

(1) Number of pages 4/1
(2) Date of repair 24-12-33
(3) Initials of the Referencer [Signature]

MADRAS RECORD OFFICE.

Government of Madras.

P. Subramanian
DEPARTMENT.

G.O. No.	816	Press
		Min.
Dated	24-12-33	18-52

Not to be folded or roughly handled

No. 3. Read the following letter from Colonel C. E. FABER, Chief Engineer; to J. D. BOURDILLON, Esq., Secretary to Government, dated 23rd March 1859, No. 8923.

SIR,

With reference to the promise contained in the Officiating Chief Engineer's letter of the 1st December 1858 No. 5933, to forward a detailed report from the District Engineer of Nellore, on the subject of the failure of the Pennair Annicut, I have the honor now to submit a review by that Officer, of all the circumstances connected with that work, from the time it was first submitted as a project for sanction till the close of the year 1858, with a detailed Statement of the expenditure upon it, and illustrative Sections.

2. As Government is in possession of the views of Colonel A. T. Cotton, it is needless for me to say more than that I believe the failure of the Annicut may be attributed, first to far too slight a Section having been adopted; and secondly, to insufficiently massive materials having been used in its construction.

3. Meanwhile however, the detailed narrative so frequently called for seems to leave nothing further to be desired, as it conveys all information that is likely to be considered necessary.

Letter from Captain JOHN MULLINS, District Engineer, Nellore; to Colonel C. E. FABER, Chief Engineer, dated Ongole, 7th March 1859, No. 454.

SIR,

With reference to the orders marginally* noted, I have the honor to submit a review of

* Officiating Chief Engineer's C. C. letter No. 7003, dated 19th January 1859.
Extract Minutes Consultation No. 2809, dated 24th December 1858.
Extract Minutes Consultation No. 68, dated 8th January 1859.
Officiating Superintending Engineer's C. C. letter No. 7053, dated 15th January 1859.
Extract Proceedings Chief Engineer No. 7298, dated 24th January 1859.

the circumstances connected with the Pennair Annicut from the time it was first submitted as a project for sanction, until the close of the year 1858.

2. The section for the work as first proposed is shewn in the enclosed Plan marked A, this was not approved of by the Revenue Board who forwarded, in December† 1853, the revised Section marked B for the consideration and report of the then Acting Civil Engineer of the 2nd Division, who considering that a Bridge which was combined with the rejected Section, would endanger the safety of the work, recommended the adoption of the Board's arrangement, and accordingly the execution of the work on the latter plan was ordered to be carried out in February‡ 1854.

3. The Annicut on the Section thus sanctioned was completed in August 1855, under the superintendence of Captain Ritherdon, at a cost of Rupees § Memorandum para. 3 dated 5th January 1858 sent to Chief Engineer. 89,494-7-8. The rough stone Apron was packed in yard layers as shewn in Section marked C, and the Officer in charge remarks that "the loss from the freshes during the 2 years it was under construction was very small indeed."

4. The masonry work was very well executed in laterite stone, and the under Sluices were most excellent specimens of work in this material, and stood many freshes without injury, but the freshes at the end of 1855, which however never rose to a greater height than 9 feet above the crown of the work, showed that the rough stone Apron was not capable of resisting the action of the water. The effect of these freshes is shown in the Section marked D, and it seems highly probable that had stone of proper size been brought from the quarries by a Railway, instead of the small¶ sizes which alone could be conveyed by bandies, very small modifications of the Section would have sufficed to render the Annicut permanently stable.

¶ $\frac{1}{4}$ to $\frac{1}{8}$ of a cubic yard and many still smaller.

5. These freshes of 1855 showed that some improvement was necessary to prevent the disturbance of the Apron for the future, and in December 1855, the Civil Engineer was directed* to construct a rough stone retaining wall in the Apron at a distance of 30 feet from the front wall, and to cover the surface of the rough stone between the two walls with a layer of jelly 3 inches thick. This arrangement was completed in 1856, at a cost of Rupees 2,812-7-0, and is shewn in the Section marked E.

6. On the recurrence of freshes in July 1856, it was found that the upper part of the work had been secured by the additions just described, but that the water worked out the rough stone immediately below the retaining wall, producing an exactly similar effect to that originally experienced, but at a different part of the work. This result is shewn in the Section marked F.

7. To obviate this source of injury, after some discussion,† the arrangement shewn in the Section marked G was, in the last communication marginally noted, ordered to be carried out. As will be seen from the Extract|| from the river register shewn in the margin, the river was frequently in flood between the 1st August and the end of the year, but the damage was comparatively speaking slight, and the cost of the repairs was but little. The arrangements shewn in Section G were completed early in 1857, and no accident happened afterwards to the Annicut until November 1857, when the river rose to 11 feet above the crown or 20 feet above the floor of the under Sluices on the 21st of that month and a breach of 102* yards occurred a little to the north of the centre Sluices. Besides this damage the lowest retaining wall, all the rough stone† beyond it, and most of the small Apron above it were carried away, but the upper retaining wall and the Annicut above it were, except at the breach, left quite uninjured.

* Including a cracked portion afterwards removed.
† See Section H.

8. This fresh was one of unusual height and there is but little doubt that had it lasted for a few days longer at a depth on the crown of 5 to 7 feet, the damage would have been much more extensive. It was evident that the rough stone was quite unable to withstand the force of the water, and this, the protecting material for the masonry walls having been removed, the destruction of the latter bit by bit was merely a work of time. Here again had massive blocks of stone formed the lowest Apron, very little if any damage would have resulted, but there being no means of transporting such stone to the work, it was obliged to rely on the material that was available.

9. The frequent failure of the work and the great and continual expense of keeping it efficient having rendered it necessary that considerable alterations should be made, and an arrangement shown in the Section marked K, which was submitted in November 1857, not having been altogether approved of, while opinions among those qualified from experience to judge, differed as to the best form to adopt in the then existing state of the work, the Superintending Engineer of the Southern Circle was authorized to pay a visit to the Annicut and to decide on the best Section to be given in restoring it to an efficient and permanently stable condition, and after making the necessary investigation, that Officer adopted the arrangement shewn in the Section marked L, which, together with a Railway from the Quarries, was approved of and sanctioned in Extract Minutes Consultation No. 305, dated 22nd February 1858.

10. Lieutenant Colonel Lawford quitted Nellore on the 17th of January 1858, and the works were immediately commenced, the first work undertaken being the demolition of that portion of the North, South and North centre old Section which had to be removed to construct the new Section. The Railway was also marked out and levelled and chunam kilns and mills commenced and in* February, the preparation of materials was getting on favorably, and the demolition of the old Section for about $\frac{3}{4}$ ths of its length had been sufficiently completed to admit of the foundations of the 1st retaining wall being put down.

* Deputy Chief Engineer's letter No. 3314, dated 5th December 1855.

† Letters Nos. 616 and 684, 8th and 18th July 1856, from Assistant Civil Engineer in charge.

Letters Nos. 4940 and 5364, dated 15th and 30th July 1856, from Deputy Chief Engineer.

|| Above crown 31st August 1856, 7-0.
12th October 6-6.
22nd November 1858, 4-6.
12th and 13th December 3-0.

