girls including ten per Cent for the usual wastage in manufacture, will amount to one hundred lacs, to make this number of bricks by manual labor in the usual way, supposing say for similar sake, such were possible in one day, it would require 100000 persons and 10000 pairs of bullocks, which with the cost of repairs necessary to the frog mills for the new production of raw bricks upon the brick tables according to the Data obtained from the works at Wellington would cost 50000 Rupees, this is exclusive of tools sheds hacking shifting for drying fire poles setting and burning kilns, the cost of which amounts to another 8 Rupees per thousand or 50000 Rupees more, making the return of bricks equal to ten Rupees per 1000; again at Wellington even in our most favorable working season we were never able under great pressure to produce more than three lacs of bricks per mensem, so to make the amount of brick required under the most favorable circumstances we should not be able to do it under nearly three years.

6 The above calculations have reference only to Wellington or rebabb data, at Ootacamund however where the climate is more variable and less to be trusted, I fear it would take us a much longer time to provide this quantity, and such would cost us at least ten per cent more to make; as I have before noted our laborers would all have to be drawn from the plains and we would undoubtedly have to allow them batta, and such like for days on which through no fault of their own, but merely from the inclemency of weather we could not employ them, I mean to only their right to receive pay for such days, as they would otherwise starve in a place where the commonest necessaries of bare existence are so expensive, and it is really only under such conditions that we could obtain their services; such contingencies above I consider would add ten per cent as above noted at least to the price of the bricks, and make the outlay necessary on one hundred lacs of raw bricks equivalent to 6000 Rupees or 6 Rs per 1000 for raw bench made bricks, which is the data I use for Ootacamund; at Wellington the Coolies built their own huts and were allowed one or two days leave on pay to permit of their doing so, but in Ootacamund it would require at least double or treble this time in consequence of the difficulty of obtaining materials and the distance they have to be carried for this purpose, I therefore feel certain that I have not overrated the cost of the bricks required, and that at the very lowest Estimate I can make them, the Sum noted will be necessary for the new production of raw bricks or the brick-tables.

7. The national exhibition of this present year has tended to produce or at all events advertise to the world some most excellent cheap and easily managed automatic machines to save labor, which every where but in India appears to be the first duty of an Engineer, however in almost every other part of India except that in which I am employed, native labor is so cheap and plentiful that automatic machines are necessarily depreciated, but here where I have already said we have great difficulty in obtaining labor in the first instance, and in the next having found it, it is as difficult to retain it, besides being most expensive, such machines will undoubtedly be found to be a great saving both in time and money; I would here note that I would not for a moment recommend a number of small machines for brick and tile making such as I have already seen in India, which appeared to me to be very little better than mere toys and liable to get out of order, what I propose to get is the very best machinery the day can produce and experience has always proved that the best article is always the Cheapest in the end.

8. Having alluded in the first instance to the cost of the manual labor of brickmaking as it exists I will first speak of the Machine I propose should be used for this purpose shewing their Cost &c., the prize medal for this years exhibition was awarded to Messrs Ransome Clayton & Co for their patent brickmaking machine, from all the reports I have read on the subject, the superior quality of the bricks turned out by these machines is very prominent, the next thing in favor of the Machines is that the combined cost of pugging Cutting and moulding is performed

by them at one time and in addition, the jurors report, that they are very simple in construction and easily managed; a friend of mine in England sent me out a small pamphlet on these machines, which I enclose for your information, to be returned when convenient.

9. With the aid of two men and four boys one of these machines driven by a 12 H.P. Engine can turn out from 20 to 30000 raw bricks in one day, and two of these machines would say, taking 20 working days per month produce Eight lacs of bricks in a month of the very best description which from the pressure they undergo will dry and be fit for the Kiln in one half of the time that Common hand made bricks would be, thus in the first instance doing nearly three times as much work in a month as we could possibly hope to do, and in the second from the time of exposure being so much shorter reduce the chances of loss likely to accrue by the inclemency of weather during that process.

10. These machines are advertized at £330 each, for two 660 £. which if doubled or turning the shillings into the Rupee for cost in India the most reliable Data I have to go on to cover cost of freight insurance dockage &c. will amount to 1320 Rs. to this must be added the price of 2-12 H.P. or a 25 H.P. double Cylinder high pressure condensing Engine, one of Barrett Exall and Andrews & Co who also obtained the prize Medal of the Exhibition of this year for their beautifully Constructed Engines, which require less fuel than almost any others known) at 600 £ which doubled as before named amount to 1200 £ or 12000 Rupees

thus we have

2 Machines	13,200
2-12 H.P. or 1-25 H.P. Engine	13,000
	26,200
1 Mechanical Engineer at 200/ per mensem for 2 years	4,800
Passage to and from England	2,000
1 Assistant Mechanical Engineer and Driver at 100/ per mensem for two years	2,400
Carriage from Madras to Station	2,500
Engine House and Sheds	3,500
Oil, grease, belt &c. at 50/ per mensem for two years	1,200
Fuel at 5/ at 20 Cwt per diem for 20 working days per 2 years allowing for 4 times the number of men to supply the mills than in England or to Tools for supplying the mill at 9/ per diem for 20 working days for two years	2,400
per mensem for two years	4,320
Contingencies about 2 per Cent	1,000
	50,320

11 The Machines are actually provided the quantity of Bricks named in 13 months but in the preparation of the Estimate of cost of Machines I have put down three years of working for two years to cover all loss which may occur by storms requiring us to make more bricks than is necessary, and to allow loss of time in setting up the Machinery and getting steam to the Mills &c.

12 I have shewn that by manual labor the cheapest rate at which we can possibly expect to get the bricks in their raw state delivered on the work where we

a boon to be without taking in to consideration any continuous wet weather and other hinderances likely to occur during our long drying process by machinery we find we can do the same work in one half the time at a saving of in the actual outlay of £680 &c, but again for the manual labor our 60000 ℔ will when spent be gone, as we shall have nothing to show in the way of bricks, whereas in using the machinery we not only save the above named amount of £680 &c actual outlay, but we have the machines (if required) still as good as ever, even after two years they are determined by me at 25 per cent they will still represent a value of 1965 £ which added to the 680 £ above saved and we have 2933 £ nearly half the price of the bricks to the good in actual money, while last not least we have the manual labor that would be required to make the bricks available for other work

13 I have made the Estimate for the cost of the machinery £ very high, so that even the very highest expenditure necessary for the Machinery may reliably shew the great saving effected by using it; both returned to the Engine, as we would have kept it up the first planned, perhaps be better to get two 12 H.P Engines of the Kind proposed which would not cost more than 1 of 25 H.P and the bricks ℔ would require less labor by that up, besides having two separate Engines would also the brickmaking machine being set up in convenient localities for the supply of clay &c I would recommend that these Engines

to be furnished with Grinders with intervals which allow of the use of some part of Clays, Chips and Barnabé refuse of all kind as fuel, and which would make a further saving, then as you will observe, below, I propose to the Main Machine to be used on the work, to take off a portion of the Mechanical Engineers pay &c and be partly chargeable making a further reduction on the cost of rare bricks

14 I enter into the further calculations necessary to shew the great profits derivable from using the other machines Sir D Stamps recommend, would lengthen this letter &c and that I will simply sketch out roughly their advantages and enumerate them shewing their prices delivered on the hills; we shall have many thousands superficial feet of flooring to saw up and plane besides other timber work for Trusses, Sashes windows Door framing Furniture &c, a planing Machine (those manufactured by Samuel Worcam & Co for this purpose are said to be the best, and most easily managed) would save considerable time and labor and reduce the cost of our Carpentry immensely, one of these machines can square up Scantlings of hard wood like teak 15"X12" or it will at one time plane as many small Scantling as can be placed side by side on its bed of 15" wide, the Cutters are fitted on the most approved principle and the machine prepares easily 10 sq ft of planed surface per minute, the cost of a machine of the Kind in England is 230 £ double it for freight &c and we have £600 to which must be added 40 £ more for Carriage and fixing at Ostacamund or 500

15. Jalready at Wellington have a small saw mill for vertical saws with a steam Engine attached from which I also drive a Circular saw for Cutting small scantling such as rafters &c, for the Vertical saw mill frame is too small and the Engine is not of sufficient power to work this mill profitably, I would therefore recommend that a new saw frame and feed gearing be obtained together with a couple of timber carriages, Allep[s] Hodgson & Co[s] patent saw frames with "silent feed" are the best, the timber bed used for the machine we could make up here together with all its fittings excepting, the self acting gearing and saw frame and small carriages, I have no data by me to give the exact price of this portion of the Machine but taking into consideration the price of a like machine such as would take in a scantling of 36"X40" I think we could obtain and set up the new machine for about £400/ very probably for much less, the reason we want a frame of this size is that the timber we cut is nearly all of it crooked, and thus will not entail much wastage by adzing let alone the loss of labor, to through the small frames of the kind we have at present.

16. I take this opportunity of here noting that it is generally thought to be the best plan to have sawing Machines set up in the Forest where the timber is obtained, and in the case of the Kaiwharrawhara which have to be ascended by steep ghauts it appears to be more than ordinarily necessary that every saving possible should be made in the carriage of such timber by reducing it in the forest to the requisite scantlings and thus saving the Carriage of saw waste &c, this is all very well for Forests in Europe or those situated in healthy localities in India but with reference to the Forests for which we obtain our timber for the mills, such is followed by very different results, these forests are unhealthy in the extreme as is also the whole of the Country in the plains from the Forest to the foot of the ghauts and several thousand feet up them, this unhealthiness is so great that it is with difficulty that new natives can be induced to fell and remove the timber and the European officer in charge of the Forest is only able to remain in the Forest for short intervals of time often suffering severely from fever in consequence.

17. For an efficient saw mill either steam or Water power machines is requisite and such would require the constant supervision of a European Superintendent on the spot who could not be induced to risk his health and perhaps his life except on high salary, the setting of Machine saws cannot be properly done by natives, at Wellington for the last ten years I have been doing my best to induce natives to learn the mode of setting these saws but to no purpose, I have never succeeded in getting a native sawyer or filer even under the promises of double the pay they can earn with their saws or files to learn the proper mode of setting the Machine saws, then again such machines will require occasional repairs of a nature that can only be done in a good workshop by a skilful mechanic accustomed to such repairs, a power lathe and drills would be necessary, skilled workmen of the kind just noted could not be obtained at a moments notice, it would therefore be requisite

that such workmen be always kept at hand
on high wages and lastly it is only to be expected
in such a climate that the European superintendent
and workmen would frequently be absent from sickness
or ill health and the whole Machine thus remain
idle, I am therefore convinced that Establishing
the Saw Machine &c in the forest will not effect the
saving expected in the first instance and as the
second reported below it will be seen that such an
arrangement instead of being a saving will actually
be the occasioning very great loss, I would with-
draw my opinion as to the expediency of Steam
power in the construction of the Wellington Barracks,
timber to the requisite scantling in the open
great quantity of first rate new sawn up in the
finest and straight dispatched in an apparently
sound state when delivered at Wellington they
were found to be so cracked as to be rejected
at the rate of 50 per Cent, a workshop was
also established at the village of Gun-
dlepett in the Wynaad Country which is the
nearest healthy locality to the forest here
Doors and windows Door and window frames
panels Sash work with Rebate, the new Colonnade
this workshop cost nearly as much as did
the hills and fully 50 per Cent of the sawn
up timber was lost in the case of the teak
so cracked and often curled up as to neces-
sitate its rejection the saving supposed to be
being supposed to be in consequence of the
sudden and excessive changes of temperature
to which the sawn and worked up timber
was exposed during transport, it is for the reasons
given that I am strongly opposed to having any
sawing machines in the forest.

18. When at Madras during the present
year I saw several Steam Engines lying idle in the

Abercrombie battery, if furnished with three of
these one of 12 HP and two of 6 or 8 HP would
both drive the larger saw frame planing machine
any also by the simplest mechanical contrivance
furnish up all the mortar required for the works
at about one third of the price it would otherwise
cost, such a mortar mill I have tried here
utilizing my steam Engine when it was not
required for the Saws and found to answer ad-
mirably both mixing and grinding mortar far
more effectively than is effected by hand labour.

19 Understanding that you are about to
proceed to England I would urge your using
the Machines I have asked for at once, and
if you approve of them that you be permitted
at once to order them out, as also select a
Mechanical Engineer to accompany them and
set them up who has been used to these
built machines and thoroughly understands the
management & repairs as also that of steam
machinery, the salary allowed in my es-
timate is good, I do not therefore think there
will be any difficulty in obtaining such
a person especially when it is known that the
Climate he is to be employed in is a good one
for the European constitution.

20 Should the Government agree to the
suggestions made in the above paragraph
I crave your permission to send you more
detailed specifications and descriptions of the
Machines I require noting such parts as
I think necessary to have in duplicate pro-
viding for wear and tear and in case of
accidents.

