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*Proceedings of the Madras Government, Public Works Department,
24th October 1865.*

No. 596. 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 Bellary, 6th October 1865, No. 100 :—

Sir,

1. Before leaving Madras on my present tour of inspection, I had ascertained that it was expected that the water would reach the end of the 3rd Section* about the end of August, and I arranged therefore to be at Bawanassy on the 16th September, intending to see what progress the 4th Section (44 to 60 miles), and the Teragopila aqueduct in the 63rd mile, had made since March last, and to proceed upwards and see the effect on the 2nd and 3rd Sections of the admission of water for the first time.

* 43rd mile.

2. On reaching Bawanassy, however, I learnt from the Chief Engineer, who there met me, that the weakness of the wall in the 24th mile had rendered it necessary to shut off the water immediately above that point, until the wall had been backed with earth and stone, and consequently up to the 29th ultimo, just before I left Kurnool, the water had not passed below the 24th mile, so that in this present report only a small portion of the information, which I had hoped to obtain from this tour of inspection, can be laid before Government.

3. SOONKASALA ANICUT.—On the 25th ultimo I visited Soonkasala, at which time about six to nine inches of water were passing over different parts of the anicut. The Toombuddra has been in fresh ever since March last, and the freshes have risen to a maximum of six feet two inches on the crest this season, or about two feet short of an extreme flood. The anicut has, so far as could be judged from the over-fall, stood very well, and the raised wall at the former breach has fully answered its purpose.

Estimate sanctioned in Proceedings Madras Government, No. 1,748, dated 23rd June 1865. of protecting the work there, which was incomplete when interrupted by the early freshes. The state of the rock below the anicut, which had been injured by previous freshes, cannot be ascertained until the river falls. An estimate for coping the anicut was submitted with my letter No. 97, of the 30th September 1865. I visited with the Chief Engineer the granite quarries at Pokkul, about eight miles from Soonkasala, and saw there a few large stones which have recently been quarried experimentally. Any quantity of cut stone can be obtained from the village of Pokkul and its immediate neighbourhood, and the stone is very similar in quality to that used in Mysore for Telegraph posts.

4. UNDER-SLUICES.—The masonry of these has stood well. The revolving shutters still work with difficulty, and the attempts made to close and open two or three of them were not successful. They require more power than can be conveniently applied to a couple of hand spikes, and these latter, as also one or two of the pivot beams, showed signs of giving way.

5. HEAD SLUICE.—The bay above the sluices is much silted up, as might be expected from the small draught into the channel maintained by the little water allowed to pass. The shutters which have been fitted with screw gear are reported to work easily. In rear of the sluices, for a length of 400 feet on each side, substantial rubble masonry revetments have been built, and this sluice is now, with the exception of some shutter gearing, in good working order. The depth of water on the rear apron was three feet.

6. 1ST SECTION MAIN CANAL, EARTH WORKS.—The embankments are generally in very substantial order throughout. In one or two places the right bank wants a little raising, and in the 3rd mile a trifling breach occurred in consequence of the absence of an outlet for the land drainage. In the 1st and 3rd miles a good deal of rock has yet to be removed from the cuttings, and in many places these latter are not quite complete. The revetments have made good progress, and show much improvement in the style of work. In

Revetments.

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many miles they have been completed, but in some parts they are still not sufficiently high to allow of more than four feet of water being passed down. At the Yedarur tank, in the 6th mile, the revetment is generally not more than $4\frac{1}{2}$ feet above bed level, and a great deal of the stone will require re-packing. In the 10th and 11th miles, the revetments of the small tanks are not every where up to present level of water, which is about three feet above bed level.

MASONRY WORKS.—The culvert and inlet in 2nd mile. The culvert leaks a little, and it requires additional rubble stone at the outlet to prevent scour. Culvert No. 7 in 3rd mile. This has for a long time being walled up at both ends, but whether because it was deemed unnecessary, or because it was thought too weak, is not known. Had it been open and capable of standing, it would have drained off the water which breached into the canal, as above noticed. Another culvert at the lower end of this mile is similarly blocked up.

Calingulah No. 1 in the 5th mile leaks considerably behind the wings of the three vent scouring sluices, and, through the lower end of the body wall of No. 2 Calingulah in the 8th mile, the leakage is considerable. Culvert No. 10 of three vents in the 9th mile has been endangered by the subsidence of the north end of the 1st pier, which occurred towards the end of the second week in September, at a time when little or no water was being discharged by the work. All the foundations except at the part which has failed are stated to be on rock, which indeed is visible in many places. The accident was no doubt immediately caused by scour, which had it been noticed in time could have been stopped by rubble stone, but sufficient care was not shown in putting in the foundation, and as a previous failure occurred at this place, greater precautions might have been expected. About fifteen feet of pier, and a small piece of archwork will have to be re-built. The masonry is rough, but the line is evidently good, as a large part of the unsupported arch stands uninjured. A ring bund has been formed round the end of the culvert, and water passes down the canal as usual. The centre arch of this culvert is intended to be used as a crossing, and it will need a paved floor and drainage. In the 12th mile an additional sluice for irrigation is required near Calingulah No. 6, where at present water is being passed by a cut.

General Ludlow's report No. 33, paragraph 18, dated 6th July 1863.
Proceedings of the Madras Government, No. 2,055, dated 25th July 1863.

No. 9 Calingulah, 300 yards, in the 17th mile leaks slightly all along, but not to an extent of any consequence.

7. **LEAKAGE UNDER THE BANKS.**—Almost every where the leakage through or under the banks is less than it was six months ago, and that though the sub-soil has no where increased, and will probably diminish as silt becomes deposited. Many of these* have recently been raised.

* Temporary bridges.

in order to allow of a large quantity of water being sent down, and several still need raising, the water being up to the girders, and in one or two places over the approaches. I think these alterations likely to lead to unnecessary expense, and it would be well either at once to improve these works, so as to admit of their passing the water required during the next two or three years or as long as their wood work will stand, or to remove those that are still too low altogether, and place the intended ferry boats in their stead. These bridges have now two spans of twelve feet, and probably not less than four or five spans would suffice, and as the approaches cost a good deal to construct and maintain, and the wood work is expensive, the course to be followed should be decided on at once after a due consideration of the relative expensiveness of ferry boats and temporary bridges.

8. **CANAL BED LEVELS.**—The differences in current would appear to indicate that in several places the bed of the canal is a good deal above its proper level in the 1st Section. It is not intended at present fully to complete all the work remaining to be done, as it is considered advisable to postpone, until the distribution works have

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been pushed forward, all work which is not essential to safety, and to carrying the water which will probably be needed next year, and this course is, seeing that funds are getting short, the best that can be taken.

9. **HINDRY AQUEDUCT.**—There is a foot of water on the floor, and two-thirds of the width, or about 60 feet, are open. The leakage through the masonry has much diminished, though there are still half a dozen leaks which do not show an inclination to stop, and which would be much better away. The filling in of the canal bed below the aqueduct has been fully successful in attaining the objects intended, and there is now hardly any leakage under the banks.