11. Much difficulty was then experienced in obtaining a sufficient number of Bricklayers and after endeavouring, without success, to obtain a sufficient supply from other parts of the Nellore District, the Executive Engineer in charge of the work was authorized, at the beginning of April, to write to Madras and obtain about 50 men from thence. Owing to the demand for men of this class on the Railway, &c., none could be obtained and in June 1858, when owing to my being laid up from an accident, Captain O'Connell had been sent to superintend the Annicut, applications were made to the District Engineers of North Arcot, Cuddapah and the Kistnah Division for assistance, and from the 2 latter 40 men were obtained in July 1858, during the interval however, an arrangement was made for the entertainment of Apprentices to perform stone trimming and other operations not requiring any great skill, 70 to 80 lads, whose services were of great use, were thus added to the roll of builders.

12. In the month of June† the first fresh of the season put a stop for 3 days to the work, and occasioned the fall of 180 feet of the first retaining wall, in addition to some small damage to the recently completed cut laterite Aprons at its foot.

† Letter No. 1235, dated 17th June 1858.

13. At this time also the difficulties to be overcome in completing the Railway from the rough stone Quarries caused much anxiety, and every considerable Town in the District was applied to for additional Sawyers for the sleepers. Sawyers in sufficient numbers were thus obtained, but their constant idleness and frequent absences from work on account of Native holidays and occasional bad weather, rendered the out-turn of sleepers far less than should have been the case. The Railway including sidings, &c., measures up to the Annicut ramp about 3000 yards, and out of this length on the 1st September, 700 yards remained to be completed.

14. About the beginning of July, most unfortunately as it ultimately turned out, the demolition of the portion of the old Section between the centre and south under sluices which up to that time had been left untouched was commenced, with a view to the completion of the retaining walls and Aprons of that part. This portion of the work had been but little injured in the floods of 1857, and had the tail of the lower Apron been strengthened with rough stone as a temporary arrangement, and all the available labour been thus left at liberty to complete the rest of the work on the new Section, there can be but little doubt that the consequences of the flood of 1858, would have been at any rate comparatively but little disastrous, as those portions of the new Section which were completed have stood well.

15. The construction of the Annicut at the end of August was progressing very rapidly, and every expectation was entertained that by the 1st week in October, or about 15 to 20 days before the first considerable fresh of the North East monsoon might be expected, the whole of the Aprons would be completed, and the lowest retaining wall sufficiently strengthened to enable the work to sustain, without injury, the freshes of the season,

* Letters Nos. 1946, 1980, 2004 of 11th, 13th and 15th September 1858.
See Plans M. and N.

† 13,000 square miles.

of the river at the close of the

* Valued at 5 to 6,000 Rupees.

but on the 7th of September the river commenced rising* and on the 8th, 5 feet of water were flowing over the crown of the work. The results of the fresh, which was occasioned by the heavy rains falling on the western portions of the extensive basin† south west monsoon, were particularly unfortunate, as not only was the work stopped at this critical period for a fortnight, but in addition to the extensive damage* done to newly completed parts of the Aprons and retaining walls, the level of the river was afterwards never low enough to admit of the 2nd or lowest cut stone Apron being gone on with, and it became necessary to endeavour to secure the 1st Apron and its retaining wall with rough stone. To accomplish this the people of the villages under the Annicut Channels were called upon to subscribe labour and for a few days about 800 coolies were, in addition to the usual supply kept at work and no portion of the 2nd wall was left unsupported. The repairs of the retaining walls and of the 2nd Apron was pushed on with the greatest possible rapidity, and at the commencement of October not more than a week was required to complete all that could be done that year, with the exception of continuing to strengthen up to the last moment the lowest portion of the work with rough stone.

16. Such was the condition* of the Annicut, when on the night of the 8th and 9th Oc-

* See also Plan marked O.

tober the river rose to 2 feet on the crown, and on the subsidence of this fresh to 4 feet on the evening of the latter day it was found that the damage sustained was very slight, and that only to the work which had been completed within the 48 hours preceding the rise of the river. The cessation of the fresh however, was but of short duration, for on the evening of the 11th a further rise took place and on the morning of the 12th a flood of 12 feet on the crown or 21 feet on the floor of the under Sluices had been reached. It was very soon evident that part of the Annicut near its centre had given way bodily, and hour by hour the width of the breach continued to increase, while the slowness with which the river fell showed that ere the subsidence of the freshes, the damage sustained would be very great. Notwithstanding that by the 13th $\frac{3}{4}$ ds of the Annicut had been swept away, the river was on that day $5\frac{1}{2}$ feet above the crown of the remaining portions of the work, but after this date the river fell rapidly to 2 feet on the 14th, and to the level of the Annicut by the 20th.

17. The results of this flood as well as its character, the appearance of the overfall, &c.,

* No. 2277, 13th October 1858.

Do. 2308, 14th do. do.

Do. 2326, 18th do. do.

Do. 2332, 20th do. do.

Do. 2745, 11th December 1858.

1-3rd January 1859.

See Plan P.

have been already detailed in the letters as per margin.* I regret that not having a copy of the sketch of the appearance of the overfall which was submitted with the first named letter, I have been unable to add it to the other Plans and Sections, but should you consider advisable, perhaps you will allow a copy to be added in the Central Office. The effect of the flood may be summed up in a few words. Two-thirds of the Annicut were swept away by it, and to this nothing

even now can be added beyond the fact, that some materials remain below the level of the bed of the River; but as even since the subsidence of the flood, repeated small freshes have altered the position of this material, and caused much of it to sink still lower, it must depend a good deal on circumstances, and more particularly on the interval that may elapse before the work is recommenced, how much of this debris will eventually become available in the reconstruction of the work.

18. As regards the cause of the damage amounting to the almost entire ruin of the work, there can be no doubt that its unfinished state was the reason why it fell so easy a prey under the force of the water; still looking at its condition a day or two before the flood, i. e., at the beginning of October, I think it may fairly be supposed, that an ordinary monsoon fresh would not have caused any damage of moment; for the 1st Apron was all but complete, a small portion of the 2nd Apron was finished, the whole of the 3rd retaining wall had been put down many weeks before, and the site of the unfinished 2nd Apron was covered into more than a yard in depth with rough stone, in order to support the 2nd retaining wall. The character of the flood was however, if the usually received theory of the amount of obstruction offered by Dams across Rivers be correct, a very exceptional one. From the observations contained in para. 7 of my letter No. 2745 of the 11th December, it will be seen that the level of the flood waters was raised not far short of 5 feet by the obstruction caused by the Annicut, while the theoretical increase of elevation does not exceed 2 feet. On the other hand, as will be seen by the diagrams referred to at the commencement of para. 17 of this letter, the difference of level between the

* Nearly 16 feet. See also para. 5, letter No. 2293 of the 13th October 1858.

waters above and below the work, was very unusual*, and the force of the fall enormous. This great difference must be attributed to the fact that the River rose suddenly and rapidly, and that consequently the bed

below the Annicut filled much more slowly than was the case above; but when by the breach- ing of the work, and the greater length of time the fresh had lasted, the River below had had time to fill, the overfall on the remaining portions of the work became very gentle, and harmless, and all extension of damage ceased. This occurrence would seem to point out the advisability of providing a greatly increased capability of discharge in the under Sluices of the future Annicut, as the season of 1857, and many freshes at various times, have shewn that it is characteristic of the Pennair to be almost dry in the morning, and several feet over the crown of the Annicut before night.