21. In conclusion I trust as I have
before stated you will appreciate my wish
to obtain these machines and support the

arguments I have used regarding their absolute necessity, as without them I feel certain I shall have countless difficulties to overcome in the construction of such extensive works with Labor from the plains in such a climate as Colorado which is literally colder during the working season there than at any other time of the year.

I have the honor to be
Sir
Your most Obt Servant

W. Harris Captain
Engineers

Brevet Colonel R.E.
District Engineer Columbia Dist

Canadian Engineers Office,
City of Montreal (Montmorency)
Madison 19th April 1865

No 2405. Despatch No 22 Sheet No 1

Captain Dew, A. M. Allan R.E.
Canadian Forces &c &c

Sir,

Secretary to Government
Military Department &c &c &c

Sir,

I have inspected the finished portion of the Marine Defences and Canal Entrance Plans Canal, between the 3rd and 31st ultimo, those the honor to report for the information of Government the state and progress of the works.-

The Sea Wall.

Section No 2. The Sea Wall, Quebec was breached in Oct 1862 and all the line of Quay wall to the Dry Dock Basin No 1 has been rebuilt to a height of 5 feet of the full height 2nd Section No 1 Stage No 2 between the Dry Dock Basin No 1 and the Queen's Wharf. This foundation on the base rubble of the original Section No 1 Stage No 3 was completed, and the extension towards the Queen's Wharf, the following arrangements were in progress. The wall at high water to the top was 3 feet 6 inches thick with a batter of 1 foot in 6 inches. The wall at the junction with the Dry Dock wall of the Quebec Section No 1 Stage No 3 will slope 3 feet below the Drain and they will slope at 1 to 6 to the rear, and all the quoins of the walls will be of hard cut stone. The whole of the walls will be backed with rubble stone, carefully laid, and bonded to the hard rock, and the whole of the face of the wall will be pointed with Portland Cement mortar 1 part to 2 parts of sand. The drain is to be formed with flagged stone of the largest size procurable. As an additional precaution 2 returning walls

To Govt. d/2 March 63 N 4/4

From

Captain W. Farewell
Executive Engineer

to

Lt. Col. J. Crichton R.E.
C.B. Chief Engr. &c &c
Quebec

Dy 19 December 1864
Rec'd

No 2010

With reference to the proposed buildings for the Lawrence Asylums on the Belvidere property proposes the use of labor saving machines with the view of reducing the number of laborers otherwise required for the construction of the buildings and points out the great saving both in time and labor by using machines

A. Clayton Esq
Patent Brick & Tile Machine
Patentee
Attn Mr C.
Upper Park Place
Regent Square
London

XX

walls parallel to the body of the Ancient, and connecting the side walls of the sloping apron, were to be built.— On the rubble ring bund a low wall has been constructed to prevent water in freshes passing over the site of the breach until there is a considerable quantity of water in the river below.—

There was a good deal of water passing through the loose rubble under the new body wall, but it was considered that this will be checked by the mass of stone about to be placed in rear, and that puddling between the ring bund and new body wall, and above the former, will so far reduce the leakage as to allow of the bed of the river silting up and so stopping it altogether.—

The character of the work now under construction for the strengthening of the breach is very different to that which failed last year, and which was noticed in my report as per margin.— I think however that the sloping apron, though well adapted to rivers with sandy beds, is not well adapted to resist the action of the water when it is laid upon rock, and it is difficult so to secure the foot of the slope as to guard against the removal of the stone at that point, and the consequent destruction of the apron.— The work in progress is, of its kind, as good as the circumstances of the case would allow, but had not so much of the work been done, and the time before the early freshes been so short, I should have recommended the adoption of measures which would probably have rendered it practicable to found a new body wall on the solid rock— An attempt was made to do this, but on removing the stone from the line of the wall, it was found that the loose stone of the ring bund would not stand, and the intention was therefore abandoned. I think however that it would have been quite practicable to cut off the breach entirely

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by a mud bank formed from the silt in the river bed above the Ancient, either by running such an embankment from the wall beyond the breach on either side, or by banding the open channels at some distance above the Ancient.—

4. The wish to throw water into the Main Canal both for irrigation and for the supply of Khurnool has much interfered with the facilities that might otherwise have been obtained for closing the breach.— The river for some time past has not contained more water than might readily have been got rid of through the undersluices but to maintain the supply in the Canal these have of necessity been kept closed. It would have been better had the canal been made to give way to the very important work at the breach. Almost a few hundred Rupees of compensation would have been the only loss, and not only at the Ancient itself, but in the Main Canal, as will be presently noticed, the work would have got on much better in the absence of water.—

5 I understood that the outlay on the breach would amount to about 40,000 Rupees. Much of the expense was occasioned by the stone for the ring bund having to be obtained from the revetment of the stop bund on the South side of the river, and carried along the crown of the Ancient to the breach— This stone was of small size and a great deal was carried through the breach, and the wonder is that the formation of the bund with such material proved practicable.—

6. The crown of the Ancient has, throughout both branches, stood very much better than I anticipated when reporting on it last year. The damage has been very trifling indeed, and it is now in good order.—

para: 4 of letter No 40- 2nd July.—

7. The rock in rear of the South branch has in part been

been a great deal worn by the overfall.- The worst parts were to the North of the breach, and there repairs have been effected and the hollows at the foot of the body wall have been filled with concrete. The Officiating Chief Engineer considered that experience had shown that this material stood better than stone masonry. I have never seen concrete under an overfall of more than about six feet, while in the present case the Ancient is more than double that height. At the same time it is undoubtedly difficult to construct good masonry in such positions unless the rock be first cut out, so as to afford room and holding surface for large block masonry, and perhaps before incurring the expense of such work it will be well to try the concrete. Should this fail it will be necessary wherever the nature of the rock is such as to be incapable of standing the wear and tear, to construct an apron of massive, pitched, dressed stone in a bed cut out of the rock.-

8 The body wall of the North branch was in some places damaged to a small extent by the displacement of the stones at the offsetts on the rear face - The necessary repairs have been effected.- The rock in rear of this branch has in some places broken up into large masses, which have been moved a few feet by the water. The process by which this has been accomplished is observable in many rivers - The softer parts of the solid mass are drilled out by the water, these holes at last approach to within a foot or so of each other, and this intermediate neck of rock is then fractured, and what was a continuous mass becomes divided into lumps varying in size from 1 or 1½ cubic yards to a few cubic feet, and the force of the water then removes them from their original position. Except at one spot where this action has been going on near the foot of the Ancient wall, it will be a long while before the rock will have suffered

suffered to any extent to occasion any immediate danger to the Ancient itself, but in the meantime the action should be watched carefully, and perhaps the detached rocks might be so arranged as to protect the foot of the Ancient either by packing them there, or using them to dam up the water and form a cushion pool to receive the overfall.-

para 6 of letter No 49- 2nd July. 9. The north wing wall of the North branch is built on loose rubble - The silting up of the bed of the river has reduced the leakage very considerably, and it may be anticipated that the freshes of another year will deposit sufficient silt to make it altogether water tight. There was no water near it at the time of my visit.-

The Undersluices.- 10. The masonry of the undersluices has stood very well, and is in good order - The South most has lost a couple of stones from the rear edge of the flooring, and that is the only damage occasioned by the freshes of the past season - The rock in rear, which is much below the sluice floor, is sufficiently hard to stand the wear without injury - The revolving shutters, which have been fitted to 10 out of the 12 vents, require re-hanging, as they do not shut properly, and work with difficulty - The shutters themselves are in excellent order.- The depth of water on the upper sill was 5 feet.-

The Head Sluices.- 11. The shutters of the vents which have been fitted with gearing are reported to work well. There is a large bank of silt above the sluices, and about one foot of deposit in the canal - The side slope revetment below sluice on the left bank has much of it been displaced.-

Stop bank - South side. 12. This bank was complete prior to the removal of its revetment to the Ancient breach - The stone will now have to be replaced.-

replaced.—

13.— 1st to 5th miles.— The embankments are generally very nearly finished, and in many parts quite complete.— The patches of rock in the canal bed still remain.— The bund of the small tank in the 4th mile is not quite up to full height at the upper end.— The black soil where the canal is in cutting, and consequently unrevetted, has washed down a good deal.— Main Canal 1st Section 1st to 18th miles.—

14. 6th mile.— The Veddarair Tank which breached in July 1863 is in this mile.— The work here is not yet complete, and it has been much delayed by the presence of water in the canal. Some parts of the revetment are not yet up to water level (about one foot above canal bed). Parties were at work dressing the bank and pacing revetment. Calingulah No. in this mile was breached to enable the water to be kept down to a safe level, but the length of body removed was so small as to be practically useless.— This surplus work has no Apron.—

15. 7th to 10th miles.— The canal in these miles is approaching completion. The Calingulah No. 2 in the 8th mile is finished, and has a small dry stone apron,— which may perhaps stand, but would hardly do so were the calingulah to discharge much water.— The revetment in this part of the canal is being done at 8 annas a cubic yard, a fair rate.—

The Culvert No. 10 is said to leak less than it did at first, and the paving and revetments connected with it are complete.—

In the 10th mile the making up of the banks was in progress up to Calingulah No. 3, which was complete last year.—

16.— 11th, 12th & 13th miles.— In the 11th mile the banks are nearly finished, the revetment is still far from complete. The high banks in the 12th and 13th miles are finished and in good order.— Much revetment still remains to be done, and in the tank in the 13th mile there are parts which are not yet up to the level of bed of canal, and it will be difficult to get on with this work so long as water is being passed down.—

17.— 14th, 15th & 16th miles.— In the 14th mile a good deal of revetment has been done, and much remains to do.— In the upper part of the 15th mile this work is behind hand, but below that the canal works are complete, with the exception of a little earthwork above the revetment. Calingulahs Nos. 5 and 6 have been breached purposely, but to a very small extent only.—

18. 17th & 18th miles.— Some of the revetment in the 17th mile, which was built on a very steep slope, has fallen over, and a good deal more is unsafe. It will be repaired on a proper slope, and this will cost but little.— The cutting at the end of this and the beginning of the 18th mile is complete.— The Kurnool sluice is a carefully finished work and answers well.—

Temporary Bridges.— 19. All that were required to be built were constructed last year, and have been in use ever since, and most of them have carried a considerable traffic. It is intended to raise them 2 feet this year to allow of more water being passed down, but as they have only 2 vents, or spans, of 12 feet each, I doubt whether the waterway will suffice.—

Ferry Boats.— 20. Two have been placed on this section of the canal, but they have not yet been brought into use.—

They

They are made of wood and are of the ordinary punt form and will carry two bandies without bullocks, or one cart with bullocks.—

Revetments.— 21.— These would have made much more progress but for the delay occasioned by bringing the canal into use.— I donot know why the intention, to build all the revetments to 3 feet above bed of canal before proceeding with the upper part of this work, was not carried out; as it is the sooner the water is stopped and the parts which are below the level of water intended to be admitted this year, are finished, the less the difficulty will be. The anxiety to take water down the canal to test its admission before the works were ready, and although little risk of damage was incurred, the proceeding will add to the cost. The rates for revetment have been revised, and due attention appeared to have been given to economy.—

x Letter No 40-2d July/64 para 27.—

The revetments, where laid on unconsolidated earth, are in many parts displaced, and will need repacking, but on the whole the damage sustained from this cause is less than might have been expected, and this may be due to a regular settlement over the whole slope.—

Earthwork.— 22.— But little remains to be done to the banks.— Where the canal is in cutting there is a good deal to be done in the way of clearing and widening, especially just where it passes into and out of Tanks, and this should be done as soon as possible, as it may be inconvenient to dry the Canal when the lower sections come into use.— The removal of the rock, which has remained untouched since last year, should also be attended to.—

23.— Several

Irrigation sluices.— 23.— Several of these have been constructed with their sills considerably above the level of bed of canal, and to afford them a supply, temporary dams have been placed across the channel and, in one case, water was being lifted at the Company's expense. It is probable that the sills were thus placed intentionally, with reference to the level of the lands to be watered, but at any rate the permanent arrangements should be decided on, and neither dams nor water lifting should be allowed after this season.—

Leakage.— 24.— Except in a few places where the material of which the banks are composed is very porous— the leakage through the banks is not very great, but nearly all along there is more or less leakage through the subsoil.— Where the former occurs and the toe of the rear slope was affected, single banks have been laid down which have stopped damage. In the latter case the loss of water is the only evil, as there are abundant facilities for drainage.—

25.— On the whole the condition of this section of the Canal after having had water in it for nearly 8 months is satisfactory, and if an opportunity be made for finishing off the incomplete work on the low levels, it will be quite ready to carry all, and more than all, the water which will be wanted this year.—