10. **2nd SECTION, MAIN CANAL.**—The cutting in the 20th mile is, as regards width, much in the same state as in March last, but the one-third width has been cleared to very nearly proper bed level, and water is passing through. Materials for the Zorapore bridge, which is to be built at the deepest part of the cutting, are under preparation.

11. The culvert of ten feet span in the 21st mile leaks very considerably through side walls and floor, and quite sufficiently through the arch. It is probably safe however, and it will, when the bridge in the 20th mile is finished, be only an optional crossing.

12. The banks all the way from the 20th to the 23rd miles leak, but there are only three or four places where the leakage is in distinct streams. Probably these might be stopped by removing the revetments and tamping the soil.

Several parts of the large wall in the 23rd mile, and especially near the lower end, leak more than is safe. It is intended to fill in with soil in front, which will at once reduce the leakage. The sluices in this wall have had their shutters fitted with screw gearing, and the arrangement adopted is one which works easily, and places the sluices under complete control; the gear is enclosed in a box, and cannot be damaged unless the box be first removed, but the boxes are so high above the towing path, that they will interfere somewhat with the tow ropes.

13. The high banks in connection with the Kadrabagh aqueduct sank several feet, after the admission of water, but they are being made up again to their proper level. The revetments were much displaced, and this was to be expected, seeing that there was not time to allow of the consolidation of the new earthwork before laying on the stone.

14. **KADRABAGH AQUEDUCT.**—This work has had a fair trial from the land freshes, and water has been passed over it, so that the head of canal water has been, within $7\frac{1}{2}$ feet of the maximum, and the Government will be glad to learn that the Aqueduct has stood its trial very well, and that the only damage sustained was at the buttresses of the north eastern return wings, and these have been strengthened by building in a solid mass of rubble masonry between them. The leakage through the masonry is, except at one point, where there is a spout of water, unimportant, and it is probable that had puddling instead of rammed moist earth been put down in rear of the abutments hardly a drop of water would have passed through; as it is, the rammed earth has settled very considerably, and thus the water has been able to get to the masonry. The invert under the upper arch, and the buttress apron under the centre arch, have been carefully executed, and it is to be hoped that by them the pressure will be sufficiently distributed to compensate for the absence of proper foundations at that end of the work. I observed, however, that canal water does find its way through the sub-soil, and the action of springs of this sort cannot unfortunately be watched, and as it will be a long time before the canal water will deposit enough silt in the pools above and below the aqueduct to puddle the bed, it would be advantageous, I think, were additional silt thrown in. The Chief Engineer is having a small ringing engine constructed with a punt, in order to search with piles for the leaks here and elsewhere, and perhaps with its assistance all that are of consequence may be stopped.

15. In the right embankment of the canal, about 200 yards below the aqueduct, a breach occurred, when the water was seventeen feet deep. Here a gap had been

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left in the bank, and, as has been mentioned before, the filling in of these gaps is a work requiring much care, and as a great many have been left along the line of canal for from two to three years after the banks on either side were thrown up, it would be well to have them all specially watched on the first admission of water. In this case the presence of the revetment prevented the rapid cutting away of the soil, and the breach was soon closed.

16. The wall in the 24th mile is at the ravine forty-one feet high, and when the water (from land drainage I think) first reached it, the leakage was very serious. Masonry drains were therefore constructed at fifty feet intervals at the foot of the wall in rear, and of a sufficient length to extend beyond the backing, and then the backing, which had been previously commenced, was pushed on, the upper part consisting of lumps of lime kunkur. When I first saw the wall, on the 20th September, the leakage had much diminished, and on the 29th some further diminution had taken place, and there were then twenty feet of water above the wall. The backing was within one or two days of completion. The depth with a maximum supply will be thirty-nine feet, and no doubt the upper parts of the wall, which have not yet been wetted, will leak at least at first, but whether the altered condition of the mortar in the joints will suffice to reduce the leakage to an unimportant quantity remains to be seen, and if not it will, I think, be necessary to place a bank of good soil inside the wall. The material for the backing was being brought by a tramway about three hundred yards in length: the rate paid per cubic yard being twelve Annas, viz., four Annas for lifting, four Annas for carriage, and four Annas for packing against the wall. I think about half this rate would have been enough, and the material being merely thrown down four Annas for this part of the operation is certainly a very high rate. Probably the Contractor possessed all the labor, and it may therefore have been necessary to give him the work at the time, but as the backing of the wall had been decided on six months before, perhaps during that interval more economical arrangements might have been made, especially as all along the canal a large reduction in the amount of labor employed has been made.

Paragraph 35 of letter No. 243, Proceedings Madras Government, 15th May 1865, No. 1,317.

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17. In the 25th mile shutters with screw gearing have been fitted to the six vents of the calingulah. The cuttings are out sufficiently to pass water but not to full width.

18. DRY RUBBLE WALLS WITH AN EARTHEN CORE.—Smith's Section wall at the upper end of the 26th mile is being finished with a masonry coping, and will have a parapet wall on the outer side. Lower down, the junction of Smith's Section wall with the rubble masonry wall has been well done the core has been carried well into the masonry, and the rubble walls have a good overlap.

The 42 feet masonry wall at the lower end of the mile is finished, and backed with soil.

The ground here is so porous that no rain water remained in the ravine above the wall.

19. The great bank in the 27th mile has been completed, the revetments are well advanced, and the cutting across the saddle at the lower end is nearly out to half width.

20. Some very good revetment has been done to nearly full height at the commencement of this mile. Rock cutting at the spurs is in progress, and is well advanced. At one spur the wall (masonry) was finished some time back, and now all the rock excavated is surplus material. Smith's Section had not then been

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invented, but it would have been just the thing for utilizing the rock taken out of the cuttings.

Lower down Smith's Section wall is in some parts complete, and at others about four feet short of full height. There is another junction of the masonry and core sections, but the walls are low where they meet. The earth used for the core of Smith's Section is not always as good as it would be advisable to use, as it contains too much shale and stone, which, if suitable soil cannot be found elsewhere, should be sifted out. Two irrigation sluices have been built in the walls.

21. In the 29th mile a new irrigation sluice is being built at the lower end of Calingulah No. 14; as there are five sluice vents in the Calingulah, the small quantity of irrigation water required might have been taken from one of these.

22. The 30th mile is ready for three or four feet of water, but there is still a great deal of cutting required to complete. Part of the thin wall in this mile is two feet too low, and part three feet too high. Banks very irregular. Soil from cuttings much in excess of the quantity required for banking, so that, with the very wide banks which the alignment will give, the masonry might have been dispensed with. In the 31st mile, near the upper end, the thin wall is being backed on both sides with rubble, and is nearly finished. The rock cutting at the spur is about two-thirds out, and near this point a new irrigation sluice has been built.

23. The gaps in the 32nd mile have been closed since my last inspection, and the rest of the work in that mile was all but complete.

24. The 2nd Section of the Canal is very nearly ready to pass down a moderate supply of water, and as money is much required for distribution works elsewhere, and for sections of the Canal which are more behind hand, further outlay on this section will, for the present, be confined to such work as may be found necessary as the water is admitted.