19. The Section adopted* would, I believe it completed and allowed time to dry, have stood even with such a flood as that experienced this last mon-

* See Section L.

soon. The two ends which were completed early in the season have stood without injury, and though they may not have been quite so severely tried as other

parts, still the diagrams were taken at the South end, and it is certain therefore, that the trial was sufficiently severe to test the strength of the work. Taking however the character of the River into account, it may well be worthy of consideration, whether any Section requiring such a state of entire completeness to ensure its stability, is looking to the future, adapted for the Annicut at Nellore; for letting alone the interruptions to the work in progress, which must be frequent, and might occur so often as to render completion in one season impossible, it would seem necessary, in order to prevent the chance of any part becoming uncovered, and thus proving the commencement of extensive damage, to provide for a large surplus of strength both in the Aprons and retaining walls, and this would make the Section a particularly expensive one, from the amount of masonry work it would require, and a particularly difficult one, from the necessity of collecting a very large amount of skilled labour.

20. The Statement of work Estimated and performed from the first commencement of the Annicut up to January 1859, which was in the order as per margin* directed to be submitted is enclosed.

Sent by Banghey with Book of Sections.
* Letter from the Officiating Superintending Engineer,
C. C. No. 7053, dated 15th January 1859.

Summary of Works performed at the Pennair Annicut in 1858, No. 28.

January.—Front wall at breach being broken up roughstone road at breach made passable for Carts.

February.—Excavated foundation for 1st retaining wall at breach, pumps and piccottahs put up. Chunam Kiln built and Bricks made. 1st retaining wall between south Sluice and abutment built, and most of the coping put on it.

March.—Foundation of Annicut body at breach finished to within 1 feet of top: length 306 feet— $\frac{1}{2}$ of the 1st and 2nd retaining walls finished and coping put on. 2nd Apron between South Sluice and abutment finished.

April.—Foundation of body at breach finished and wall above built to its proper height and backed with rough stone—2nd Apron between North Sluice and breach finished. Nothing done between Centre and South Sluices from want of work people. New quarries opened at Cavour. Earth-work and metalling of Railway finished.

May.—Too much water in the river to excavate for foundations of 2nd and 3rd retaining wall. 1st retaining wall excepting between Centre and South Sluices, finished—294 feet in length of 3rd retaining wall built and received its coping. Water came down and stopped the work.

June.—Work stopped by a fresh, 60 yards 1st retaining wall thrown down—3rd retaining wall being built in preference to 2nd (by Captain O'Connell's advice) $\frac{1}{2}$ of the Railway open.

July.—The whole of the 1st retaining wall and its coping finished to within 33 cubic yards, 2nd retaining wall and coping to within 180 cubic yards, and 3rd retaining wall and coping all but 24 cubic yards. Nearly half of the 2nd Apron finished.

August.—The 1st retaining wall and coping complete, 2nd retaining wall and coping complete, all but about 10 cubic yards— $\frac{1}{2}$ of 3rd Apron done.

September.—Work stopped by a fresh, portions of 1st and 2nd retaining walls thrown down; and 985 cubic yards of the 2nd Apron required to be rebuilt— $\frac{1}{2}$ of the extension of Sluice flooring completed, and $\frac{1}{2}$ the damage caused by the fresh of the 7th September repaired.

October.—1st, 2nd and 3rd retaining walls finished with the exception of a few yards of coping on the 3rd wall—1st Apron not commenced—2nd Apron finished, all but 15 cubic yards— $\frac{2}{3}$ Sluice flooring extension completed $\frac{1}{2}$ of the 3rd Apron done.

Camp Nellore :
9th February 1859. }

(Signed) A. RITHERDON, Captain,

Executive Engineer, Northern Division.

(Signed) JOHN MULLINS, Captain,

District Engineer, Nellore.

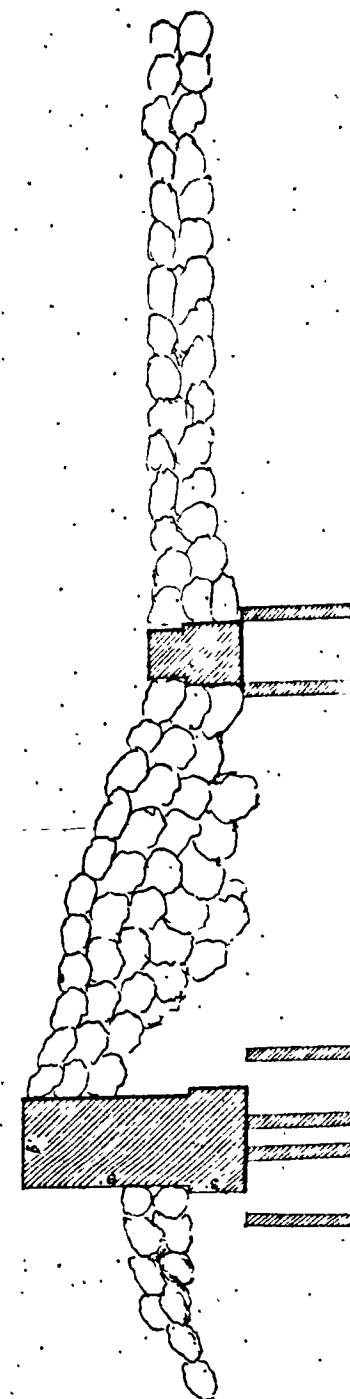
No. 4. * ORDER THEREON, No. 816; dated 6th April 1859.

Ordered that the history of the Pennair Annicut now submitted be printed, and the illustrative drawings lithographed together with those sent by Captain Mullins with his letter of 11th December 1858, No. 2745. This document promised, so long ago as 1st December 1858 No. 2809 having been so long delayed, the Government were under the necessity of causing a narrative to be compiled in their own office which has been lately printed and copies furnished to the Chief Engineer.

(Signed) J. D. BOURDILLON,
Secretary to Government.

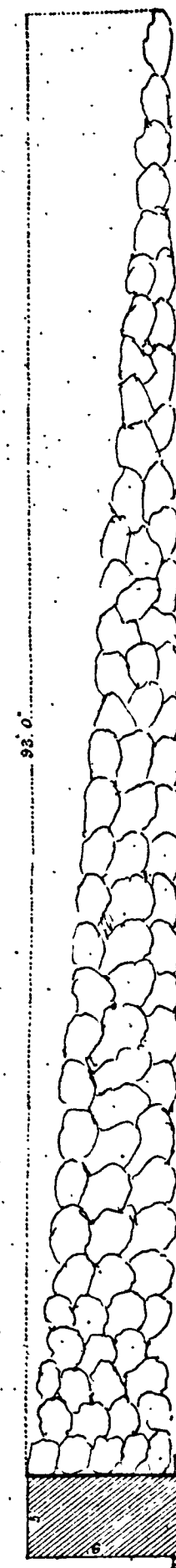
Section A.

*showing the arrangement originally proposed
but not sanctioned.*



Section B.