Aindry Aqueduct 26.— The arches of the Aindry Aqueduct had, prior to the inspection made last year, been completed to two thirds of their width, and when the water

water was passed over, it was found that the part of the South abutment which was outside the arch shewed signs of yielding to the pressure of the water and earth in rear, and there being masons available, it was thought advisable to construct the remaining third of the arches, and at the time of my visit 4 arches had been completed and two were nearly ready to be keyed, and as the North arch underwhich runs the Bellary road had been completed before only 2 arches remained to be finished.— The aqueduct over the 60 feet width has been inclosed by a temporary wall on the west side, and by a part of the permanent parapet on the east.— The floor has been plastered. The leakage through the north abutment is now very small— Some of the arches shew signs of considerable leakage, but it was at the South abutment that the great leakage occurred.— It would appear that the lower courses of the masonry there were laid without mortar, and the water passing through the sandy soil in rear found its way through the masonry in large jets— Through the South arch, the spandril or face-wall, and through the wing walls also, a great deal of water passed, and left on the face of the masonry a coating of lime, which has been removed from the interior of the masonry.— The plastering which has since been executed at the backs of the abutments and over the flooring will no doubt go far to diminish the leakage, and I believe also that it will be found that the joints of the masonry, notwithstanding the amount of mortar removed, will be found better filled and more water tight than was the case before.— Leakage through the abutment itself will also be expected be obviated by the large mass of rammed earth which has been placed there, but until another trial has been made it is not practicable to give an opinion as to whether recourse to asphalte will not be found necessary though, if the parts which were most leaky should be found to have been so far improved as to leak no more than many other parts, where the masonry joints had been more carefully constructed, I think this expence may be avoided.—

Now that the arches are approaching completion, it would be as well to finish the Aqueduct altogether, so that the accounts may be closed, as it is not worth while to leave the parapets only incomplete. Opinions may differ as to whether it was altogether advisable, at a time when funds were running short, to turn the last third of the arches, but now that this has been done the comparatively small extent of other masonry should be completed.—

2nd Section Main Canal— 18½ to 32nd miles.—

27. Part of 18½ mile below the Aqueduct— The banks below the Aqueduct were constructed of black soil and the surface soil was similar, but at a depth of 2 or 3 feet below the surface there was a great bed of sand.— Unfortunately, in constructing the banks, the good soil between them was removed, and on the admission of water the leakage through the subsoil was

was found to be so great as to endanger the masonry retaining walls and the embankments behind them. The water was stopped, and that already admitted quickly drained off, and the filling in of the pits with good soil was then commenced. Two estimates have been framed and sanctioned for this work, the first provides for the filling in near the aqueduct and for some distance down the canal, and this part was almost finished when I saw it: the second continues the filling further down, and also adds somewhat to the thickness of the new stratum of non-porous soil; and this work had just been commenced. I am of opinion that the measures adopted were the best that were available, that on the next admission of water a great change from the former unsatisfactory state of affairs may be anticipated, and that should it be found that the leakage is still too considerable to make it prudent to leave it to be stopped by deposits from Canal water, the best course will be to increase the thickness of the rammed earth. The masonry retaining walls are complete and in good order, as are also the revetments in continuation of these, and the earthworks are finished with the exception of a little top levelling and the dressing of the rear slopes. All the earth required is upon them. It was expected that in a fortnight after the 23rd March, the canal at this point would be ready for another trial, and the officiating Chief Engineer promised to report the result

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P.W.D. No. 1540 of 27th May/64.

result, which will be at once communicated for the information of Government.

28. 19th mile. – Canal is finished up to the commencement of the cutting above the Gooty road Bridge, and the cutting was being cleared out. The Bridge with its approaches has been finished, and the loop drive in connection with the Hullur Road has been completed, and is in use.

To Calingulah No. 10 a well packed apron has been added with a retaining wall. A flow-weir has been constructed in rear of the 2 sluice vents of the Calingulah. Some loose rubble beyond these aprons will probably be required, and there is abundance of this material on the spot. From this Calingulah and from Calingulah No. 11 at the beginning of the next mile the surplus water is to be carried by one channel, and the arrangements for effecting this are to be made without delay.

The lower part of the cutting in this mile is being cleared out, some of the rock is very hard and is being blasted.

The revetment and bank of the rest of this mile are complete.

29. 20th mile. To Calingulah No. 11 an apron similar to that at No. 10 has been added.

A new irrigation sluice has been constructed.

The heavy cutting in this mile has been completed to full width at the lower end and many other parts are nearly out, but the upper end of the cutting contains a large proportion of very hard rock, and there only

only 1/3rd of the full width has been excavated down to the proper level, and the other 2/3rds are in various stages of progress, and much remains to be done - The character of the rock varies greatly - The hardest description is a basalt, resembling whinstone, and containing veins and dykes of quartz - Another hard stone is a conglomerate, containing much quartz - There are numerous shales, some of which are hard but brittle and separate easily into small rhomboidal crystalline fragments. - These shales are in many places covered with slabs of hard rock from 1 to 2½ feet thick, which once formed a continuous bed, but has been broken up into slabs of various sizes by the movements of the underlying strata. Above this slab stratum, nearly all over the cutting, a distorted friable shale is found.

The work is still in the hands of the contractor referred to in my report of last year - The blasting para. 31. - however is managed by the Company, though the cost is defrayed by the contractor - As is losing by the work, I am told, and it would seem that he clings to it only because he hopes for an increase of the rate. - It cannot be a matter of surprise that the rate is found unremunerative, for the work has been carried out with a careful avoidance of all proper arrangement, and no fair rate could possibly have left a profit. - The harder rocks when blasted come out in blocks of 1 to 4 tons, and these are then reduced by reblasting, or with hammers and crowbars, until the pieces become small enough to be carried up out of the cutting by coolies - The additional expense thus occasioned has been very great, and by a judicious use of cranes or travellers and perhaps of a tramway also, the work could have been done in a satisfactory, expeditious, and economical manner - If the Company ultimately reimburse the contractor, as would seem more than possible, they will lose a large amount of money; which they are not, I think, in any way called upon to pay, seeing that after the difficulties of the work had been experienced, and the contractor had found himself unequal to the task of overcoming them, the option of throwing up the contract was afforded him, and he declined to avail himself of the opportunity of cancelling his engagement. The skinging has been finished up to the sluice at 1,700 yards, and below that the revetment is up to full height, and the canal complete. A temporary bridge has been constructed at the lower end of the cutting -

Yoorapore Bridge 30 The Bridge for the accommodation of Yoora-
M.G. No. 1540 of 27th May 1864. - pore and its neighbourhood is to be built at a
favorable site at the deepest part of the cutting -
It has not yet been commenced, but the collection
of materials has been begun. -

31. 21st mile - The banks and revetment have been completed. The culvert which was found to leak a great deal was being uncovered, with the intention of plastering its exterior surface, but as the culvert will not now that the Yoorapore Bridge has been added to the list of crossings, be

necessarily needed a passage, and as the work would involve the removal of a great many cubic yards of earthwork, with perhaps doubtful results, the Officiating Chief Engineer considered it might be left alone, and I agreed with him.—

32— 22nd mile. This mile is complete including Calingulab No 12, to which the wall referred to in para 34 of last year's report has been added, but finishing a very satisfactory manner— The site is a rock the surface of which is the shape of an inverted saucer, and consequently the water has an inclination to run along the rear of the banks both above and below— The wall will stop the discharge in the latter direction only— Below the Calingulab a wall which, including a part in the 23rd mile, is 2000 feet long takes the place of an embankment and is complete.—

33— 23rd mile— Below the wall just referred to the revetment has been completed up to the 24 mile, and the banks need only a little trimming and levelling— The right or contour bank is likewise, with its revetment, nearly finished up to the same point— Beyond this up to the Hadrabagh Aqueduct, and below that to the end of the mile, which is 100 yards further down, a great deal of earthwork remains to be done, and the heavy revetments have yet to be commenced— A short distance above the aqueduct the soil is a porous lime kunkur, and though the banks, and a few inches of the surface soil, are of better material, a great deal of leakage must be anticipated under, but not through the banks— This will however only occasion loss of water—

The embankments near the Aqueduct will be very lofty, and the admission of water will require to be carefully managed— They are to have interior slopes at 2 to 1, and exterior 1½ to 1.—

Hadrabagh Aqueduct letter No 230 of 24 March 1865.—

34. The condition of this work has already been reported upon in transmitting a revised supplemental estimate for the additional works deemed necessary to render its stability possible— The ramming earth backing to the upper abutment has made considerable progress, the rest of the additional work was not commenced— Concrete for the flooring over the arches was being laid— The main wing walls are much too short to hold the embankments properly and the masonry of the side walls of the duct is not of a description likely to be watertight—

35. 24th mile— The wall at end of right contour bank, with its irrigation sluice and stone revetment is finished.—

The bank (single) for a length of 500 yards nearly up to the first ravine is fully finished and revetted; to the rest of the bank a good deal more work is required to be done.—

The wall 200 yards in length across the ravine is finished, all but a few feet of coping— It is intended to strengthen the wall by placing a bank of shingle in rear for ⅓rd the height and a slope of about 1½ to 1—

The wall has been well built—

The earthwork below the wall to end of mile rather behind hand— The shingling, except for 100 or 150 yards near the wall,

wall, is nearly finished.

1.36. 25th mile. Calingulah No. 13 finished. The between-
events will want some apron, as the ground, though rocky,
is not hard enough to stand near.

The Earthworks are 7/8ths done, and the revetment near-
-ly finished.

37. 26th mile. The upper part of this mile, as far as
the first valley, is in much the same state as last
year, and a great deal of clearing and backing has to
be done.

Across the valley a wall of the new section i.e. a core
of rammed earth with dry rubble retaining walls, is
being built. The filling in was behind hand, and it
will not be watertight unless care be taken to water
it and to place its base on tolerably solid material.
The surface soil is so full of small stone that water
would pass through it as readily as through a sieve.
It is said that this wall is costing more than the
old section of masonry. The limestone for rubble
costs 12 annas a cube yard, the estimate allowing
8 annas only. The filling was expected to be done
at the rate of 3 yards the rupee, but this is found
insufficient, as the soil is brought about 1/4 of a mile
and there is no water near. This wall is about
1/3rd done.

Below the wall there is some very good revetment
which was done at 3 yards the rupee, but the stone
is now not so easily obtained as was the case at
first, and this rate does not pay. A short distance
below there was to have been a masonry wall 200
feet in length. Of this 100 feet have been built and,
in lieu of the remainder, the new section with earthen core
has been substituted. This was a mistake for it will
be a very difficult matter to make a good junction,
and the appearance also will not be satisfactory. Pro-
-bably the only safe plan will be to carry on the ma-
-sonry wall double and gradually diverging, at the
same time increasing its batter, until the same
section as that of the dry rubble walls is reached, there
will then be room for a proper core. This wall is 40
feet high at the nullah, it looks very weak and its
dimensions are much below those usually allowed.
Some soil has been thrown behind it, and it is un-
-doubtedly advisable to continue this backing all
across the low ground.

(6½' top width plus height of wall into 5 inches, being 4" to foot batter in front & 1" to foot in rear.)

The next wall is finished. It is of moderate height
and joins on to a low hill at the lower end. Beyond
the hill there are a few hundred yards of embank-
-ment, which have been carefully revetted, and the
mile ends with a masonry wall across the valley,
52 feet high at the ravine, and like the other walls,
constructed with a rubble and sand core. This too
feet long and has cost something over 30,000 Rupees.
It is very nearly finished, and will want backing;
the masonry is good, but the section is weak.
A good deal of excavation remains to be done to com-
-plete the canal across the spurs, but only a little work
will be required to pass down a stream 30 feet wide,
and 2 feet deep, and that is to be provided for first-

38. 27th mile. Down to the deep valley the bank and
revetment are well advanced, but the cutting is far

from

from complete - The abandoned bank is being run — vide para 40 of last year's report —
down by railway to the deep valley, and the embank-
-ment there is being partially made up also from
pits, and is about 2/3rds done - It will be finished in
2 or 2½ months - Cost of earth brought by rail is 4 As.
-nad a cubic yard - The pit soil is more than half
small stone. -

Some cutting at the spur is required to complete canal -

39 - 28th mile - The long wall in this mile is sub-
-mitted the same state as last year, except that at
the upper end a short length on an improved section
has been added - It requires to be backed with soil -
The short masonry wall further down is 6 feet above
bed, and a length of the new section has just been
commenced - It will be better to continue the masonry
wall, with however the improved section adopted at
the beginning of this mile. -

Beyond this to the end of the mile the core section
wall is continuous, and is about half done. -

In this mile there are only a few yards of ordinary
embankment -

40. 29th mile - For the first 300 yards the core section
wall is continued; it is about 1/3rd done, and the greatest
height will be 28 feet - Thence the cutting across the
spur is about half done, and below that, down to Calin-
-gulah No 14, the bank is very nearly finished, with
revetment. The Calingulah is in the same state as
last year; stone for the sluice vents under prepara-
-tion - Thence to the end of the mile the high banks
are very nearly finished, and the revetments also are
not far short of full height -

41. 30th mile -

× Earth core & dry stone walls

41 30th mile - In the first quarter mile the bank
and revetment are very nearly finished - Thence to
half mile, bank 3/4ths done and will be shingled - Nearly
all the rest of the mile will be a combination of
cutting and single wall with a thin bank in rear, and
this part is 3/4ths done - The last few yards are form-
-ed with a bank, which is nearly complete, and will
be shingled -

42. 31st mile - The mile commences with a length of
200 yards of core section wall, which is about 1/3rd done
After that the single wall has not been touched since
last year, and has to be backed - Thence to the end of
the mile the bank is complete except trimming, and
the revetments, all but 200 yards near the lower end,
are finished - These banks are high and their interior
slopes are 2 to 1 -

43. 32nd mile - A little trimming and levelling are
alone required to complete this mile - Revetments
complete - There are one or two small gaps, which
have been purposely left - one is at the spot where
Calingulah No 15 was to have been built -

General state of the 2nd section -

44 - The amount of work done in this section during
the past 9 months is very satisfactory, and while
there is much to do to render the canal complete -
there will be no difficulty in getting the section ready
to pass down a moderate supply by the end of June
The state of the Kadrabagh Agueduct is however far
from satisfactory, and until this work has been so
in capable on trial, and the embankments connec
with it have settled, it must be doubtful how soon

it

it will be possible to take down a continuous supply. The great walls of this section have also yet to be tried: that they will leak considerably can hardly be doubted, and their stability is perhaps rather to be hoped for than to be confidently expected. The scouring sluices, which it was at one time intended to place in these walls, have been omitted, and this is perhaps an advantage.