25. THIRD SECTION, MAIN CANAL.—The Sultanpore tunnel in the 32nd mile is nearly finished, but not yet floored. As far as I could judge from appearance of the pathways to the south of it, there will be but very little traffic through it.

26. From the 32nd mile to the Ullur Aqueduct in the 35th mile, the Canal is in a forward state, except at the rock cutting a short distance above the aqueduct, where much difficult work remains to be done. This cutting is in the hands of a Contractor, but it was my impression that larger charges of powder, lodged below three or four layers of the limestone rock, would facilitate its removal, and prove more economical than small charges in each successive layer. The Contractor thought otherwise.

27. ULLUR AQUEDUCT.—This aqueduct has been completed with the exception of the coping, and a little plastering to the waterway. To form the roadway under the first arch, however, there is a good deal of kunkur to be removed. The masonry of the aqueduct executed since my last inspection appears to have been carefully done. I understood from the Assistant Engineer in charge that the aqueduct has been built at a cost within the amount allowed in the estimate.

28. The 36th, 37th, and 38th miles were nearly finished six months ago, and they were not inspected in detail. The road gap in the 38th mile has not yet been closed.

29. Only a part of the cutting in hard conglomerate rock, at the lower end of the 39th mile, has been done, and a special working party had to be sent down to do it. The wall at the end of this mile, and beginning of the 40th mile, is finished, and the sluices in it also. A considerable length of this wall will require backing, and the same may be said of the short wall a little lower down, the masonry of which is complete. The cutting at Maliyala is out to a small width, and a temporary bridge has been built across it. The scouring sluice at the lower end of the mile has been finished and fitted with shutters, which are to be worked by differential pulleys, running over head on a timber frame, with a traveller similar to that used with foundry cranes. The frame seemed rather slight for working the middle vents, but it was tested at the workshops. The pulleys were fixed, and

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the Chief Engineer and myself were unable to make an experimental trial of them. A towing path will be wanted round this sluice.

Should the differential pulleys be found to work well at this sluice, where the depth of water will be twenty feet, I think they will prove a useful mode of applying the requisite power for working head sluice shutters in many places, and they possess the advantage of being simple, and they need but a very small number of men to work them, while the framing would be inexpensive if supported on the piers between the vents.

30. The high banks in the 41st and 42nd miles have settled a good deal, and disturbed the revetments to some extent. Opposite Mudigutla, where an old tank bund underlies the bank, the leakage appeared greater than should be with the small depth of water which has accumulated from land drainage. I mentioned this leakage to the Executive Engineer when at Kurnool, and he will see to it on his next visit. At the lower end of the 42nd mile, a new scouring sluice of six vents has been built since March last, and I suppose it is intended to include an item on its account in the supplemental estimate for the section, as no sanction has been given for this work. The wings have been, by mistake, built as straight walls two feet wide at top, and this has to be corrected in order that the pathway may be continued from the banks on either side to the sluice.

31. The 43rd mile, the last of this section, is complete. The embankment, which is formed of much decomposed shale, has settled a good deal but regularly, and it will probably be tolerable water-tight after a time.

32. In the 3rd section the few works not quite ready for the water will probably be finished by the end of the first week in October, and at any rate long before the water can get to the end of the 2nd Section.

33. 4TH SECTION, MAIN CANAL.—The works in this Section have been much delayed by the rains. In the 46th mile, Culvert No. 1 of eight feet leaked so much that it was unroofed and examined, and it was then found that the skewbacks were many of them almost destitute of mortar, and it was clear they had always been so; added to which the joints are most irregular, and some of them two or three inches wide. The work was done in a very careless manner, and even the arch faces bear but little resemblance to an arch.

34. In the 49th mile, 160 out of 230 feet in length of the eight-feet Culvert, No. 3 have been completed. The outfall and roadway ramp are nearly finished, the inlet not commenced. Two three-feet Culverts in the 50th and 51st miles, and an irrigation sluice in the former mile have been built since March. The banks in these miles are in a forward state, and the revetments have made good progress.

35. Some of the cuttings between the commencement of the section and Puggydial, which were thought to be complete, were found to be a few inches too high, and a thirty feet channel has been run through to the proper depth to pass water down to the 53rd mile. The Culvert, fourteen feet, in this latter mile for the crossing opposite Puggydial is in the same state as in March last.

36. The earthworks from the 53rd to the 59th miles have progressed fairly, but labour seems to have been short during the last five or six months. A large quantity of revetment has also been carefully executed, and it is gratifying to find that the Executive Engineer's exertions to do the work at a fair rate have been very successful, and that what cost about 6 Rupees six months ago in the 58th mile, can now be done for from 2½ to 2¾ Rupees a cubic yard, including ramming the backing thoroughly. In the 57th mile some experimental revetting or pitching with blocks of lime kunkur has just been commenced, and this is expected to cost 1 Rupee a cubic yard, and I think it will do very well if carefully packed.

Sixty-three chains of the 58th mile are now revetted to from three to seven feet above canal bed level, and in many other parts the revetments are well above bed level, but still a great deal of this description of work remains to be done.

37. In the 59th mile the work at the eight-feet Culvert, which had been stopped by the rains, has just been re-commenced. The out-fall channel is complete. Calingulah No. 4 is in progress, but is not yet above ground.

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38. Jupad bridge in the 60th mile has its piers and abutments five feet high: the masonry is good. The office at this station has been left untouched since March, pending the sanction of a supplemental estimate, the submission of which has been delayed by the press of more important work.

39. The supplemental estimates for the earthworks of the 4th Section, which ends with the 60th mile, are with the Chief Engineer, and I expect to receive them in the course of a few days. The amount is very large, but it will be better to defer notice of their contents until their submission for sanction, as the past expenditure has been subjected to careful enquiry, and the Chief Engineer's report thereon will accompany the estimates. The supplemental estimates for masonry are nearly ready.

40. It is difficult to say when the 4th Section below Puggydial (53rd mile) will be ready to pass water, but I hope that water will be sent down in time to try all the banks, &c., and remedy all defects before the commencement of next year's freshes, and I think that this probably will be accomplished.

41. 5TH SECTION MAIN CANAL.—Only a few of the works in this section were visited. No. 1 Culvert in the 61st mile has blown up, and a considerable length of the abutment on the lower side has fallen. The water rose to only 18 inches above the crown, so that the indifference of the masonry, and of its materials,* was the cause of the accident, although the narrow-

* The stone is an indifferent clay shale.

ness of the out-fall channel (three feet) ponded up the water; the part not protected by the embankments will be re-built in limestone.

42. TERAGOPILA AQUEDUCT.—This work has been much delayed by cholera and the rains, and the morning of my visit all work was stopped by the rains of the preceding night. It is being built with the full width of waterway, and I think this is a prudent arrangement. With the exception of the upper abutment, the masonry is very nearly finished to the level of the springing, and some of the skewbacks are laid. These latter are of laminated limestone on edge, and this is perhaps rather opposed to the usually received ideas as to the position in which stone should be placed in a permanent work. The masonry is good, and the aqueduct promises to be a serviceable and handsome work.