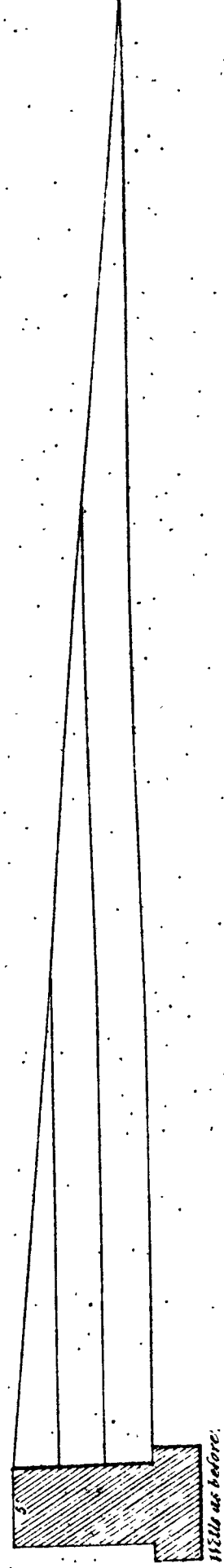
*Showing the section sanctioned by the Revenue Board in the D.P.W.
and on which the work was first constructed in 1854 and 1855.*



Wells as in Section A.

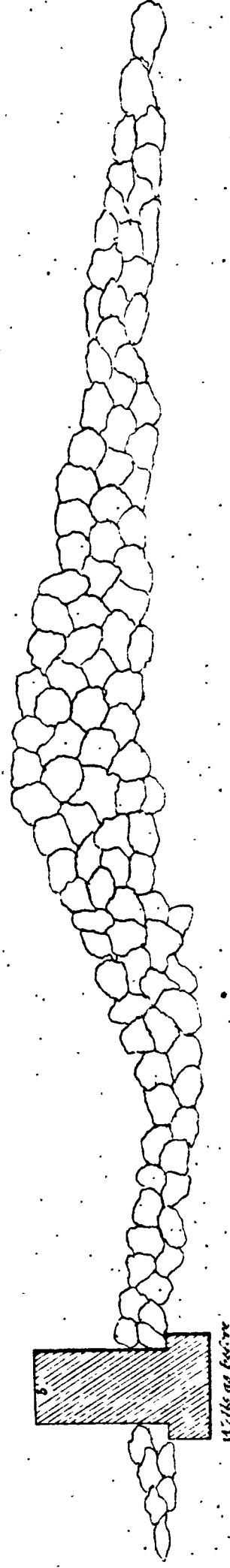
Scale, 10 feet to an Inch.

Section C.



Section D.

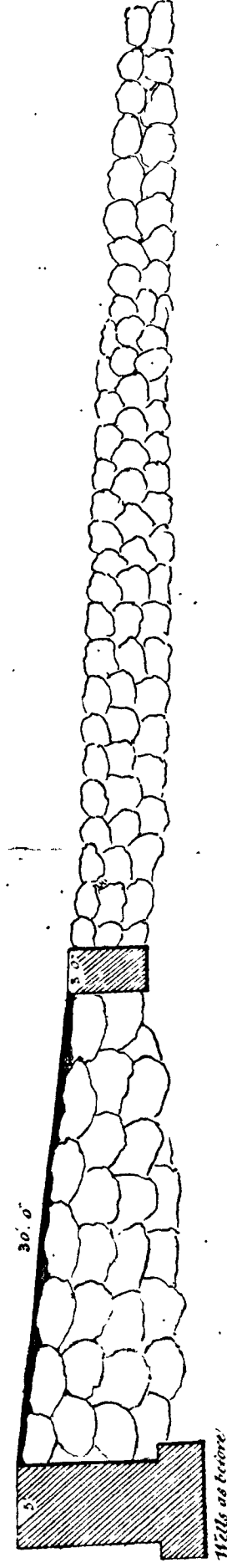
Showing the effect of the freshes of 1855 on Section B.



Scale 10 feet to an inch.

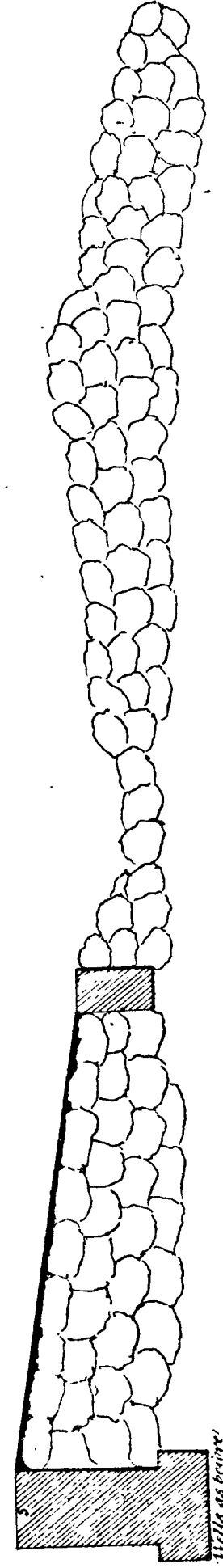
Section E.

Showing the first modification of Section B executed in 1856.



Section F.

Showing the effect of the early freshes of 1856 on Section E.

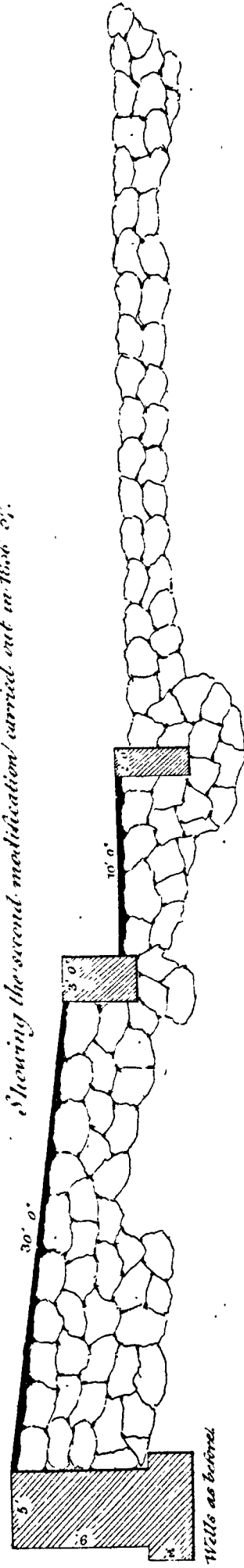


The black denotes jelly in chumam.

Scale 10 feet to an inch.

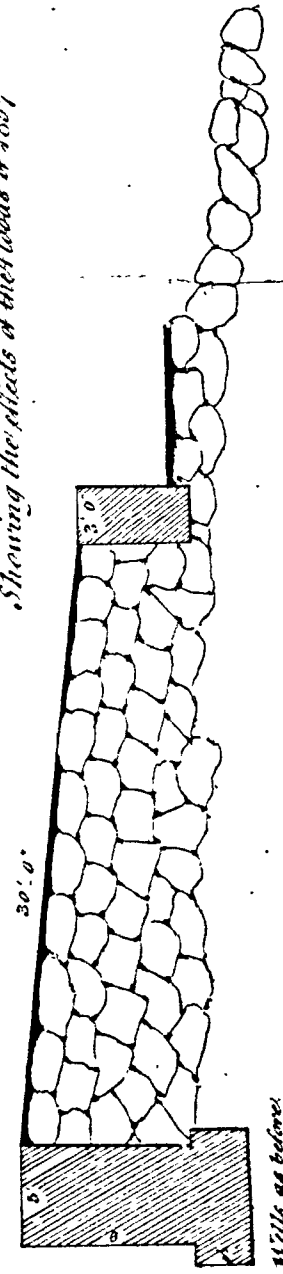
Section G.