As mentioned in last year's report the soil throughout this section is unfavorable for water tight Embankments.

Distribution.

Nothing has as yet been done towards the construction or laying out of irrigation channels the irrigation however will be very limited, and the land between the canal and the river being but a narrow strip, the arrangements will be very simple.

Railings or parapets to walls.

45. No provision has as yet been made for railings or parapets for the great walls in this section, but some protection of this sort appears to me to be indispensable, and if cattle are to be used in towing, there is not room for any thing but a railing. A drop of 30 to 50 feet is not a pleasant contingency, and it is one that should be guarded against before the line of the embankment becomes, as it soon will become, a thoroughfare. I may add that the long Calingalak towing path stands in need of a similar protection, though their elevation is far less.

3rd Section of Main Canal. 33rd to 43rd miles.

46. 33rd mile. The banks and revetments are very nearly complete throughout. The Sultanpore crossing wants planks and puddling over the crown,

and the walls and contour banks at the South end are incomplete, and the former were commenced of an insufficient thickness and two feet are about to be added. The main bank over north and of culvert has to be made up.

47. 34th mile. Calingalak No. 16 is complete except coping and a one vent sluice at each end. There is no apron, one will be necessary. The earthwork of the banks has been all thrown up, and has to be trimmed and sections. The absence of sections for the guidance of the work people has led to work much in pieces, in several places. Some shingling has been done. Calingalak No. 17 was complete last year. It has no apron and perhaps one might be dispensed with by raising the lodgwall a few inches, as it struck me that all surplus water might be discharged at No. 16 Calingalak.

48. 35th mile. (about 3 miles). The cutting at the commencement is very nearly finished. The banks below, down to end of next cutting, are very nearly finished and revetted. The cutting is about half done, the rate is 4 annas a cubic yard for lime-kunkur, which is the soil met with all along here. Then there is a long cutting about 3½ feet in depth, which is nearly finished and the bank across the small valley beyond is complete and revetted. Beyond this there will be a cutting through sideling ground, 9 feet deep at upper edge, and this is hardly commenced. The narrow cut through this will have to be pushed on

ow, if water is to be passed down in June or July.- Below this down to the Ullur Aqueduct, the bank is very nearly complete, and much of it revetted, but there is a short length where it is only half done. The rate for revetment here is 2 annas for the bottom yard and 1 anna additional for each successive yard, and this is very cheap.-

Below the Aqueduct only a very little Earthwork has been done since last year, and this part is therefore still barely commenced.- The last 150 yards up to Caligulah No. 18 will be core section wall, and this is half finished.- Caligulah still wants a coping to complete.- No apron has been yet given.-

49. This Aqueduct has its arches turned, and the spandrils and wings partly built. The materials used are dark limestone for the arch faces and cutwaters, and a lighter variety for the rest of the work, both these stones make excellent masonry. The arches and especially the third last turned are by no means as carefully built as they should have been: irregularities and open joints are far too numerous, and even the faces are not true, and it will not be surprising should work so constructed leak.- A large quantity of rough timber has to be [x] erected above and below the aqueduct, which at present stands in a rectangular pit, and the road approach will necessitate much excavation.- The circumstances of the place rendered such a work quite unnecessary, and many thousands of Rupees might have been saved, but for the Chief Engineer's objection to bridges.- Ullur Aqueduct

[x] not provided for in the estimate so far as I can judge from the plan.-

50. 36th & 37th miles. In the former nearly all the revetment, which was incomplete last year, has been finished, and some Earthwork has been done, but the bank is not yet quite complete.- The cutting at the end of the mile is very nearly finished.- In the 37th mile a little more Earthwork is required, and some small amount of revetment.- The irrigation sluice for which a gap was left is not yet built.-

51. 38th mile.- Up to the wall, banking, and revetment nearly finished.- Wall complete except at upper end, where a gap for a passage has been left; most of the Earthwork backing thrown up.- Bank below this up to double wall very nearly finished. The double wall is now 15 feet high, it will be 17 feet. To the end of the mile revetment finished, and only a few cubic yards of Earthwork remain to be done. The irrigation sluice here has not been commenced, and the gap for it remains unclosed.-

52. 39th mile.- Down to Caligulah No. 19, bank finished all but a little dressing, and revetment complete.- The average rate for this latter has been 4 annas, and much of it is very good.- Caligulah in the same state as last year.- Bank and revetment below Caligulah complete, down to the cutting near the end of the mile, rate for revetment 4 annas a cubic yard.- A great deal of the cutting has been done, and on the whole it has turned out better work than was expected, but at the lower part the surface is composed of hard limestone and conglomerate rock which, though in detached pieces, is difficult to get out, and as the rate allowed for the cutting - 4 annas a cubic yard - is too low for this work, it would be better to raise it to 6 or 7 annas for the rock, which will probably be found to extend

Para: 56 of last year's report.-

extend for a small depth only, and afterwards to fix another slake for the subsoil, when its nature has been ascertained. The sluice in the wall immediately below the cutting has not yet been built. the wall is nearly up to full height.

53. 40th mile.- The wall in continuation of that in the preceding mile is very nearly finished, and part of it is being capped- Thence to the double masonry wall, the main mass of earthwork has been done, and the revetment has made some progress- The wall is very nearly finished, and it looks far from safe- It might have been left out with advantage- For 150 yards below wall, the earthwork is 3/4ths done, revetment not commenced- The inner toe of the bank here is a good deal out of line- Thence down to the cutting at Malayala the banks and [illegible] are approaching completion- The cutting is much behind hand, and is tough work- Thence down to scouring sluice the works are in much the same state as last year- The sluice is in progress; the entrance and tunnels are complete, and the vents nearly up to the level of covering stones- The cut stones for the shutter grooves are very fine blocks- Below this to the end of the mile the banks and revetments are complete.-

54- 41st & 42nd miles- The banks and revetments of both these miles are for the most part finished, and the remainder are approaching completion- One gap remains to be filled in in the 41st mile. The proposed scouring sluice near Madigutta in the 42nd mile has been omitted, and this is an improvement. Calingulack No 20 at the end of the mile was complete last year.

55. 43rd miles- The cutting at the upper end of the mile is almost finished, the bank below this was complete last year- The irrigation sluice, for which a gap has been left a little below the middle of the mile, has not yet been commenced- Some little making up of the banks in this mile is required where the settlements have been considerable- The junction with the Nagatore Canal has not yet been completed.-

General state of the section.- 56. If attention be paid to the few parts where we are rather behind hand this section should be ready to pass water down by the 1st July-

Several irrigation sluices have yet to be built, they are small works and could be finished in a few weeks Nothing has yet been done to the distribution channels There are some 7 or 8 thousand acres of land available for irrigation probably under this section of the Main Canal, but in the absence of irrigation channels but a small part of the area is likely to be watered this season, and it is to be regretted therefore that arrangements have not been made for laying out and pushing forward these works- The ryots cannot wait until the close of the season before determining what the crops of the year are to be, and if they were to turn dry lands into paddy fields this year, the channels ought to have been ready by the end of March at latest, so as to give them an opportunity of ascertaining what the arrangements would be.-

Additional funds will be required for the third division.- 57. The above three sections form the Sindry division- The Executive Engineer at present in charge has not as yet had time to compare the work in all the miles with the balance of the sanctioned estimates available for its completion, but he considers that to finish the division altogether, according to the arrangements which have been sanctioned, an additional supplemental grant of between 2 and 3 lacs will be needed.

58. 44th mile.

58. 44th mile.- The gap left for an irrigation sluice has been partially closed, but the sluice has not yet been built. Up to the end of the Nagatore Bank bund, the work is in much the same state as last year, but it has recently been recommenced. Below this to sluice at 39 chains bank is complete and patches of revetment done. The sluice has been built of good stone. Distribution channel is being laid out. Thence to end of mile, banks complete and revetted.

59. 45th mile. As far as the Nagatore Bridge, the banks are nearly complete and revetted as far as intended and required, and the earthwork of the entire mile is approaching completion.- Approaches of Bridge nearly finished; the pits have been cut to a depth of nearly 3 yards on ground required for the slopes of the approaches, and these latter will have further to be carried down into the pits, or retaining walls must be built.

60. 46th mile.- An 8 feet culvert has been completed at 6 chains. It was intended to be a crossing, but its floor is about 13 feet below the level of the country, a large outlay would be required for approaches and the headway is insufficient. The masonry of the arches is very remarkable.

The canal in this mile is very nearly finished, a little rock clearing remains to be done.- Some revetment has been built with stone out of the cutting.

61. 47th mile.- Calingalah N:1 has some very carefully packed rubble apron partly done. Cost 5 Rupees a cube yard.- The sluice apron well built, and if carried out to the end of the wings with packed rubble, it will do very well.- Calingalah otherwise complete. Canal down to this

4th Section or Nagatore Division.-

vide Sp. Chief Engr's letter No. 1799-31 dated with tracing attached.-

P.W.D. No. 2438-24 Aug 14 para 14.

this nearly finished, below that incomplete.- At 59 chains a gap has been left for a road; bank here will be 20 feet high. The single bank requires a good deal more earth.- It has been revetted to a height of several yards with a rotten slate, which will melt away in a short time.- The culvert No. 2, 8 feet span, in this mile is proposed to be omitted.- It was intended partly for drainage and partly for a crossing, but it would be very badly adapted for the latter, and at this point perhaps a crossing is not absolutely necessary for a communication between villages, though that between the fields must not be lost sight of. The omission of the culvert and its connected contour bank would add 7.70 acres to the water spread of the tank, and this is not of very great consequence, as the land is red soil of poor quality. The next crossing will be at a little more than 1½ miles lower down, and this latter culvert also will make a very different passage, as its floor will be 10 feet below the level of the country.- I would recommend that the omission of culvert No. 2 be left to the Chief Engineer's discretion, it being understood that the question of the provision of a suitable number of crossings will be decided separately, with reference to the orders passed on that subject.