43. Above the masonry revetments, on the Canal above the aqueduct, the interior slopes were being revetted with the brown and purple shale obtained from the bed of the Canal. This material is difficult to quarry, but it is so rapidly destroyed by exposure, that it would be useless after the lapse of a year, and even had the rate been only 3 or 4 Annas it would have been better to leave it alone, but the actual rate was 1 Rupee 2 Annas and the work therefore could hardly be termed anything but a great waste of money. Fortunately the quantity done was but small, and I believe that the Chief Engineer has stopped it, and proposes using blocks of lime kunkur instead. It would be preferable to leave the banks unrevetted, and increase the slope to 2 to 1 by turning over the interior slopes, than to place the shale upon them, which would be disturbed by their settlement and be useless for re-packing.

44. The scouring sluices in the 70th mile are complete with the exception of their shutters and the surplus channel below.

The culvert immediately below these sluices had part of its arch blown up by the head of water. The irrigation sluice in this mile has been fitted with a shutter and screw gearing, and the fitting of the shutter with its stone grooves has been carefully done.

45. At the lock in the 73rd mile, the head lock of the 6th Section, one of the cylindrical valves has been fixed in position, and its cut stone setting is complete: the other valve is now being fitted. The masonry of the lock is nearly complete, and all the later work has been faced with good limestone. The Executive Engineer states that the completed valve works easily, and it appeared to have been carefully set up. These valves are principally of wood, but at the

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Kurnool Workshops I saw the sections of a cast iron valve of similar pattern, which had been sent out from England. There was no water at the lock, and the working of the valve could not therefore be tested.

46. The Teragopila aqueduct is the only work in this section which must take several months to complete. There is however no reason why this aqueduct should not be completed and water, for the trial of the banks and other works, sent down directly water is available in the Tumbuddra next year. The quantity required will not be large, as the canal is double banked throughout, and it may be expected that all the tanks in the upper sections will be filled or nearly filled towards the close of the freshes of the current season. It is of course of great importance that the works of the 5th section, at the lower end of which the irrigation water is discharged into the Caulee, should be in a condition for regular work in May next, and therefore advantage should be taken of the first fresh in the Tumbuddra next year, which may be expected in March, to send down enough water for the trial of the banks.

47. The Government will be glad to learn that the Chief Engineer has been giving his attention to some subsidiary works, in connection with the surplus sluices and calingulahs, and which are necessary for the convenience of the public. The sluices are *some* of them large and powerful, and the water from them, on its way to the river, crosses roads and foot paths which become dangerous, if not impassable. It is intended therefore to place road dams in some cases, with sub-vents for ordinary discharges, or light bridges at these, and two road dams have already been constructed.

48. PROTECTION TO ROADWAY AT HIGH WALLS, &c.,—The aqueducts, high walls, and calingulahs are about to be furnished with iron or wooden railings, or with masonry parapets, as a protection to the tow path. The parapets will be built wherever there is room, and the aqueducts will have iron railings, but wooden railings are expected to be the most economical for the other works, as a large quantity of indifferent or shaken teak wood can thus be utilized.

49. IRRIGATION.—The area of land irrigated this season will be about 1,000 acres. The crops I observed were very late, and the cultivation, except near Nidagude (10th and 11th miles) indifferent, but whether the appearance of the crops was due to the nature of the soil, or to want of skill on the part of the cultivators, I cannot say. At any rate the cultivation should be commenced not later than the beginning of June, for otherwise the best crops will not reach maturity before the supply of water begins to run short.

50. DISTRIBUTION WORKS.—The distribution works, if the short channels from the sluices in the first section be excepted, have not yet been commenced, and it is to be regretted that attention was not given a year or eighteen months ago to the preparation of the necessary surveys and of the estimates, for I observe from the last report of labour that the reduction of work along the main canal has lowered the number of Coolies* from 16,434, in April 1865, to 6,570 in August 1865, and had the arrangements been ready, a large portion of the labour thus discharged might with great advantage have been set to work on the distribution works.

* Daily average.

51. WORKSHOP AT KURNOOL.—The buildings, with the exception of the foundry, are in a very ruinous condition, and the protection for the stores is altogether inadequate. I have just received from the Chief Engineer plans and estimates for permanent buildings on a reduced scale, and these will be disposed of in a few days. The work now in process in the shops is principally the building of ferry boats, and the making up of shutters with their lifting gear for the numerous surplus and irrigation sluices on the main canal. A ringing engine with a punt for driving piles, to ascertain the position of leaks, has also nearly been completed.

52. CUDDAPAH SURVEYS.—The surveys between Cuddapah and Somaisweram are complete, and Mr. Knorpp is now at Kurnool engaged in completing the cross

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sections, and in making plans of masonry works, estimates, &c. The work has been continued in the same careful manner which characterised the portions I had an opportunity of examining in the middle of last year. As planned, the canal is, after passing the Bundalapulli spurs, to cross the saddle near Kūmalūr, which will, it turns out, afford a very favorable line. The Kulligherry spur, just above the Cheyār, is to be passed by cutting

Paragraph 26 of letter No. 65 of 5th August 1864, Proceedings Madras Government, No. 2,591, 7th September 1864.
Do. do. paragraphs 27 to 34.

and walling, the Cheyār to be crossed by an aqueduct, and the canal carried along the face of the Dongasōni hills. Some of the cuttings are, as may be supposed, extremely formidable, but generally the very deep cuttings are favorably situated for blasting, and the expense of merely throwing down the masses of rock into the river would, per cubic yard, be very trifling. It will certainly be some years before the idea of commencing the canal in these sections could be prudently entertained, but I do not think that the cost would form an insuperable obstacle, by any means, to its formation, when the canal from Soonkasala to the Pennair, and from Somaisweram to the Kislapatam back-water, is in a prosperous condition, and used as a line of navigation. At any rate it is something to have reliable information about the ground to be got over, and the information obtained is sufficiently complete to enable the Chief Engineer to decide on the description of works required and, within a margin for variations in rates, the cost of a canal through these hills can be ascertained.

No. 597. ORDER THEREON, 24th October 1865, No. 3,191.

CIVIL WORKS, No. 87.

1. Communicated to the Manager of the Madras Irrigation and Canal Company for information.

2. No observations on the Report appear to be necessary.
(True Extract.)

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

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

Exd. S. T. Augustin.

Government.

Consulting Engineers Office.
Irrigation and Canal Company.

N^o 100. Barrary 6th October 1865.

From

Captain John Mullins P.E.

Cons. Eng. for I.C.C.

To H^{on} Secretary to Government

Depart^t of Public Works.

Sir,

Before leaving Madras on my present
tour of inspection, I had ascertained that it was
expected that the water would reach the end of the
Nile 3rd Section about the end of August, and I arranged
therefore to be at Bawansy on the 16th September,
intending to see what progress the 2nd Section (44.6 to Nile)
and the Seragofila Aqueduct in the 63rd Nile, had
made since March last, and to proceed upwards
and see the effect on the 2nd and 3rd Sections of the
admission of water for the first time.