Showing the second modification carried out in 1856 & 57.



Section H.

Showing the effects of the floods of 1857

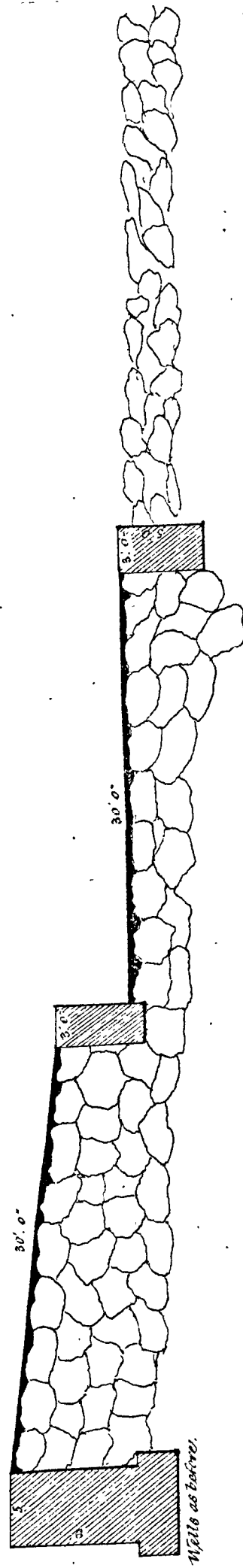


The black denotes jelly in chumam

Scale, 10 feet to an inch

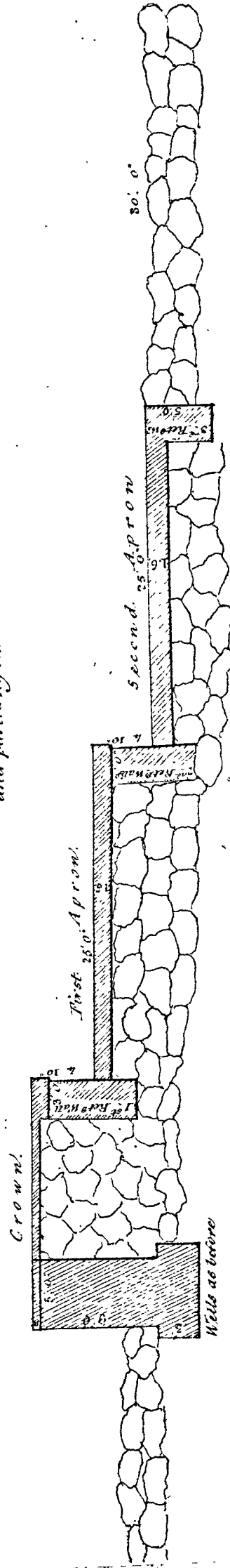
Section K.

Showing the modification proposed by the District Engineer in Nov. & Dec. 1857.



Section L.

Showing the revised Section, designed by Lt. Col. Langford and partially carried out in 1858.

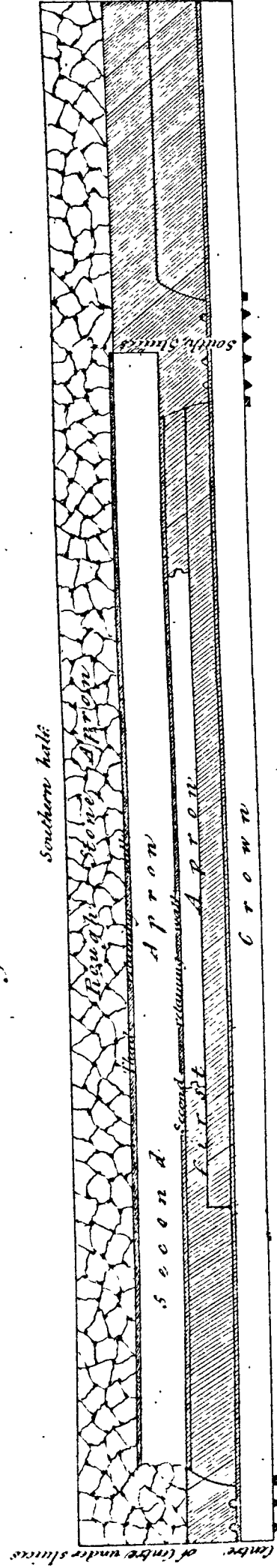


The black denotes jelly in chumam.

Scale, 10 feet to an inch.

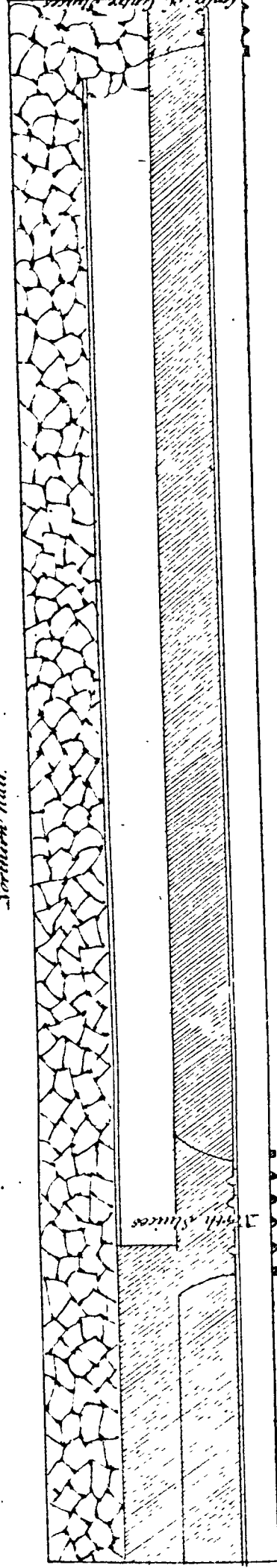
Plan M.

Showing the state of the works immediately before the freshes of Sept. 1853.



The completed portions of the masonry work are shaded.

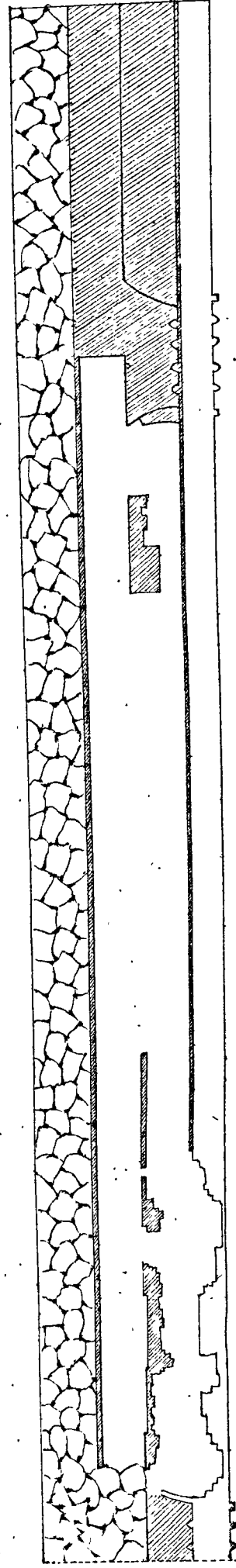
Northern half.