62. 48th & 49th miles.- In the former mile the cutting is nearly complete, the banks require a good deal more earth.- In the 49th mile both the cutting and the banks are not nearly finished, except in the last 10 chains of the mile.- At 50 chains the excavation for the 8 feet culvert

culvert at No. 3. is ready - floor will be about 13 feet below the level of the ground - It will not make a good crossing - the mile de[s]cription has not been commenced -

63. 50th & 51st miles - At the upper end of the 50th mile the earthworks are behindhand - The masonry of the 3' culvert at 42 chains not yet commenced - The earthworks of the last 3/4ths of the mile nearly finished - The first half of the 51st mile has its earthwork nearly complete, and the revetment is several yards in height - The mullah is still open - The remains of the open wall sluice are being cleared away - Thence to end of mile 3/4ths of earthwork done, and revetment commenced at one part -

64. 52nd mile - The 3 feet culvert is in progress - side walls and part of arch done, and part of the cut fall channel - Thence to Calingulah No. 2 the cutting wants a little clearing only - Calingulah sluices not completed, apron not commenced - Canal completed below this, all but a little clearing and filling up gaps left for crossings -

65. 53rd mile. Down to the 14' culvert at 31 chains, the canal nearly finished - Below this contour bank approaching completion and partly revetted, and the single bank is in some parts nearly full height, but elsewhere 3 to 4 yards below the proper level. Revetment has made good progress but much of the stone is very bad, and will have to be replaced - This error ought to have been avoided as it was well known (vide para: 75 of last year's report) that some of the slate in this division would not stand exposure - The rate varies from 6 to 10 annas - In the last few chains of this mile, the earthwork is much behind hand and the revetment has not been commenced - The 14 feet culvert has had the excavation completed, and the one abutment which was constructed from 6 feet culvert remains in the state in which it was 6 months ago - New work not commenced -

66. 54th mile - As far as the gap at 15 chains, a few yards of revetment done, stone partly good, slope rather steep - The banks on the two sides of the gap are in a different alignment. Thence to 25 chains revetment about 3 yards high, and it averages 2 feet above the bed of canal - The bank is 1½ to 2 yards higher than the revetment. From 25 to 40 chains, revetment not commenced - From the half mile down to the end, the revetment is in various stages of progress -

The mullah is at 51 chains, and there one bit of a front wing of the open wall sluice remains; the rest was carried away last year. At 73 chains there is a roadway gap -

The embankment is generally high enough for the level of the water which it is desired to carry this year, but the low parts want pushing forward, and there is none too much time for the careful filling in of the gaps -

67. 55th mile - In the upper part of this mile the bank has yet to be raised 4 to 6 yards; in the lower part it is nearly full height. Revetments not commenced - There are several gaps to be closed -

68. 56th mile - The banks in this mile are nearly finished. Revetment stone is being collected for parts where such a protection is not required - The construction of revetment not commenced - Calingulah No. 3 is in much the same state as last year - The sluice vents were built up some 4 or 4½ feet, but so badly that this work is being taken down - The rate 2½ Rupees a cubic yard is said to be too low -

69. 57th & 58th miles - In the 57th mile the bank is in much the same state as last year - The completion of the earthwork has just been taken up - Revetments not commenced - At 42 chains there is a gap at which an

an Embankment 25 feet high has to be formed - From the commencement at the 58 mile to the 35th chain the revetment has been built one foot above bed, work not very good - Below this the revetting is going on fast, but its cost is said to be not less than 5 Rupees a cubic yard, and the estimate allows Rs: 1½ - The quarries are 5 miles distant, the bandies are paid 11¾ annas a trip, and they bring about ⅙th cubic yard - The quarrying is not a separate charge - The proper rate would be about 3½ Rs: a cubic yard. The slope is 1¼ to 1, average thickness 2½ feet - Some parts are up to full height - In some places the thickness of the revetment is greatly in excess of both the intended and estimate allowance, and this will occasion further excess - The Executive Engineer promises to see to this at once. The earthwork for the top of these high banks costs 3 to 4 annas a cubic yard according to the lead - In the last ¼th mile about 6 chains of bank, averaging 36 feet in height, have just been commenced -

70. 59th to 60th miles - Up to the end of the Cut in the former mile a great deal of earthwork remains to be done - At 55 chains the excavation only for an 8' culvert has been set out - Contour bunds 3¼ths done - Thence to site for Calingulah at 51 chains, little or nothing done since last year - A little more excavation executed at Calingulah No. 4 - No masonry commenced - Thence to end of mile very little done - In the 60th mile a little earthwork had been done within the last few days, but otherwise the works had been at a standstill since last year - The foundations of the Unpaid Bridge were just being put in, so that here too little or no progress has been made -

Unpaid Office -

71 - The walls are about 6 feet above basement - work good - The amount of the estimate is Rupees 2444 - the expenditure Rupees 3777 - The Executive Engineer will be prepared to report shortly upon this work, but he had not at the time of my visit the details necessary to show the cause of the great excess -

General state of the works of the section -

72 - The progress made during the 9 months since my last inspection is very far from satisfactory - The quantity of masonry work executed is very insignificant, and where the heavy embankments were begun last year, they are still very far, not only from completion, but much below the level which they must reach before water can be admitted - The Acting Chief Engineer, who had inspected the works of the section shortly before my visit, expressed a doubt as to whether water could be taken below Puggoreal this year, and certainly it will require great exertions to get the section ready, and should dry weather occur, as is frequently the case in June, it will not be possible to get the arrears of work brought up in time to make any use of the water for cultivation - Nothing has yet been done beyond commencing the laying out of one channel in the 44th mile, Remarks providing for the distribution of water -

The state of the masonry works was as follows -

Completed -

1 Bridge, 5 Irrigation sluices, 1 eight feet culvert, 4 three feet culverts, 1 Calingulah -

Partially built -

2 Calingulahs, 1 three feet culvert, 1 Bridge -

Not Commenced -

3 Irrigation sluices, 3 eight feet culverts, 1 three feet culvert, 1 fourteen

1 fourteen feet culvert, 1 six feet culvert, 1 Calingula.—
The Executive Engineer thinks that 3/4ths of the Earthwork of the section have been completed.—

73. A revised estimate Rupees 92545 for revetments was sanctioned in Proceedings of the Madras Government No. 2871 of the 5th October last, after the Chief Engineer had been afforded an opportunity of ascertaining what the proper rates should be, and what grantikes were required.— It would seem however that the same officer who entered in the estimate 10 annas a cubic yard for the 54th mile, 1 Rupee for the 55th and 56th miles and 1½ Rupees for the 57th mile, gave the revetments in the last three miles, and in the latter half of the 54th mile, on tow contract at 3/4 Rupees a cubic yard. The estimate allowances, as compared with the cost of the work of this portion, stands approximately thus: Revetments.— G.M.S. No. 2394-20 Aug.

	Estimate	Contract.
Half of 54th mile	Rs. 832	
55th —	13486	
56th —	6718	
57th —	20904	
Up to 6 feet above bed.		85855
To complete to 2 feet above water level		15570
	Rs. 41937	Rs. 101425.

In the 58th and 59th miles the cost will probably exceed the allowance by 2 Rupees a cubic yard, and there are 23,500 cubic yards, so that the effects in these two miles will be about 47,000 Rupees.— It is clear therefore that the estimate was framed without proper information as to the distance of the quarries &c, and it may be expected that the actual cost of the revetments of the section will not be less than 3½ times the amount of the estimate and to be sufficient,

Rate for Earthwork in 54th to 57th miles.—

74. I was informed also that a considerable quantity of earthwork in the 3½ miles above referred to had been let to the same contractor at 6 annas a cubic yard, the original rate being 2¼ annas and the revised rate 3 annas.—

75. This section has been unfortunately circumstanced during the past year, and though this does not excuse the want of care in preparing estimates, or account for much of the shortcoming in the way of progress, it no doubt has had a considerable effect upon the state of the section.— Soon after my last visit the Assistant in charge of the Inpad Range was laid up with Cholera.— In November the Executive Engineer and an Assistant were severely injured by a tiger, and the Assistant died shortly afterwards.— The result is that with the exception of one subordinate, there is no one in the section at present who has any knowledge of the works or the accounts, beyond what has been gathered during the last two or three months; and I understood that there was great difficulty in ascertaining what work had been paid for, and what not.—

Probable amount of supplemental sanction which will be required for the Section — not known.

76. The present Executive Engineer could not tell me what amount of further sanction will be required to complete the works, and he is at present so much occupied in putting arrangements into proper order, and investigating the accounts, that it will be sometime before he will be able to set to work on the preparation of revised estimates.

77.— 61st mile

77. 61st mile.- Down to the 8' culvert, much earth-work remains to be done. Culvert completed except inlet.- Masonry indifferent.- Below this to the end of the mile the earthworks are behind hand, and in parts the banks have not yet been commenced.-

78. 62nd mile.- The inlets to the two 8 feet culverts in this mile remain to be excavated.- The earthworks throughout are incomplete, but the amount of work to be done is not large.-

79. 63rd mile.- Down to the Agueduct near the village of Terragoila, both banks have made good progress and though much work has to be done to complete those banks, not much more need be done before passing water down.- Thence to the end of the mile the right bank is behind hand, the left bank is nearly complete. Below the Agueduct there is to be a revetment with pointed joints to either bank, for a length of 4 chains, and a similar revetment for 2 chains above the agueduct: and, beyond these revetments, ordinary dry stone revetments are to be given up, and down, to the point where the ground surface is on a level with the canal bed.- The pointing is, I think, an additional expense, without any corresponding advantage, and as, where it is given, the slope is to be 1 to 1, and elsewhere 1½ to 1, I should say the latter description of work will be the more substantial of the two.-

Terragoila Agueduct.-

80 On excavating for the foundations of this work the rock was found to be at a much greater depth below the surface than had been anticipated, and the foundations are being laid at 37 feet below canal bed instead of 30½ feet, as shewn in the sanctioned plan.- Some of the details of this plan have been altered, but the general arrangement remains the same.- The two piers were 4½ and 6 feet high, the foundation of the upper abutment was being laid, and the excavation for the lower abutment was not quite out.- The stone used for the facework is very good, it costs 2 Rupees* delivered at the work.- Stone obtained on the spot is being used for the hearting, and the Engineer employed on the work expressed a doubt as to whether it was sufficiently good, as it is said to deteriorate rapidly on exposure to either air or water.- This question should be looked into before it is too late.-

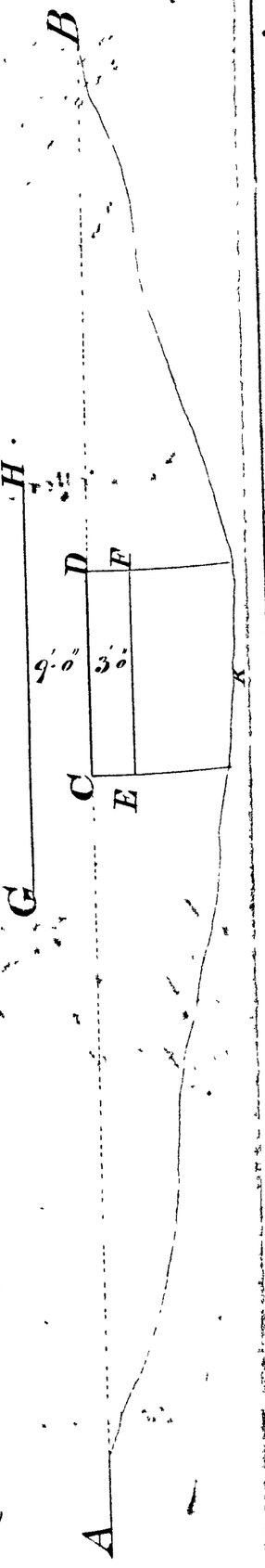
*a Cubic Yard

Proposed alteration of the Agueduct vide latter part of the Ag. Chief Engr. letter No. 1799 of the 31 March 1865.-

81.- The Acting Chief Engineer mentioned to me, when I was at Nurnool, that he wished to reduce the width of this agueduct, so as to hasten its completion and reduce the cost.- He hoped to have visited the work with me, but was prevented by the arrival of the Officiating Chief Engineer appointed by the Board.- However on hearing the particulars of the proposed alteration from the Executive Engineer* I informed the Acting Chief Engineer, demi-officially, that I would forward the proposition for the consideration of Government, and that I should not offer any objection to its adoption, but at the same time I pointed out what the effect would be as regards increase

*on the 25th March.-

increase of velocity, and left him to decide whether it would be advisable on a line of navigation to make the change.- It will be observed that the Acting Chief Engineer, in his letter quoted marginally above, and which appears to have been written after the receipt of my note, says that the change proposed by him will not alter the velocity or discharge - The discharge will of course remain the same, but I think there can be no doubt whatever that the Acting Chief Engineer is mistaken in supposing that the velocity will not be increased - The sanctioned Aqueduct has a clear width of 89 feet and a depth of 9 feet and its floor was to be on a level with the Canal bed - The Acting Chief Engineer's proposition is to place the floor 3 feet below the level of the Canal bed, and to make the width 66½ or properly 66¾ feet, this arrangement being based on the fact that $89 \times 9 = 801 = (9+3) \times 66\frac{3}{4}$, and supposing that the three feet of depth below canal bed is equivalent to and equally effective with a similar depth above the canal bed.- The marginal diagram will make the case perhaps more clear **AB** is the Canal bed, **AKB** the surface of the ground, **CD** the floor of Aqueduct as sanctioned, **EF** that proposed, **GH** the surface of the canal water.- 4,000,000 cubic yards an hour are the maximum quantity of water to be carried, but probably the discharge will seldom exceed 3,000,000 - as the difference will be absorbed by irrigation above this point - Taking the latter quantity, the mean



velocity with the 89 feet width would be $\frac{3,000,000}{89} = 3370$ yards or 1.91 miles an hour, and with the 66¾ feet width it would be something less than

$$\frac{3,000,000}{66\frac{3}{4}} = 4494 \text{ yards or } 2.55 \text{ miles an hour.}$$

The lower level of the aqueduct floor would, it appears to me, be effective only in one way; it would give the moving water a surface of water instead of a masonry surface to run on, and consequently the lower strata of the water would be less impeded, and the average velocity of the whole square section would be increased without increasing the surface velocity in proportion - If this view be correct, I should anticipate that there would be a deposit of silt on the low level floor, and that at most, the water section would have a practical effect equivalent to an additional 6 inches of depth, and then the mean velocity would be

$$\frac{3,000,000}{70\frac{1}{2}} = 4255 \text{ yards or } 2.41 \text{ miles an hour.}$$