2. On reaching Bawansy however I learnt from the
Chief Engineer, who there met me, that the weakness
of the wall in the 24th Nile had rendered it necessary
to shut off the water immediately above that point, until
the wall had been backed with earth and stone, and
consequently up to the 29th Altiss, just before I left
Kumool, the water had not passed below the 24th
Nile, so that in this present report only a small
portion of the information, which I had hoped to
obtain from this tour of inspection, can be laid before
Government.

3. On the 20th ultimo I visited Sookasala, at which time about 6 to 9 inches of water were passing over different parts of the Aricut. The Lumbudna has been in fresh ever since March last, and the freshes have risen to a maximum of 6.2" on the crest this season, or about 2 feet short of an extreme flood. The Aricut has, so far as could be judged from the overfall, stood very well, and the raised wall at the former breach has fully answered its purpose of protecting the work there, which was incomplete when interrupted by the early freshes.

Estimate sanctioned in P.O. No. 1748 dated 23rd June 65

The state of the rock below the Aricut, which had been injured by previous freshes, cannot be ascertained until the river falls. An estimate for coping the Aricut was submitted with my letter No. 97 of the 30th Sept. 1865 and I visited with the Chief Engineer the granite quarries at Pokkul, about 8 miles from Sookasala, and saw there a few large stones which have recently been quarried experimentally. Any quantity of cut stone can be obtained from the village of Pokkul and its immediate neighbourhood, and the stone is very similar in quality to that used in the Dykes for telegraph posts.

4. The masonry of the sluice has stood well. The removing shutters still work with difficulty, and the attempts made to close and open 2 or 3 of them were not successful. They require more power than can be conveniently applied to a couple of handspikes, and these latter, besides one or two of the pivot beams, showed signs of giving way.

Under sluice

5. The bay above the sluice is much silted up.

Head sluice

as might be expected from the small draught into the channel maintained by the little water allowed to pass. The shutters which have been fitted with screw gear are reported to work easily. In rear of the sluice, for a length of 400 feet on each side substantial rubble masonry piers have been built, and this sluice is now, with the exception of some shutter gearing, in good working order. The depth of water on the rear apron was 3 feet.

1st Section Main Canal, Earth works.

Pierments

6. The pierments are generally in very substantial order throughout. In one or two places the right bank wants a little raising, and in the 5th mile a trifling breach occurred in consequence of the absence of an outlet for the land drainage. In the 1st and 3rd miles a good deal of rock has yet to be removed from the cuttings, and in many places the latter are not quite complete. The pierments have made good progress and shew much improvement in the style of work. In many miles they have been completed, but in some parts they are still not sufficiently high to allow of more than 4 feet of water being passed down. At the Yedariu tank, in the 6th mile, the pierment is generally not more than 4 1/2 feet above bed level, and a great deal of the stone will require repacking. In the 10th and 11th miles, the pierments of the small tanks are not everywhere up to present level of water, which is about 3 feet above bed level.

Masonry works.

The culvert and inlet in 2nd mile.

The Culvert leaks a little, and it requires additional rubble stone at the outlet to prevent scour. Culvert No. 7 in 3rd mile. This has for a long time been walled up at both ends, but whether because it was deemed unnecessary, or because it was thought too weak is not known. Had it been open and capable of standing, it would have drained off the water which breached into the Canal, as above noticed. Another culvert at the lower end of this mile is similarly blocked up.

Calingulah No. 1 in the 5th mile leaks considerably behind the wings of the 3 vent scouring sluices, and, through the lower end of the body wall of No. 2 Calingulah in the 8th mile, the leakage is considerable. Culvert No. 10, of 3 vents in the 9th mile has been endangered by the subsidence of the North end of the 1st pier, which occurred towards the end of the 2nd week in September, at a time when little or no water was being discharged by the work. All the foundations except at the part which has failed are stated to be on rock, which indeed is visible in many places. The accident was no doubt immediately caused by scour, which had it been noticed in time could have been stopped by rubble stone, but sufficient care was not shown in putting in the foundation, and as a previous failure occurred at this place, greater precautions might have been expected. About 15 feet of pier, and a small piece of

is rough, but the line is miserably good, as a large part of the unsupported arch stands uninjured. A ring bund has been formed round the end of the Culvert, and water passes down the Canal as usual. The centre arch of this culvert is intended to be used as a crossing, and it will need a paved floor and drainage. In the 12th mile an additional sluice for irrigation is required near Calingulah No. 6, where at present water is being passed by a cut.

No. 9 Calingulah 300 yards in the 17th mile leaks slightly all along, but not to an extent of any consequence. Almost everywhere the leakage through or under the banks is less than it was 6 months ago, and that though the subsoil has nowhere increased, and will probably diminish as silt becomes deposited. Many of these have recently been raised, in order to allow of a larger quantity of water being sent down, and several still need raising, the water being up to the girders, and in one or two places over the approaches. I think these alterations likely to lead to unnecessary expense, and it would be well either at once to improve these works, so as to admit of their passing the water required during the next 2 or 3 years, or as long as their woodwork will stand, or to remove those that are still too low altogether, and place the intended ferry boats in their stead. These bridges have now 2 spans of 12 feet, and probably not

Leakage under the banks.

Temporary bridge

General C. L. Lewis, Jr.
No. 33
16 July 1855
P. M. S. No. 2555 of 25 July

less than 4 or 5 spans would suffice, and as the approaches cost a good deal to construct and maintain, and the wood work is expensive, the course to be followed should be decided on at once after a due consideration of the relative expenses of ferry boats and temporary bridges.

8. The differences in current would appear to indicate that in several places the bed of the Canal is a good deal above its proper level in the 1st Section. It is not intended at present fully to complete all the work remaining to be done, as it is considered advisable to postpone, until the distribution works have been pushed forward, all work which is not essential to safety, and to carrying the water which will probably be needed next year, and this course is, seeing that funds are getting short, the best that can be taken.

9. There is a foot of water on the floor, and $\frac{1}{2}$ of the width, or about 60 feet, are open. The leakage through the masonry has much diminished, though there are still half a dozen leaks which do not show an inclination to stop, and which would be much better away. The filling in of the Canal bed below the Aqueduct has been fully successful in attaining the object intended, and there is now hardly any leakage under the banks.

10. The cutting in the 20th mile is, as regards width, much in the same state as in March last, but the

Canal bed levels

Sliding Aqueduct

2nd Section
Main Canal.

the ^{one} third width has been cleared to very nearly proper bed level, and water is passing through. Materials for the Lorapone Bridge, which is to be built at the deepest part of the cutting, are under preparation.

11. The Culvert of 10 feet span in the 20th mile leaks very considerably through side walls and floor, and quite sufficiently through the arch. It is probably safe however, and it will, when the Bridge in the 20th mile is finished, be only an optional crossing.

12. The banks all the way from the 20th to the 25th miles leak, but there are only 3 or 4 places where the leakage is in distinct streams. Probably these might be stopped by removing the settlements and tamping the soil.