Scale, 75 feet to an Inch.

Plan N.

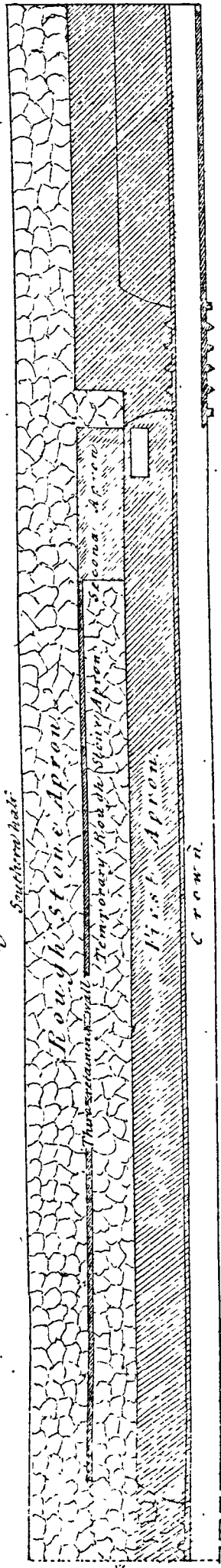
Showing the state of the works immediately after the freshes of September.



Scale, 75 feet to an Inch.

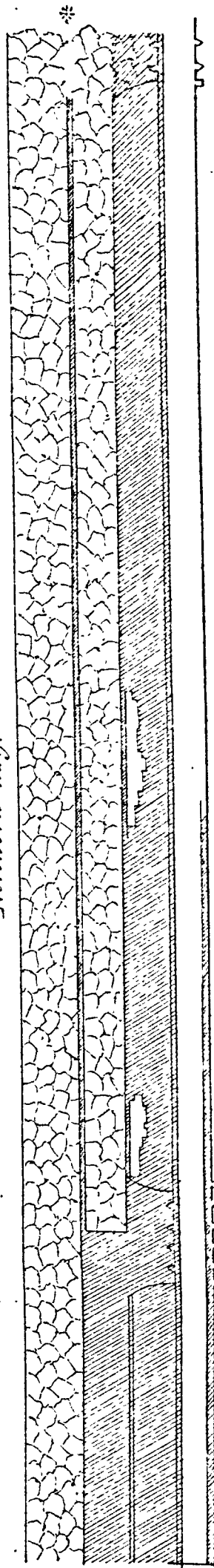
Plan O.

Showing the state of the works immediately before the start of October 1858.



N

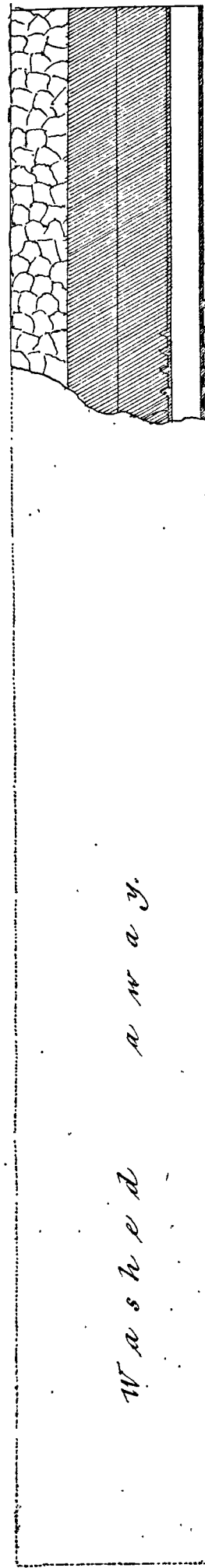
Northern half.



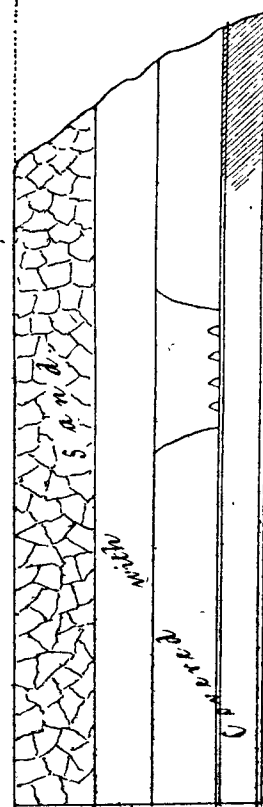
Scale, 75 feet to an inch.

Plan P.

Showing the results of the flood of October 1858.



Washed away.



Scale, 75 feet to an inch.

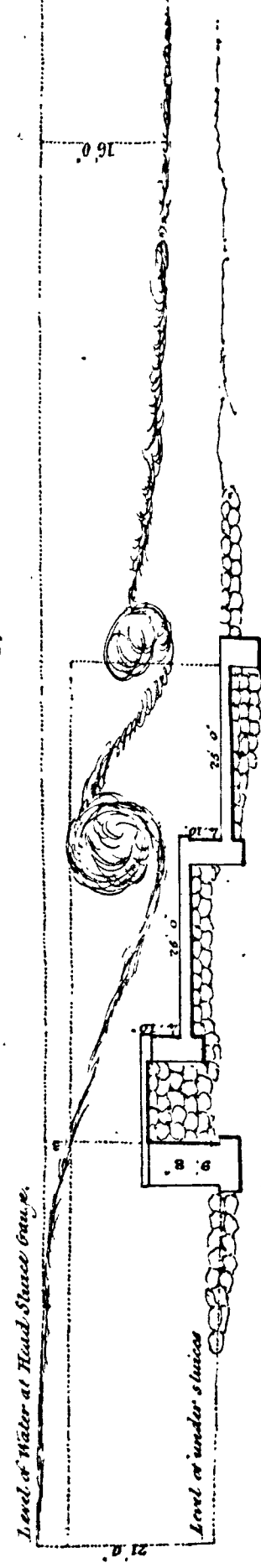
Drafting Sup^r and Manager.
Gen^l Little, Pres. D.P.W.

Signed / John Mullins, Capt^r
District Engineer, Vellore.

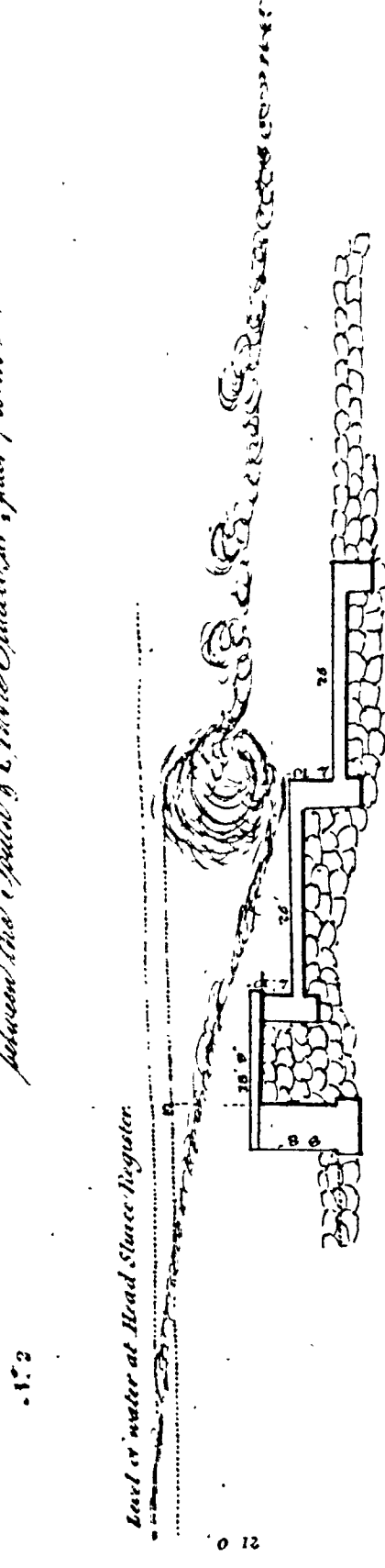
Signed / A. Pillerdore, Capt^r
Treas^r Eng^r N.D.