In these calculations it has been supposed that the canal with 3,000,000 yards an hour, will run 9 feet deep - I do not know whether it has been arranged to do so, but if either this depth represents a greater discharge, or the 3,000,000 cubic yards would be passed with a less depth, the results would be in proportion, and the principle involved the same, and still the only point requiring consideration would be whether an increase of velocity would be advisable, though as in either of the above cases, the velocity with the 89 feet width would be much higher, and the increased velocity with the reduced width much greater, this one point would perhaps be of greater importance

as

as involving what might prove to be a current highly obstructive to up stream navigation.—

82. The alteration of the aqueduct would not involve an alteration of the banks, as the head of water required to give the increase of velocity would be but a few inches, neither would it add to the cost of the works, and as the choice between the two aqueducts rests upon considerations, which may properly be left to the decision of the responsible officers of the Company, I would recommend that the Chief Engineer, be allowed, with the concurrence of the Agent and Manager, to adopt whichever design may be thought most suitable.—

83. 64th mile.— The right bank for the first 5 chains is behind hand, below that both banks are nearly finished— There is a good deal of cutting to be done in this mile to complete. The culvert, 8 feet, at 70 chains is complete, with the exception of the inlet channel.— Main Canal.—

84. 65th mile.— The body of the partly built Caligalah now forms the lower part of the left bank— The sluices at 22 chains just finished— The irrigation channel from the sluices not yet commenced— and it will involve a good deal of work, as the cutting will be deep for a considerable distance— The cutting in this mile could be finished in 10 to 15 days, and there is not much other work to be done—

85. 66th to 70th miles.— In the 66th mile the work is rather behind hand, though nearly enough has been done to carry a yard of water— Below the culvert work only just recommenced since last year— The first 30 chains of the 67th mile are much as they were last year, lower down considerable progress has been made during the last 2 months— The construction of the 8 feet culvert near the end of the mile has

has not yet been commenced— In the 68th and 69th miles work has only recently been recommenced after a long cessation— It is now making good progress and will, at the present rate, be finished in about 2 months— The Irrigation sluice at the 77th chain of the 68th mile is being partially rebuilt, the crack noticed last year having been found to extend further than was supposed— The earthworks of the upper part of the 70th mile are nearly finished. At the village of Punnalpar a ramp for a crossing has been nearly completed— There will be a ford here when the water is low, and a ferry at other times— The surplus sluice of 6 vents finished all but 2 or 3 courses: all the work, except the old wings, built of very good limestone, which was lately found in the bed of the Canal in the 71st mile— The culvert a few yards below will be finished in a few days— At the lower part of this mile no earth-work has been done lately, but there is not much required to complete— A coping has been added to the sluice at end of mile, and it looks well—

86 71st & 72nd miles— From the quarry in the 71st mile stone is being taken for Lock No 1 in the 73rd mile— It is a sound laminated limestone, obtainable in blocks of large size and easily worked— The 8 feet culvert is 3/4ths finished— It is intended for a passage and will be very dark— It is proposed to extend it for a few yards in rear of the bank, to admit of a roadway being taken over it; probably this arrangement would, if the road diversion be taken into account, save but

little

little, and the darkness of the culvert would be increased by the extra length. A great deal of excavation to be done for the outlet and inlet channels of this culvert. The earthwork of this mile is complete, with the exception of a little clearing. In the 72nd mile the heavy cutting (Metacondal) has been finished, except a little clearing and trimming.

97. It will require very hard work to get the Aqueduct completed in time to pass water down for this season's irrigation, still it may be accomplished, and as with stone masonry the work soon dries, it may be safe to submerge it in less a short time after the completion of the masonry, if care be taken to puddle all the surface exposed to the water. The banks and revetments near the Aqueduct will also need pushing on. Elsewhere in this Section there is no heavy work to be done, and there will probably be no difficulty in finishing some miles entirely, and the rest sufficiently, to carry as much water as can be utilized, before the 1st August next. Some of the Contractors in this section have been extremely dilatory in the execution of their contracts. The Executive Engineer holds security balances, and the defaulters should be required to complete by a date sufficiently early to allow of the work being taken out of their hands and finished at their expence, if they neglect any longer to do what remains to be done.

General state of the 5th Section – 63½ mile.

Beyond the construction of sluices in the bank of the Main Canal, nothing has yet been done towards providing means of distributing irrigation water. The area

Distribution works

of land commanded by this section is very considerable, and its breadth, measured from the Canal, is great. It lies on both sides of the Bowanassy river, and a large channel will be taken across that river by an aqueduct, within a short distance of the Bowanassy Station buildings.

Funds. – 88. The Executive Engineer considers that the funds already sanctioned for earthworks will suffice. A supplemental sanction will be required for the masonry works, and for the revetments in the 63½ mile in connection with the Aqueduct.

Bowanassy workshops. – 89. These shops have been completed for some time, and there is an abundance of work. There are two circular saw tables, a lathe &c. and these find full employment for the engine.

Surplus works – 90. The Calingulah, which is to discharge 300,000 cubic yards of water into the Caulee, has not yet been commenced. The channel in connection therewith has made good progress, and will be finished at an early date; it is partly revetted, and the arrangements appeared good, and likely to be efficient.

6th Section – 91. 73rd mile. The earthworks and revetments above Lock No. 1, and in connection with the scouring and head sluices, have made considerable progress. The scouring sluice is within 3 feet of full height. The embankment between the head sluice and lock, and the channel from the sluice to the canal below the lock, have not been commenced. The lock values are lying near the lock; their workmanship is not as good as it might be, but as these are the first of this

this pattern that have been constructed, probably future
valves will be better than these. The frames of the
Lock gates are at Bowmanaxxy: they were made at
Kurnool. The work for the seating of the valves and
for hanging the lock gates is in progress. Below the
Lock to the end of mile, the Earthworks are half
done except for 15 chains.-

92. 74th & 75th miles.- The work in the 74th mile
has been recently commenced - a large party of coolies
is at work upon it.- In the 75th mile very little Earth-
=work has been done.- At the 5th chain the 2 arch
Bridge has been completed and the approaches are
nearly finished - Almost all the surface of the Bridge
is plastered, and it would have been better, I think,
with excellent stone obtainable within a moderate
distance, had the pier and the abutments been stone
faced, as the plaster will soon be damaged by boats.-
The wings and superstructure of the Bridge are
rough cast, and in appearance it falls short of
what one would expect to see on a project of this
magnitude.-

93. 76th mile.- There are no masonry works - The
banks and cutting very nearly finished - soil, laterite
with pimple shale below, or black cotton. The esti-
=mate rates have been found very insufficient.-

94. 77th mile.- Earthworks nearly complete. The
masonry of the Culvert 10 feet at 61 chains finished - Would
make a good passage, but the headway, 7 feet, is rather
small.- Outlet and inlet have yet to be done.-

95. 78th mile.- Upper part heavy soil, in the lower
part there is a good deal of shale and limestone
Excavation and banks 78th done.- The off take of
the irrigation channel will be at 70 chains.-

96. 79th mile.- Lock No. 2. This will be a treble lift.
7/8ths of the masonry of the first chamber done - Stone
and work very good - This Lock has the large openings
between the culvert and chamber - Lock No. 3. Masonry
complete except that dependent upon the valves, and
the double culvert at the upper end - Stone good - ma-
=sonry passable rubble, but very different to that at
Lock No. 2.- A good deal of excavation done between
Locks Nos. 2 and 3.-

97. 80th 81st & 82nd miles.- Very little done since last year
as the Canal from the 79th mile to the 91st is one of irri-
=gation only and the works have been stopped.-

98. 83rd mile.- Lock No. 7 - right wall of both cham-
bers, 2 retaining walls, left wall to springing of culvert,
and abutment of under bridge, ready.- work stopped.-

99. 84th to 91st miles.- In these miles only a little
work was done, after the inspection made last year,
before the work was stopped.-

General state of 6th Section.- 100.- From the 73rd to the 78th miles the works are
now making good progress, and they may be expected
to be ready to carry water by the 1st August next,
should such be necessary; but in the absence of dis-
=tribution works, but little if any irrigation will be
possible this year. There are no sluices in the banks
of the Main Canal and several will be required.

Funds.- 101.- For the 6 miles which will carry irrigation water,
supplemental

supplemental estimates will shortly be ready.- The canal being here on a small scale (carrying only 45000 cubic yards an hour), the amount of supplemental sanction required will not be large, though its proportion to the original sanction will be considerable.

7th Section-mile 92 to 114- Sootoor Ancient & Headwork

102. The Ancient carries the Canlee at Sootoor is to throw into the 7th Section 100,000 cubic yards of the water brought by the Main Canal as far as the end of the 92nd mile, and then carried by the surplus works (para 90 above) into the Canlee.- It is proposed this year to complete the Ancient to 5 feet above the sill of the undersluices, or one half of the full height. The undersluices are already completed to the 5 feet level and the body of the Ancient also for a length of 70 feet in continuation.- On the West side beyond or behind the present line of the river bank, the Ancient and wings have been completed to full height. It will take but a short time to complete the Ancient to the 5 feet level.- Rock has generally been found about 3 feet below the surface; at the undersluices it was however a depth of 4 feet.- This year the overfall will not be very great, and perhaps it may be the cheaper plan to let the river clear the bed below the Dam, but until the rock has been exposed it cannot be determined what work, in the way of aprons, will be needed.- The wall between the under and headsluices is full height.- The Headsluice is complete with the exception of the cross stones and coping: waterwings have been added on the lower side.- This sluice as originally designed was a very thin work, and to increase its depth from front to rear, an arch 10 inches wide has been turned over each pair of the old vents, and in rear of the alternate piers a battered buttress, square on plan, has been added.- The alteration was made when the old work has been nearly completed, and the addition has been well executed.- A Plan of the work, as built, has been called for.

The Engineer in charge of these works informed me that the cost of the headwork, a rusticated masonry has been about 4½ Rupees a cubic yard, and that of the plain and rather rough rubble masonry Rupees 3-12-" to Rupees 4-"-"-. The estimate allowed Rupees 2-8-" a cubic yard, but I think the actual rates are reasonable, as the stone is brought a distance of about 5 miles.- The archwork is very good and the cost is said not to have exceeded 8 Rupees a cubic yard.

The Regulating Lock has not been commenced, the work having been stopped after the excavation had been nearly completed, on the suspension of all navigation works.-

Bridge over Nullah. 103.- This Bridge is complete with the exception of a few courses of the parapets and the approaches. The stone is good, the masonry sufficiently good, and the Bridge will look very well.-

Main Canal.- 104. 92nd mile- Down to the 12th chain where the ground has only recently been broken the cutting is being taken out to a width of 15 feet.- The cutting is 14 feet deep, the rate allowed was 1/6 annas, the lower which is purple slate shale, 4 annas a cubic yard.- (The upper part has cost 12 annas.)