Several parts of the large wall in the 23rd mile, and especially near the lower end, leak more than is safe. It is intended to fill in with soil in front, which will at once reduce the leakage. The sluices in this wall have had their shutters fitted with screw gearing, and the arrangement adopted is one which works easily, and places the sluices under complete control; the gear is enclosed in a box, and cannot be damaged unless the box be first removed, but the boxes are so high above the towing path, that they will interfere somewhat with the tow ropes.

13. The high banks in connection with the Kadrabagh

Kadabagh Aqueduct sank several feet, after the admission of water, but they are being made up again to their proper level. The piers were much displaced, and this was to be expected, seeing that there was not time to allow of the consolidation of the new earthwork before laying on the stone.

14. This work has had a fair trial from Kadabagh Aqueduct. The land freshes, and water has been passed over it, so that the head of canal water has been within $7\frac{1}{2}$ feet of the maximum, and the Government will be glad to learn that the aqueduct has stood its trial very well, and that the only damage sustained was at the buttresses of the North Eastern return wings, and these have been strengthened by building in a solid mass of rubble masonry between them. The leakage through the masonry is, except at one point, where there is a spout of water, unimportant, and it is probable that had puddling instead of rammed moist earth been put down in rear of the abutments hardly a drop of water would have passed through; as it is, the rammed earth has settled very considerably, and thus the water has been able to get to the masonry. The invert under the upper arch, and the buttress apron under the centre arch, have been carefully executed, and it is to be hoped that by them the pressure will be sufficiently distributed to compensate for the absence of proper foundations at that end of the work.

P.M.G. 15th May 1857

been decided on 6 months before, perhaps during that interval more economical arrangements might have been made, especially as all along the Canal a large reduction in the amount of labour employed has been made.

17. In the 25th Drile shutters with screw gearing have been fitted to the 6 vents of the Calingulak. The cuttings are out sufficiently to pass water but not to full width.

18. Smith's section wall at the upper end of the 26th Drile is being finished with a masonry coping, and will have a parapet wall on the outer side.

2nd part of para 37 of the 243. P.M.G. 7th May 1857
Lower down, the junction of Smith's Section wall with the rubble masonry wall has been well done, the core has been carried well into the masonry, and the rubble walls have a good overlap. The 42' masonry wall at the lower end of the mile is finished, and backed with soil.

The ground here is so porous that no rain water remained in the ravine above the wall.

19. The great bank in the 27th Drile has been completed. The piers are well advanced, and the cutting across the saddle at the lower end is nearly out to half width.

20. Some very good pierment has been done to nearly full height at the commencement of this mile. Rock cutting at the spurs is in progress, and is well advanced. At one spur the wall (masonry) was finished some time back, and now all

all the rock excavated is surplus material. Smith's section had not then been invented, but it would have been just the thing for utilizing the rock taken out of the cuttings.

Lower down Smith's section wall is in some parts complete, and at others about 4 feet short of full height. There is another junction of the masonry and core sections, but the walls are low where they meet. The earth used for the core of Smith's section is not always as good as it would be advisable to use, as it contains too much shale and stone, which, if suitable soil cannot be found elsewhere, should be sifted out. Two irrigation sluices have been built in the walls.

21. In the 29th mile a new irrigation sluice is being built at the lower end of Calinguloh No. 14; as there are 5 sluice vents in the Calinguloh, the small quantity of irrigation water required might have been taken from one of these.

22. The 30th mile is ready for 3 or 4 feet of water, but there is still a great deal of cutting required to complete. Part of the new wall in this mile is 2 feet too low, and part 3 feet too high. Banks very irregular. Soil from cuttings much in excess of the quantity required for banking, so that, with the very wide banks which the alignment will give, the masonry might have been dispensed with. In the 31st mile, near the upper end, the new wall is being backed on both sides with rubble and is

1 nearly finished. The rock cutting at the spur is about $\frac{2}{3}$ ~~out~~ out, and near this point a new irrigation sluice has been built.

23. The gaps in the 32nd mile have been closed since my last inspection, and the rest of the work in that mile was all but complete.

24. The second section of the Canal is very nearly ready to pass down a moderate supply of water, and as money is much required for distribution works elsewhere, and for sections of the Canal which are more behindhand, further outlay on this section will for the present be confined to such work as may be found necessary as the water is admitted.

3rd Section Main Canal 25. The Pultanpore tunnel in the 32nd mile is nearly finished, but not yet floored. As far as I could judge from the appearance of the pathways to the south of it, there will be but very little traffic through it.

26. From the 32nd mile to the Ullier Aqueduct in the 35th mile, the Canal is in a forward state, except at the rock cutting a short distance above the aqueduct, where much difficult work remains to be done. This cutting is in the hands of a contractor, but it was my impression that larger charges of powder, lodged below 3 or 4 layers of the limestone rock, would facilitate its removal, and prove more economical than

than small changes in each successive layer. The Contractor thought otherwise.

27. This Aqueduct has been completed with the exception of the coping and a little plastering to the water way. To form the roadway under the 1st Arch, however, there is a good deal of Kumkur to be removed. The masonry of the Aqueduct executed since my last inspection appears to have been carefully done. I understood from the Assistant Engineer in charge that the aqueduct has been built at a cost within the amount allowed in the estimates.

28. The 36th, 37th, and 38th miles were nearly finished 6 months ago, and they were not inspected in detail. The road gap in the 38th mile has not yet been closed.

29. Only a part of the cutting in hard conglomerate rock, at the lower end of the 39th mile, has been done, and a special working party had to be sent down to do it. The wall at the end of this mile, and beginning of the 40th mile, is finished, and the sluices in it also. A considerable length of this wall will require backing, and the same may be said of the short wall a little lower down, the masonry of which is complete. The cutting at Maliyala is out to a small width, and a temporary bridge has been built across it. The scowling sluice at the lower end of the mile has been finished & fitted with

shutters, which are to be worked by differential pulleys, running over head on a timber frame, with a traveller similar to that used with foundry cranes. The frame seemed rather slight for working the middle vents, but it was tried at the workshops. The pulleys were fixed, and the Chief Engineer and myself were unable to make an experimental trial of them. A towing path will be wanted joined this sluice.

Should the differential pulleys be found to work well at this sluice, where the depth of water will be 20 feet, I think they will prove a useful mode of applying the requisite power for working head sluice shutters in many places, and they possess the advantage of being simple and they need but a very small number of men to work them, while the framing would be inexpensive if supported on the piers between the vents.

30. The high banks in the 41st and 42nd miles have settled a good deal and disturbed the revetments to some extent. Opposite Mudigutta, where an old tank lined underlies the bank, the leakage appeared greater than should be with the small depth of water, which has accumulated from land drainage. I mentioned this leakage to the Executive Engineer when at Kurnool, and he will see to it on his next visit.