Signed / J.W. Bell, Civil Engr^r
Chief Engineer.

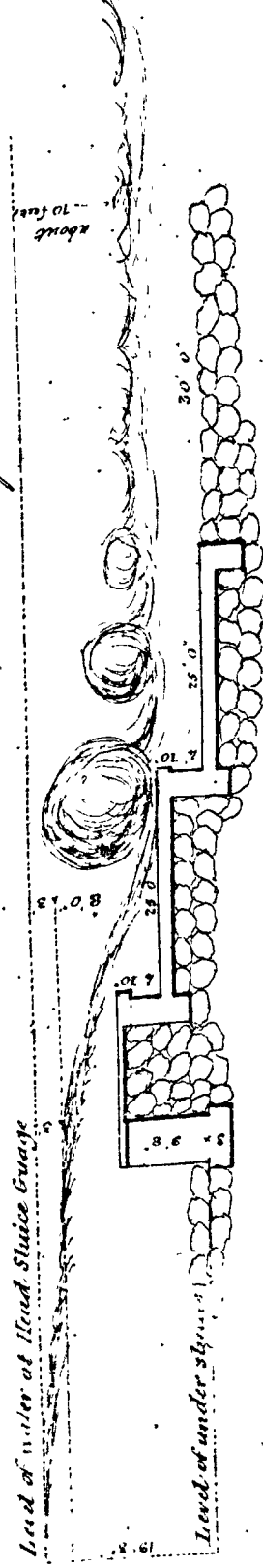
*Irish, of the appearance of the pearl at the
 Gannet's Summit.
 between the South Sluces and the South Wing Wall.
 at 2 p.m. 7th Nov. on the 12th Oct. 1858.*



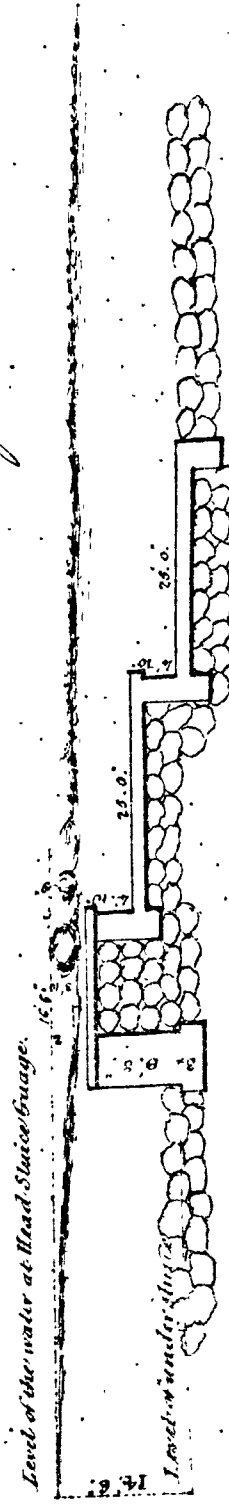
Sketch of the appearance of the property at the
 owner's demand.
 between the "Sketch" of the Survey at "part 7 d. M" on the 12th of 1858.



Sketch of the appearance of the portrait at the
Fennair Anniversary
between the South Africa & South Africa Hall, at 5 P.M. on the 12 Oct. 1868.



Effect of the appearance of the portrait at the
Fennair Auction,
between the South Sea Bazaar & South Wing of Wall at 1/2 past 7 A. M. on the 13th Dec. 1858.



Scale 20 feet to an Inch.

Signed: J. John Mullins, Captain.
 Discharged Engineer, 10th Mass.

PLAN of PENNAIR ANNICUT.

Showing state of the Work on the 11th Oct 1886.



Notes:-

- 1st Apron: Brick retaining wall without coping thus
- 2nd Apron: Fenced lateral work thus
- 3rd Apron: Unfenced lateral work (excepting 3rd Apron, ready for lateral)



Prepared by Supt and Minors
Govt Public Works Dept

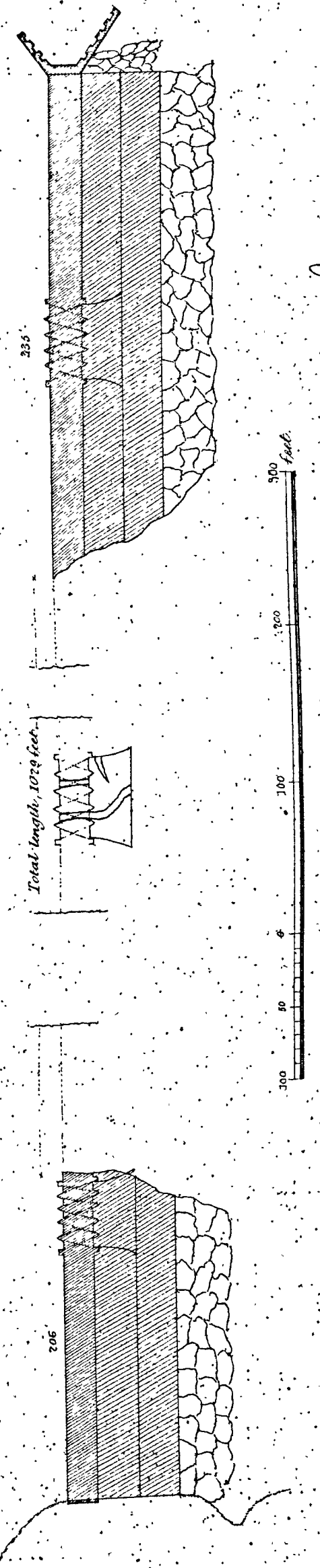
Signed, John Mullins, Capt
District Engineer, Madras

Signed, Aug^r Withersden, Capt
Executive Engineer, M.D.

J. H. Bell
Lieut. Colonel
Chief Engineer

PLAN
of the
PENNAIR ANNICUT

Showing the breach made by the fresh on the 12th Oct 1858.



Draught Supd and Mang.
 Govt Litho Press DPW
 27th Nov 1858
 Bramadarun
 Signed J. Mullins, Captn
 District Eng^r Nilore
 Signed A. Richardson, Captn
 Ex. Eng^r ND
 M. Sell
 Lieut Col
 Chief Engineer

3

District Engineer, Madras

Chief Engineer L. O. M.

Chief Engineer D. O. W.
Fort Saint George

With reference to the orders marginally
 stated, I have the honor to submit a review of the
 circumstances connected with the Pennair Aicut
 from the time it was first submitted as a project
 for sanction, until the close of the year 1858.