Culvert

Culvert No. 3 at 67 chains not commenced – Down to this from 12 chains, excavation nearly out except side slopes, and for the rest of the mile earthwork more than half finished –

105. 93rd mile – Culverts Nos. 4 and 5, at 10, and 72 chains respectively, not commenced, but the excavation for the former is 1/3rd done. – Bridge No. 2 for the Rundial road not commenced – Very little done to the Canal in this mile, except for a 15 feet channel which has recently been commenced. –

106. 94th mile – First half of mile the same as last year – In lower part of mile the 15 feet channel has been begun for a few chains, and below that ground has been broken to full width and various depths. –

107. 95th 96th & 97th miles – In the first 54 chains of the 95th mile earthworks about half done. Here the excavation for Calingulah No. 1 is nearly finished, and a few yards of stone have been collected – Below this to end of mile Earthworks about 1/3rd done. –

Culverts Nos. 6 and 7 have not been commenced – In the 96th mile down to culvert No. 8, earthworks well advanced – For the culvert excavation partly made, and foundations also for the length deemed requisite for a 15 feet channel – The Calingulah at the 65th chain of the 97th mile has its upper wing 2 feet thick of full height, the lower wing complete, and the body 2 feet above canal bed – 6 sluice vents have been inserted in the body and this is an improvement – A large mass of earth has to be removed for the surplus channel – This might be done by making a few cuts and allowing the water to clear away the rest. The proposed cuts a small channel from the sluices – to the Nullah, the water of which this Calingulah is to pass, is some 10 feet below level of canal bed, proper aprons will, as

para: 111. mentioned in my report of last year, be required and the excavations should be made the whole length of the Calingulah for sufficient width to allow of this work being done, and then the rest of the earthwork can be cleared away by the water – The stone used for this surplus work is an excellent blue limestone and the work is good – The Nullah being dammed by the canal, banks are required along its two sides to prevent inundation, and these have not been commenced, and culverts Nos. 9 and 10, which are to prevent accumulation of surface drainage behind these banks, have not been begun – Below this to the end of the mile earthworks 5/8ths done. –

108. 98th mile – Earthworks very nearly finished – Rates in this part are from 1 1/3 to 2 annas a cubic Yard. –

109. 99th & 100th miles – There was to have been a trebble vent culvert No. 11, near the commencement of the 99th mile, but this has been altered to 2 spans of 20 feet each: the excavation is partly out – The limestone collected for this work is good. – For culvert No. 12, a short distance below, the excavations have been commenced Earthwork nearly complete for a few chains below Culvert No. 11; thence to the north bund of the Byap Cuddie Tank, very little done – In bed of tank to end of mile 15 feet channel partly excavated, and the same

to –

to the South bund of the Tank in the 100th mile.- No 13 culvert which was intended to pass the Tank water under the canal has not been commenced.- It is now proposed to obtain a transfer of the Tank to the Company and the correspondence on this subject was submitted for the consideration of Government with the letter as per margin.- Below the Tank to the end of the mile the earthworks are well advanced.-

× No 241 d/12th Apl. 1875

110. 101st mile.- Of the culverts allowed for this mile it is now proposed to omit Nos 14 and 15. For culvert No 16 a little excavation has been done and some materials are ready- Culvert No 17 not commenced. The rock excavation for No 18 culvert has made but little progress since last year.- The earthworks throughout the mile are behind hand.-

111 102nd & 103rd miles.- The earthworks in the 102nd mile are in much the same state as last year, except that for 15 feet in width, the cutting has been carried to the full depth- Down to the 38th chain of the 103rd mile earthworks 2/3rds done.- The excavations for No 20 culvert not yet ready.-

112. 104th mile - From this mile to the present end of the section, the canal was originally intended to form part of the lower section, but was afterwards added to section No 7 The excavation for culvert No 1 is partly out and materials for the masonry have been collected.- For culvert No 19, which was transferred from the preceding mile to a site near the end of this mile, the excavations have been commenced, and now again it is proposed to omit this culvert, and turn the water

make into No 1 culvert above.- Whether those alterations were well advised or not I can hardly judge, but they tend to delay the works, and to interfere, pending the repeated references, with the arrangements for carrying them on. The earthworks in this mile are a little more than half done.-

113. 105th mile.- Down to culvert No 2 at 31 chains, earthwork about half done, and the cutting for 15 feet channel is out to full depth.- The excavations for the culvert have not been touched since last year.- Thence to the end of the mile nothing done to earthworks since last year, except the 15 feet channel, which has recently been commenced.- The catchpit, which will be required in connection with the Mundial Tank supply channel, has not yet been designed.-

114. 106th mile.- Down to culvert No 3 at 30 chains nothing done since last year, except 15 feet cutting part- Excavation for culvert well advanced, masonry not commenced- Thence down to end of mile 15 feet channel nearly completed.-

115. 107th mile.- The Excavation for culvert No 4 at 20 chains not touched since last year. The earthworks in the upper half of the mile in the same state as last year, except that the 15 feet channel is nearly complete.- In the lower half mile a good deal of work has been done and the earthworks there are about 2/3rds done.- The Bridge at 40 chains for the Cuddapah and Cumbum road has its left abutment 6 feet

6 feet high, the right 7 feet, and the piers the same height. Some of the masonry rough, but the later work is better than the earlier. The progress of this Bridge in the last 9 months has been very slow, and it was proposed to defer turning the creeks until next year. Cost of rubble masonry Rupees 3 to 3¼, and of the face work Rupees 5-12-0. The limestone comes from Chumbáram, and the slate from Sitarámpúram; some of the latter is too nearly allied to the purple shale, and it would be better not to use it, if the supply of limestone can be increased.

116. 100th mile. Culvert No. 5 at 42 chains. Excavation partly out, masonry not commenced. Earthwork in the upper half mile 3/5ths, and in the lower half done.

117. 109th mile. Down to about the 30th chain excavation out to full width for half depth, and to full depth for the 15 feet channel. Below this, 15 feet channel only taken out. The excavation for culvert No. 6 is partly out, masonry not commenced.

118. 110th to 114th miles. At culvert No. 7 in the 110th mile nothing done yet. At 6 chains in the 111th mile culvert No. 8 will be built, work not commenced. In the 112th mile the excavations for the Bridge in the same state as last year, and it is now proposed to move the Bridge a few yards lower down, so as to avoid running the west approach through a plantation of young trees, and as the cost of the change would not perhaps exceed 5 Rupees, there can be no objection to this alteration. In these 3 miles the earthwork executed is confined to the 15 feet channel, which will soon be completed. In the 113th mile ground has just been broken for the 15 feet channel. Work has not yet been commenced in the 114th mile. The rates now allowed for the small channel, which is being taken out in the above 3 miles, are 1 Rupee for 10 yards in cotton soil, 8 yards 1 Rupee for 9 yards below this, and 1 Rupee for 8, 7 or 6 yards for gravel according to the degree of hardness.

General state of the 7th Section
× June 1864.

119. This section has made but small progress since the date of my last inspection. In most of the miles the earthworks appear to have been at a standstill until quite recently, and with the exception of the head-works, the quantity of masonry done is next to nothing. Cost of some 25 culverts required for the section, the construction of only one has been commenced, and there but a portion of the foundation has been laid. Difficulty in obtaining carriage for materials is stated to have occasioned the delay in commencing these works. At the time of my visit I found that the works were being pushed on with a view to get a 15 channel completed from end to end of the section, and it was proposed also to build only such a length of the culverts as would suffice for such a channel. At Iyalúr, 107th mile, it was intended to make a temporary bridge and to postpone the completion of the permanent structure, and similarly in the 93rd and 112th miles temporary bridges were to be put up. It appears to me however that under these conditions would suffice to make even the reduced width of canal fit to carry even the 2 feet of water, which was all that was proposed, and that consequently while there would be no difficulty in completing a 15 feet ditch it would not be a canal; besides this consideration, it is certain

certain that to admit water would greatly interfere with the completion both of earth and masonry works, and where the former were down to nearly full depth, there would be other inconveniences such as difficulty in rectifying measurements &c. the building of the culverts in part would render them when completed less serviceable, above to which, when the surrounding soil had become saturated with water, the difficulty and cost of completing the foundations would be much increased. In the next place it was uncertain whether the Toombudra water would be available, and Canlee water alone could not suffice for direct irrigation, with no reserve of water to fall back upon, and as not a single irrigation sluice has been built or even estimated, and not a channel planned, it seemed impossible that any returns could be obtained; and consequently the only possible advantage that would arise, to balance the many disadvantages above glanced at, and to which may be added the inconvenience to the neighbouring villages of having the arrangements throughout, and especially in the 95th and 97th miles, where drainage has to be received into and passed across the canal incomplete, would be the being able to say that water had been carried to such and such a mile. Such being the case, after inspecting the 8th section, and finding that there also water could not be utilized this year, it seemed to me that the best arrangement would be to transfer to the 4th section a considerable portion of the imported labor, which had just been obtained to the number of about 800 coolies for the section under notice as by this means it might be practicable to render certain the completion of the works from the 63rd to the 60th miles, without which water could not be conveyed to the 8th section. There was

only one objection to this plan, and that was that it was, at the first glance, extremely hard to take away from the Executive Engineer of the Bowanassy division the labor which he had, with so much difficulty, obtained for his works, but as undoubtedly the results from irrigation under the 8th section, the first of that division, would, were water conveyed to it, vastly exceed any that could be derived from the 7th section, it appeared that he too would directly benefit by the transfer. I therefore wrote to the Acting Chief Engineer stating what the opinion formed by me, and which would be given in this report, was, in order that valuable time might be saved, should he think fit to adopt the suggestion of the transfer of labor, and I have since heard that he has arranged to bring up the coolies, though it was feared that perhaps a large number would have to be put upon the works near the Terogapila Agency in the 63rd mile, owing to the failure of the contractor there together with his work properly.

Funds. 120. The supplemental estimates for the 7th section are under preparation, but they were not sufficiently advanced to enable the Executive Engineer to name the amount which would be necessary. It is certain however that on both earth and masonry works the rates have been, and will be, largely exceeded.

Embankments too near the cuttings. 121. In many of the miles of this section the embankments have been placed much too near the cutting. In some places there is no room for a berm at all, and in others the top line of the cutting will fall within the base of the banks, and the latter will consequently have to be turned over. Road sections for the guidance of the work people

work-people been put up, these mistakes would have been avoided, and the rule should be so to lay out the work, that it may be impossible for the workmen to go wrong, except as a result of such gross and manifest negligence as will justify the redoing of the work at their expence.

122. Provision has to be made for ferry boat crossings, cattle ramps &c. and these arrangements could be more economically made before the banks occupy the ground required for these purposes. — Ferries.

123. Nothing whatever has been done towards the provision of distribution works; surveys, levels, plans and estimates have all to be prepared, and as there should be no doubt of the completion of the main canal in time for the irrigation season of 1866, there is no time to lose, if advantage is to be taken of the power to irrigate even such an extent of lands as the works may be prepared to water in the first year. — Distribution work.

124. 115th mile. — Upper half mile nearly, and lower half not nearly, complete. In the half mile a good deal of purple shale and hard kunkur has to be removed. A quantity of excellent limestone has been prepared for Lock No. 1 at lower end of mile. — This being a navigation work will not now be gone on with, but the Calingulah in connection therewith has to be built, and is not yet commenced. — 3rd Section Main Canal 115th to 143rd miles.

125 116th & 117th miles. — The 116th mile is in heavy cutting throughout, a large amount of work has been done but much remains to do. — There is a great deal of shale and lime kunkur, and these make the work difficult. The upper part of the 117th mile is nearly complete, and the banks are in fair section. — Calingulah No. 2 at 50 chains has been built according to the plan, of good stone, with the exception of the sloping apron, for which there was no item in the estimate. — Wings want additions. — It is proposed to open vents in the body, an absolute necessity as without these the canal could not be emptied, and to alter the wings. Weir channel not commenced. — Calingulah No. 3 at about 75 chains has its wings built, but not the body, which is said to be too short to discharge the water; this can be remedied by the insertion of sluice vents. Wings far too short. Between the above two Calingulahs the cutting is in very hard lime kunkur, or conglomerate, and the revised rates here have proved insufficient. —

126. 118th & 119th miles. — Down to 22 chains in the 118th mile but little work remains to be done. Thence to end of the mile earthworks 3/4ths done. — About 1/16th of the masonry of Lock No. 3 at 32 chains done before the work was stopped. — The first 25 chains of the 119th mile are 2/3rds done, below that work very nearly complete. The lower part of this mile has silted up a good deal. —

127. 120th & 121st miles. — In the former mile for some distance a drain was cut last year, and the canal excavation has just been commenced. — Some material have been collected for Calingulah No. 4 at 38 chains, and the trial pit shews that the foundations of this work will have to be laid not less than 9 feet below the surface. Thence to end of mile ground not broken. Some stone has been collected for Calingulah No. 5 in the 121st mile of which, in the first 20 chains, and the last 10 chains, the earthworks are nearly finished and in the remainder the cuttings are in parts nearly out to full depth and elsewhere the ground has only just been broken. —

128. 122nd & 123rd mile

128 122nd & 123rd miles. - For the first 10 chains, the banks are partly thrown up, and in the last 10 chains they are nearly complete; the intermediate 3/4th mile not commenced. The work at Calingulah No 6 has not been started. In the 123rd mile the banks and cuttings are complete. The canal has silted up a little. Calingulah No 7 at 25 chains finished, except apron. Work and stone good. The cost has exceeded the estimate by about 300 Rupees, owing to the distance of the quarries. - Excavation for lock nearly out, and for Bridge, and waste weir culvert, in progress. This is one of the places where, instead of a separate bridge, the tail bay of the lock will be bridged.

129. 124th & 125th miles - The first half of the 124th mile and Lock and Calingulah No 8 at 23 chains, not commenced - Earthworks of lower half mile complete. In the 125th mile the earthworks for the upper 45 chains - about 2/3rds done, and below that except for a few chains where ground is not broken, most of the work is done. Lock and Calingulah No 9 not commenced except excavation for the latter. -

130. 126th & 127th miles - Down to the 40 chain of 126th mile a good deal done, beyond that ground broken only here and there - Lock and Calingulah No 10 will be at the end of this mile and are not commenced. - In the last 10 chains of the 127th mile 1/3rd of the earthwork done, elsewhere ground unbroken. -

131. 128th & 129th miles - In the former mile down to 37 chains nothing done, thence for 20 chains approaching completion and about half done below this. No 10 A Lock and Calingulah will be at 60 chains, and are not yet commenced. In the 129th mile culvert No 1, of 4 feet at 64 chains, nearly completed to springing - Stone very good and is obtained from the Lock quarry in the 132nd mile - The earthwork of the first 70 chains not commenced, and that of the last 10 chains is nearly finished. -

132. 130th & 131st miles - The first 37 chains of the former, and the last 40 chains of the latter, mile, have the earthworks nearly complete, elsewhere ground not broken -

133. 132nd mile - At 10 chains Calingulah No 11 building according to plan, but in front apron, it will require several additions - work and stone good - At Lock site, just below Calingulah, a great deal of excellent dark limestone has been quarried - banks above Calingulah nearly finished - Cutting below lock site for a few chains half done and below that nearly complete to end of mile -

134. 133rd - 134th & 135th miles - The earthworks in the 133rd mile are very nearly finished, and the banks all the way along are in very good section. - In the next mile to the 43rd or 44th chain the work has made good progress, and some chains are almost finished - Below this ground not broken - The first half of the 135th mile not commenced, the remainder well advanced.