At the lower end of the 42^d Mile, a new sluice of 6 vents has been built since March last, and I suppose it is intended to include an item on its account in the Supplemental Estimate for the Section, as no sanction has been given for this work. The wings have been, by mistake, built as straight walls 2 feet wide at top, and this has to be corrected in order that the pathway may be continued from the banks on either side to the sluice.

31. The 43^d Mile, the last of this Section, is complete. The embankment, which is formed of much-decomposed shale, has settled a good deal but regularly, and it will probably be tolerably water tight after a time.

32. In the 3^d Section the few works not quite ready for the water will probably be finished by the end of the first week in October, and at any rate long before the water can get to the end of the 2^d Section.

33. The works in this section have been much delayed by the rains. In the 46^d Mile, Culvert No. 8 of 8 feet leaked so much that it was uncovered and examined, and it was then found that the skewbacks were many of them almost destitute of mortar, and it was clear they had always been so; added to which the joints are most irregular, and some of them 2 or 3 inches wide. The work was done in a very careless manner, and

and even the arch faces bear but little resemblance to an arch.
34. In the 49^d Mile 160, out of 230, feet in length of the 8' Culvert No. 3, have been completed. The outfall and roadway drains are nearly finished, the inlet not commenced. Two 3' Culverts in the 50th and 51st miles, and an irrigation sluice in the former mile have been built since March. The banks in these miles are in a forward state, and the pavements have made good progress.

35. Some of the cuttings between the commencement of the Section and Puzgidal, which were thought to be complete, were found to be a few inches too high, and a 30 feet channel has been run through to the proper depth to pass water down to the 53^d Mile. The Culvert, No. 14, in this latter Mile for the crossing opposite Puzgidal is in the same state as in March last.

36. The earth works from the 53^d to the 59^d Miles have progressed fairly, but labour seems to have been short during the last 5 or 6 months. A large quantity of pavement has also been carefully executed, and it is gratifying to find that the Executive Engineer's exertions to do the work at a fair rate have been very successful, and that what cost about 6 Rupees 6 months ago in the 58^d Mile, can now be done for from $2\frac{1}{2}$ to $2\frac{3}{4}$ Rupees a cubic yard, including Rammi the

the backing thoroughly. In the 57th Mile some experimental raveling or pitching with blocks of lime kunkur has just been commenced, and this is expected to cost 1 Rupee a Cubic yard, and I think it will do very well if carefully packed.

63 Chains of the 58th Mile are now ravelled to from 3 to 7 feet above Canal bed level, and in many other parts the ravelments are well above bed level, but still a great deal of this description of work remains to be done.

37. In the 59th Mile the work at the 8 feet Culvert, which had been stopped by the rains, has just been recommenced. The outfall channel is complete. Calingulah N^o 4 is in progress, but is not yet above ground.

38. Jupad Bridge in the 60th Mile has its piers and abutments 5 feet high: the masonry is good. The Office at this Station has been left untouched since March, pending the sanction of a Supplemental Estimate, the submission of which has been delayed by the press of more important works.

39. The Supplemental Estimates for the Earthworks of the 4th Section, which runs with the 60th Mile, are with the Chief Engineer, and I expect to receive them in the course of a few days. The amount is very large, but it will be better to defer notice of their contents until

10
their submission for sanction, as the fact expenditure has been subjected to careful enquiry, and the Chief Engineer's report thereon will accompany the Estimates. The Supplemental Estimates for Masonry are nearly ready.

40. It is difficult to say when the 4th Section below Puggidial (53 Mile) will be ready to pass water, but I hope that water will be sent down in time to try all the hauls ~~etc.~~ and remedy all defects before the commencement of next year's freshes, and I think that this probably will be accomplished.

5th Section Main Canal

41. Only a few of the works in this Section were visited. N^o 1 Culvert in the 61st Mile has blown up, and a considerable length of the abutment on the lower side has fallen. The water rose to only 18" above the crown, so that the indifference of the masonry, and of its materials, was the cause of the accident, although the narrowness of the outfall channel (3') ponded up the water; the part not protected by the embankments will be rebuilt in limestone.

*the stone is an indifferent clay shale

Zerapila Aqueduct 42. This work has been much delayed by cholera and the rains, and the morning of my visit all work was stopped by the rains of the preceding night. It is being built with the

the full width of waterway, and I think this is a prudent arrangement. With the exception of the upper abutment, the masonry is very nearly finished to the level of the springing, and since of the skewbacks are laid. These latter are of laminated lime stone on edge, and this is perhaps rather opposed to the usually received ideas as to the position in which stone should be placed in a permanent work. The masonry is good, and the aqueduct promises to be a serviceable and handsome work.

Letter No 243 para 81
P.M.G. 1317-15 May 1865

43. Above the masonry piers, on the canal above the aqueduct, the interior slopes were being revetted with the brown and purple shale obtained from the head of the canal. This material is difficult to quarry, but it is so rapidly destroyed by exposure, that it would be useless after the lapse of a year, and even had the rate been only 3 or 4 annas it would have been better to leave it alone, but the actual rate was 1 Rupee 2 annas and the work therefore could hardly be termed anything but a great waste of money. Fortunately the quantity done was but small, and I believe that the Chief Engineer has stopped it, and proposes using blocks of lime kunkur instead.

It would be preferable to leave the banks unrevetted, and increase the slope to 2 to 1 by turning over the interior slopes, than to place the shale upon them, which would be disturbed by their settlement and be useless for repacking.

44. The seining sluices in the 70th mile are complete with the exception of their shutters and the surplus channel below. The culvert immediately below these sluices had part of its arch blown up by the head of water. The irrigation sluice in this mile has been fitted with a shutter and screw gearing, and the fitting of the shutter with its stone grooves has been carefully done.

44. At the lock in the 73rd mile - the head lock of the 6th Section - one of the cylindrical valves has been fixed in position, and its cut stone setting is complete. The other valve is now being fitted. The masonry of the lock is nearly complete, and all the later work has been faced with good limestone. The Executive Engineer states that the completed valve works easily, and it appeared to have been carefully set up. These valves are principally of wood, but at the Burnool work shops I saw the sections of a cast iron valve of similar pattern, which had been sent out from England. There was no water

water at the lock, and the working of the valves could not therefore be tested.

45: The Teragopila Aqueduct is the only work in this section which must take several months to complete. There is however no reason why this Aqueduct should not be completed and water for the trial of the banks and other works, sent down directly water is available in the Lumbuddra next year. The quantity required will not be large, as the Canal is double banked throughout, and it may be expected that all the tanks in the upper sections will be filled or nearly filled towards the close of the freshes of the current season. It is of course of great importance that the works of the 5th Section, at the lower end of which the irrigation water is discharged into the Canals, should be in a condition for regular work in May next, and therefore advantage should be taken of the first fresh in the Lumbuddra next year, which may be expected in March, to send down enough water for the trial of the banks.

46: The Government will be glad to learn that the Chief Engineer has been giving his attention to some subsidiary works, in connection with the surplus sluices and Calingulabs, and

work. I observed however that Canal water does find its way through the subsoil, and the action of springs of this sort cannot unfortunately be watched; and as it will be a long time before the Canal water will deposit enough silt in the foot above and below the aqueduct to puddle the bed, it would be advantageous, I think, were additional soil thrown in. The Chief Engineer is having a small piling engine constructed with a punt, in order to search with piles for the leaks here and elsewhere, and perhaps with its assistance all that are of consequence may be stopped.