135. - 136th & 137th miles - At the 27th chain of the 136th mile the excavation for Calingulah No 12 has just been commenced, and that for the lock was partly done last year. The earthworks of this mile are very nearly finished. In the 137th mile the excavation for Calingulah No 13 is nearly ready - The earthworks of the first 20 chains and of the last 30 chains of this mile half done, the remainder not commenced -

136. 138th & 139th miles - The former mile is finished all but a little trimming, and the latter is quite complete. -

137. 140th mile - Complete down to 35th chain, where Calingulah No 14 is about half built - Excellent stone is obtained

obtained from a quarry on the back side, at a cost of 4 to 5/3 annas the cubic yard. The culvert over weir channel is to have 3 vents of 3½ feet span each, and is in progress - down to the 3/4th mile cutting commenced and part of it nearly complete, below that ground not broken -

133 141st & 142nd miles. - From the 12th to the 15th chain in the former mile Earthworks just commenced, beyond this ground not broken - The first 12 chains of the 142nd mile are complete - Calingulah No. 15 will be at 8 chains, and for it a little stone has been collected - At 36 chains for a double 4½ feet culvert the excavations are nearly out, most of the stone requires has been collected and much of it is dressed - This is a first rate limestone, as obtained from Upalie, and cost in the rough, 14 annas a cubic yard. - Earthworks not commenced below the 12th chain -

139. 143rd mile and a small part of the 144th mile - Work not commenced - Lock No. 16 will be the last lock, and I understood from the Assistant Engineer that it has no bridge over the tail bay, this was noticed in submitting the revised estimate for this section for sanction, and as the sketch plan of the head works of the 9th section shewed a roadway leading to a bridge at the lock and as some passage is here required, it will be necessary that some explanation of the intended arrangements should be afforded by the Chief Engineer -

Ptn to No. 514 of 22nd July 65.
Ptn to No. 2207 of 28th Sept. 64. para 5 of my letter No. 93 of 9th Sept. 64. -

General state of the 8th Section -

140. The progress made since my inspection last year in this section is satisfactory - Nine months ago very little had been done, whereas now in many miles the earthworks are either finished or approaching completion, and with the working parties now available the incomplete portions will soon be ready - The embankments are every where in good section where finished, and this is the only part of the canal where sections for the guidance of the work people have been used, and the results are just what might have been expected, - A good deal has been done to the Calingulahs, though not as much as would have been accomplished had the designs for these been in all respects suitable - No navigation sluices or channels have as yet been planned or estimated. - (17)

Slopes of Embankments. 141 All the Canal banks in this section, whether high or low, have interior slopes of 1½ to 1. - Where the soil is good such slopes will stand very well, but generally in this section good soil is not obtainable for the high banks, and is found only where the canal is in deep cutting immediately below the locks, and the highly soluble dark clay, called black cotton soil, must, where under water, require much flatter slopes. - There are only one or two places where soil of this description uncovered by revetments has been subjected to the action of water, these are in the first section and the flattening out of the side slopes, and the washing down of the soil have occurred to a great extent. This point was noticed in para 146 of last year's report, but it does not appear to have received consideration, as the new banks are being thrown up on the original alignment, whereas, if the regular section of canal is to be maintained with the flat slopes, which will form themselves, it is evident that the embankments require to be placed further apart, and as this could have been done without any increase of expense, it is a pity that some attention has not been paid to the requirements in this respect. It may be added that where the banks were approaching completion prior to the rains of the last season their slopes have already assumed a lower incline than 1 in 1½. -

Ferries 142. No arrangements have yet been made either for revenue ferry boats or for cattle ramps. -

Tanks - 143. It is expected that the rates allowed in the revised estimates, for earthworks will suffice, except where lime kunkur or slate shale occur in the cuttings, and these rocks are often so hard a description that the cost of getting them out

out will largely exceed the estimated amount. The Executive Engineer considers that the further sanction required on this account will be in the

115th mile	do	Rs. 3,080
116th	do	7,200
117th	do	2,900
119th	do	2,250
120th	do	2,000
121st	do	700
122nd	do	1,200
137th	do	900
141st to 143rd	do	1500
		21,730

Revised plan and estimates for the Calingulahs are under preparation. Where these works have been partly built, they must receive such alterations and additions as will render them secure and efficient, but I suggested to the Executive Engineer that where no commencement has been made, he had better obtain the Chief Engineer's sanction to an entirely new arrangement. In several cases these calingulahs are entirely inadequate to discharge the water carried by the canal, their wing walls are of insufficient length, they require sluices made to empty the canal and to prevent the silting up of the bed, their aprons, where any have been allowed for are unsuitable and insufficient, the weir channels require the protection of revetment, and in fact the sum entered for these works Rs in the sanctioned estimates represents but a small part of the necessary cost of transferring the water from the upper to the lower reaches. The Executive Engineer estimates the additional outlay required to be

10 Calingulahs at Rs 2,500	= 25,000
7 ditto ditto at 2000	= 14,000
17 double revetments of 5 chains each at Rs 800	= 13,600
	52,000

* Rs 34,418 for 17 calingulahs.

144 The

9th Section Main Canal 144 to 178 miles

144. The estimates for this section were sanctioned in Proceedings of the Madras Government No. 2807 of the 28th September 1864. The works have not as yet been started.

Kurnool workshops and office.

145. The accommodation afforded by the buildings at present in use is quite insufficient and very unsuitable. The buildings belong partly to the Company and partly to the landlord of the adjoining house, which has hitherto been rented by the Chief Engineer, as a dwelling house.

* Rs 50650

I was shown when at Kurnool the plans and estimates of the proposed new buildings and, since my return to Madras, these have been forwarded to me by the Agent, but I cannot dispose of them until the block plan of the present site, and a similar plan of the site for the new buildings which has been selected on the right bank of the Canal, a little above the Sindry Aqueduct, are received. The subject will therefore require a separate report, and I will only mention here that suitable permanent buildings for offices and workshops are undoubtedly required at Kurnool, the accommodation to be provided should be confined to the wants of that neighbourhood, and the idea, which I believe Colonel Cotton entertained, of making Kurnool a Central Station and depôt in connection not only with the works from Soonkasala downwards, but with the Bellary and Goat works also, should be abandoned. I am very glad to say that the Agent in his letter transmitting the estimates, coincides in this opinion. In passing the accounts from time to time, I have found it necessary to notice the heavy expenses incurred for transporting Stores from Kurnool to the lower sections, and I only wish this outlay could have in most cases, been entirely avoided, but in many instances much of the previously incurred expense of sending the stores from

from Madras to Kurnool could have been saved.

Contract work.

146. An observation made by the Executive Engineer of one of the Divisions that some contractors borrow money at 5 per cent per month, to enable them to carry on their works, and the difficulties which have arisen from the employment of incompetent, dishonest, or pauper, contractors in several of the sections, renders it desirable that one or two remarks should be made on this subject. In the first place it cannot be advantageous to the Company that any contractor without Capital, and obliged therefore to borrow money at rates even approximating to those above mentioned, should be employed. It is evident that if the rates be not higher than is fair the contractor must fail in completing his work, and if on the other hand he be able to carry out his contract, it can only be because the rates are far in excess of what the work could be done for. The contract system is an excellent one if only the requisite conditions be observed and these are 1st that the contractor should be conversant with work of the description of that to be done 2dly that he should be a respectable man, and 3dly that he should have the means requisite for the purpose. It is however not possible always for an Executive Engineer to ascertain these particulars reliably and the precautionary measures, which will do to a great extent instead of such knowledge, are a proper agreement and tangible security. The agreement should be precise and the penalties moderate yet sufficient, and they should be strictly enforced. Heavy penalties which could not be inflicted without injustice are worse than useless, because a contractor makes up his mind from the commencement that they are only nominal. For earthwork generally the petty contract, entered into with the gangs of workmen is on the whole the best, and the most economical, plan, and I have noticed that where this arrangement prevails, the rates are relatively much lower than where the work has been let on regular contract. In this case also the rates can be more easily regulated, with reference to the soil actually met with, and with good management work can be done in this way with but very little trouble.

For masonry works very much greater care is requisite in entering into contracts. It must be unwise to give such work to any one but a man of approved character and qualifications and, though it may save trouble in the first instance, to hand over the execution of masonry works to any contractors who may offer to execute them, the trouble usually comes afterwards in augmented proportions, and considerable losses may be sustained as well. It is of course an excellent plan to get all the materials on contract, but here again, in most cases, it will be better to get each material from the persons accustomed to make or collect it, and not through a middle man.

Distribution works.

147. It will have been observed from the remarks on the general state of each section that with the exception of a few yards of irrigation channel in the first section of the canal, nothing has been done since last year towards the provision of distribution works. Without irrigation channels any returns worth mentioning cannot be obtained, and it seems probable therefore that the area which will be brought under cultivation this year will be extremely limited. It would have been practicable, I think, to have arranged for the estimates for such

such works under the 4th and 5th sections being prepared, in time to admit of considerable progress being made by the commencement of the approaching irrigation season; but as yet for only one section, the 6th, have any estimates of this kind been received, and they were considered to require revision - Some additional Surveyors will be required for these works, and the Agent on the 21st ultimo applied for sanction for 4 of them, and so soon as I hear from him what their salaries are to be, his letter will be submitted for the favorable consideration of Government.

P.W.D. No. 800 of 23rd March 1865 -

148. In the report made after last year's inspection, notice had to be taken of the entire absence of any means of consolidating earthworks, whether in rear of revetments and masonry works or in other situations where such consolidation was essential to sound work - Since then some improvement has taken place, but the rammers used are of the flat light kind commonly used for surfacing, and they have but little effect on Earthwork - Some heavy rammers were being made up at the Kurnool workshops, and these will no doubt be an improvement but in every section or subsection numbers are required, and should be made up by common village carpenters, at a cost of a few annas - Perhaps the best of the simple forms of rammer is the Paisley masher - a truncated hexagonal, or octagonal, pyramid, 7 to 8 inches diameter at the lower, and 5 inches at the upper end, 1¼ to 1½ feet high, and weighing about 15 lbs - These can be made out of any branches of trees of sufficient size, at a very small expenditure of labor, and by any one who can handle an adze, and common chisel -

Consolidation of Earthworks -

I have the honor to be,
Sir,
Your most obedient servant,
J. M. Mullins Capt R.E.
Consulting for I. & C. Company -

Copy with Letters Engrs
Dy 19th June 1865 No 36.

Proc. of Govt for 2 May 1865 No 1892

From The Engineer for M.C. Co.
To
The Secretary to Govt
P.W. Works -

Dated 19th April 1865.
Rect 24

Enclosure one Ms

Reports on the Soonkesala Anicut and Headworks and on the 1st to 9th Sections of the Main Canal, &c &c -

No 305

Civil Works

Public Works Dept

No 1317

Proceedings of the Madras Government
Under date the 15th May 1865
Read the following

From the Supg Engineer
M.C. Canal
Reports on the Soonkesala Anicut and Head Works and on the 1st to 9th Sections of the Main Canals, &c &c

(Here enter 19th April 1865 No 243)

The foregoing reports will be communicated to the Chief Engineer of the Madras Irrigation Canal Company through the Manager of the Company's, with a request that the suggestions therein made may receive consideration.

The Government approve of the proposal made at the Conclusion of Para 81 regarding the alteration of the Veragosilai Aqueduct

To the Cons Engr M.C.C & Letters
Manager to Do

Ens 1317 - 15th May 1865

Dr - 15th May

From

The Consulting Engineer

Madras Irrigation & Canal Company.

To

Dated 19th April 1865.

Reporting on

the state and progress

of the first eight

sections of the Com-

pany's main

Canal.

Regarding the information

to be furnished

in the Circular

and order

of Government.

Copy in a Letter to England
of 14th June 1865 No. 38

26th 1865 Despatch
Bo. of Court for May
No 1317
Bo: of the Madras Court
of 15th May 1865

Read in Council

The report by the
Surveyr. Engr. of a Canal
in on the first eight
Sections of the Red Sea Canal - with orders
thereon -

No 305 - 305