15: In the right embankment of the Canal about 200 yards below the Aqueduct a breach occurred, when the water was 17 feet deep. Here a gap had been left in the bank, and, as been mentioned before, the filling in of these gaps is a work requiring much care; and as a great many have been left along the line of Canal for from 2 to 3 years after the banks on either side were thrown up, it would be well to have them all specially watched on the first admission of water. In this case the presence of the Permentment prevented the rapid cutting away of the soil; and the breach was soon closed.

16: The wall in the 24th mile is at the ravine 41 feet high, and when the water from land drainage I think first reached it, the leakage was very serious. Masonry drains were therefore constructed

id. no para 37
1740 - P.M.G.
8 - 24th Aug 1864

at 50 feet intervals at the foot of the wall in rear, and of a sufficient length to extend beyond the backing, and then the backing, which had been previously commenced, was pushed on, the upper part consisting of lumps of lime kunkur. When I first saw the wall, on the 20th September, the leakage had much diminished, and on the 29th some further diminution had taken place, and there were then 20 feet of water above the wall. The backing was within one or two days of completion. The depth with a maximum supply will be 39 feet, and no doubt the upper parts of the wall, which have not yet been settled, will leak at least at first, but whether the altered condition of the mortar in the joints will suffice to reduce the leakage to an unimportant quantity remains to be seen, and if not it will, I think, be necessary to place a bank of good soil inside the wall. The material for the backing was being brought by a tramway, about 300 yards in length: the rate paid per cubic yard being 12 annas, 8th of annas for lifting, 4 annas for carriage, and 4 annas for backing against the wall. I think about half this rate would have been enough, and the material ~~was~~ merely thrown down. 4 annas for this part of the operation is certainly a very high rate. Probably the contractor possessed all the labour, and it may therefore have been necessary to give him the work ~~and~~ at

Protection to roadway
at high walls ~~and~~

Irrigation.

and which are necessary for the convenience of the Public. The sluices are some of them large and powerful, and the water from them, on its way to the river, crosses roads and foot paths which become dangerous, if not impassable. It is intended therefore to place road dams in some cases, with subvents for ordinary discharges, or light bridges, at these, and two road dams have already been constructed. 47. The Aqueducts, high walls and Caligulals are about to be furnished with iron or wooden railings, or with masonry parapets, as a protection to the towpath. The parapets will be built wherever there is room, and the aqueducts will have iron railings, but wooden railings are expected to be the most economical for the other works; as a large quantity of indifferent or shaken teakwood can thus be utilized.

48. The area of land irrigated this season will be about 1000 acres. The crops I observed were very late, and the cultivation, except near Nidagide (10th 11th miles) indifferent, but whether the appearance of the crops was due to the nature of the soil, or want of skill on the part of the cultivators, I cannot say. At any rate the cultivation should be commenced not later than the beginning of June, for otherwise the best crops will

will not reach maturity before the supply of water begins to run short.

48. The distribution works, if the short channels from the sluices in the first section be excepted, have not yet been commenced, and it is to be regretted that attention was not given a year or 18 months ago to the preparation of the necessary surveys and of the estimates, for I observe from the last report of labour that the reduction of work along the main canal has lowered the number of coolies from 16,434 — in April/65, to 6,570 in Aug/65, and had the arrangements been ready, a large portion of the labour thus discharged might with great advantage have been set to work on the distribution works.

49. The buildings, with the exception of the Work shop at foundry, are in a very ruinous condition, and the protection for the stores is altogether inadequate. I have just received from the Chief Engineer plans and estimates for permanent buildings on a reduced scale, and these will be disposed of in a few days. The work now in progress in the shops is principally the building of ferry boats, and the making up of shutters with their lifting gear for the numerous surplus, and irrigation, sluices on the main canal. A pumping engine with a pump for driving piles, to ascertain the position of leaks, has also nearly been completed.

50. The surveys between Cuddapah and Buddapah Surveys Somaswaram

Somaswaram are complete, and Mr. Knopp is now at Kurnool engaged in completing the cross sections, and in making plans of masonry works, estimates &c. The work has been continued in the same careful manner which characterised the portions I had an opportunity of examining in the middle of last year. As planned, the canal is, after passing the Bumbalapulli spurs, to cross the saddle near Kimalur, which will, it turns out, afford a very favourable line. The Kulligherry spur, just above the Cheyar, is to be passed by cutting and walling, the Cheyar to be crossed by an aqueduct, and the canal carried along the face of the Dongasani hills. Some of the cuttings are, as may be supposed, extremely formidable, but generally the very deep cuttings are favourably situated for blasting, and the expense of merely throwing down the masses of rock into the river would, per cubic yard, be very trifling. It will certainly be some years before the idea of commencing the canal in these sections could be prudently entertained, but I do not think that the cost would form an insuperable obstacle, by any means, to its formation, when the canal from Sunkasala to the Pennair, and from Somaswaram to the Kistapatam back-water, is in a prosperous condition, and used as a line of navigation. At any rate it is something to have reliable information about the ground to be got over, and the information obtained is sufficiently complete to enable the Chief Engineer to decide on the

para. 26 of letter 11-65
of 5 Aug/64 - P.M. 4.
11-2891-7 Sept/64 -

- do - do - para. 27 of 31-65

the description of works required and, within a margin for variations in rates, the cost of a Canal through these hills can be ascertained.

I have the honor to be
 Sir
 Your Most Obedt. Servt.
 John Lindley (Capt. R.E.)
 Consulting Engineer for S. & C. Co.

C. 2280 Oct 16 50 A. 24 1/2

C. 2280 29 6

Copy in a letter to Eng. Lindley
 275: Dated London 17th of 1865

1865-1866
 No 1190
 Chief Engineer of the
 Madras Irrigation
 & Canal Co.
 J. H. C. Co.
 The Secretary to Govt.
 dated 6th October 1865
 The Madras Irrigation
 and Canal Co. report
 on the Sanitary and
 and on the 14th/1865
 of the 5th section
 of the Main Canal
 No 3191-24th Oct 1865

P. H. D. 2-

Proceedings of the Madras Government.
 Under date the 24th October 1865.
 Read the following.

From the Consulting Engineer
 Irrigation and C. Co.

Inspection report on the
 Coonkavallo^{ment} and on the 1st
 to 4th and a portion of the
 5th section of the Main Canal

R. B. 6th October 1865
 No 100.

communicated to the
 Manager of the Madras Irrigation
 and Canal Company for in-
 formation -

No observations in the
 report appear to be necessary

W. H.

W. H.
 Do

Copy in a letter to England
of 5th December No 70 of 1868

to Viscount Depe
to no. of Great for Cech

AD 3191
Paris of the Milano
D / 24 Oct 68

London
24/10/68

Madras & Co.
Canal - The report of
May 1868