The section for the work as first proposed, shown in the enclosed Plan marked *A* was not approved of by the Revenue Board who forwarded, in December 1853, the revised section marked *B* for the consideration and report of the then Acting Civil Engineer of the 2nd Division. He considering that a bridge which was combined with the rejected section, would endanger the safety of the work, recommended the adoption of the Board's arrangement, and accordingly the execution of

[illegible]

Letter 1929

the work on the latter plan was ordered to be carried out in February 1854.—

*Extract Proceedings

1881 d 13 Feb 1854

3 The annicut on the section thus sanctioned was completed in August 1855, under the Superintendence of Captain Peiterson, at a cost of Rupees 894 9/16—7—8. The rough stone apron was packed in yard layers as shown in section marked C, and the Officer in charge

remarked that "the loss from the freshes during the 2 Years it was under construction was very small indeed?"

them or similar
d 15 January 1855
Sent to Chief Engineer

4 The masonry work was very well executed in laterite stone, and the under sluices were most excellent specimens of work in this material, and stood many freshes without injury. But the freshes at the end of 1855 which however never rose to a greater height than 9 feet above the crown of the work, showed that the rough stone

stone apron was not capable of resisting the action of the water. The effect of these freshes is shown in the section marked D, and it seems highly probable that had stone of proper size been brought from the quarries by a railway, instead of the small sized which alone could be conveyed by handies, very small modifications of the section would have sufficed to render the annicut permanently stable.

*5/8 of a cubic yard
and many still smaller.

5 These freshes of 1855 showed that some improvement was necessary to prevent the disturbance of the Apron for the future, and in December 1855 the Civil Engineer was directed to construct a rough stone retaining wall in the apron at a distance of

*Deputy Chief Engineer
1831/2 - 5 Dec 1855

30 feet from the front wall, and to cover the surface of the rough stone between the two walls with a layer of lilly 3 inches thick. This arrangement was completed in 1856 at a cost of Rupees 2812-7-6 and is shown in the section marked E.

On

6. On the recurrence of freshes in July 1856, it was found that the upper part of the work had been secured by the additions just described, but that the water worked out the rough stone immediately below the retaining wall producing an exactly similar effect to that originally experienced, but at a different part of the work. This result is shown in the section marked F.

7. To obviate this source of injury, after some discussion, the arrangements shown in the section marked G were, in the last communication marginally noted, ordered to be carried out. As will be seen

from the Extract from the River Register shown in the margin, the river was frequently in flood between the 1st August and the end of the year, but the damage was comparatively speaking slight, and the cost of the repairs was but little. The arrangements shown in section G were completed

early

including a cracked portion afterwards removed.

* See Section H

early in 1857, and no accident happened afterwards to the annulet until November 1857, when the river rose to 11 feet above the crown or 20 feet above the floor of the under sluices, on the 21st of that month a breach of 102 yards occurred a little to the north of the Centre sluices. Besides this damage the lowest retaining wall, all the rough stone beyond it, and most of the small apron above it were carried away, but the upper retaining wall and the annulet above it were, except at the breach, left quite uninjured.

8. This fresh was one of unusual height & there is but little doubt that had it lasted for a few days longer at a depth on the crown of 5 to 7 feet, the damage would have been much more extensive. It was evident that the rough stone was quite unable to withstand the force of the water, and this, the protecting material for the masonry walls having been removed, the destruction of the latter bit by bit was merely a work of time. Here again had massive blocks of stone formed the lowest apron, very little if any damage would have resulted, but

there

there being no means of transporting such stone to the work, it was obliged to rely on the material that was available.

9. The frequent failure of the work and the great and continual expense of keeping it efficient having rendered it necessary that considerable alterations should be made, and an arrangement shown in the section marked K, which was submitted in November/57 not having been altogether approved of, while opinions among those qualified from experience to judge differed as to the best form to adopt in the then existing state of the work, the Superintending Engineer of the Southern Circle was authorized to pay a visit to the Anicut and to decide on the best section to be given in restoring it to an efficient & permanently stable condition, and after making the necessary investigation, that Officer adopted the arrangement shown in the section marked L, which together with a railway from the Quarries, was approved of, and sanctioned in G.O. Mins. Comd. N305 dated 22nd February 1858,

the summary of work performed in each month enclosed.

29/1
10 Lieutenant Colonel Lawford quitted Bellary on the 17th of January 1858, and the works were immediately commenced, the first work undertaken being the demolition of that portion of the North, South and North Centre old section which had to be removed to construct the new section. The Railway was also marked out & levelled & Chennam Beland & Mills commenced & in February, the preparation of materials was getting on favorably and the demolition of the old section for about $\frac{3}{5}$ th of its length had been sufficiently completed to admit of the foundations of the 1st retaining wall being put down.

11 Much difficulty was then experienced in obtaining a sufficient number of bricklayers and after endeavoring, without success, to obtain a sufficient supply from other parts of the Madras District, the Executive Engineer in charge of the work was authorized, at the beginning of April, to write to Madras & obtain about 50 men from thence. Owing to the demand for men of this class on the Railway & none could be obtained and in June 1858, when owing to my being laid up from an accident, Captain O'Connell had been

sent

Sent to Superintendents the Annicut, applications were made to the District Engineers of North Arcot, Madras and the Ristrach Division for assistance, and from the 2 latter 60 men were obtained in July 1858.

During the interval however an arrangement was made for the entertainment of apprentices to perform stone trimming & other operations not requiring any great skill, 70 to 80 lads, whose services were of great use, were thus added to the roll of builders.

12. In the month of June the first fresh rain of the season put a stop for 3 days to the work, and occasioned the fall of 150 feet of the first retaining wall, in addition to some small damage to the recently completed cut laterite aprons at its foot.

Letter. 12.35a
17 June 1858.

13. At this time also the difficulties to be overcome in completing the railway from the rough stone quarries caused much anxiety, and every considerable town in the District was applied to for additional labourers for the sleepers. Labourers in sufficient numbers were thus obtained, but their constant idleness and frequent absences from work on account of native holidays & occasional bad weather

14. weather, rendered the outturn of sleepers far less than should have been the case. The railway including sidings & measures up to the annicut ramp about 3000 yards & out of this length on the 1 September 700 yards remained to be completed.

15. About the beginning of July most unfortunately as it ultimately turned out the demolition of the portion of the old section between the Centre and South underdrains which up to that time had been left untouched was commenced, with a view to the completion of the retaining walls & aprons of that part. This portion of the work had been but little injured in the floods of 1857, and had the tail of the lower apron been strengthened with rough stone as a temporary arrangement, and all the available labour had been thus kept at liberty to complete the rest of the work on the new section, there can be but little doubt that the consequences of the flood of 1858 would have been at any rate comparatively but little disastrous, as those portions of the new section which were completed have stood well.

15 The construction of the annicut at the end of August
 was progressing very rapidly, and every expectation was
 entertained that by the 1st week in October, or about
 15 to 20 days before the first considerable fresh of
 the North East monsoon might be expected, the whole
 of the aprons would be completed, and the lowest
 retaining wall sufficiently strengthened to enable the
 work to sustain, without injury, the freshes of the
 season, but on the 7th of September the river commenced
 rising and on the 8th 5 feet of water were flowing over ^{Liters 1946, 1980}
 the crown of the work. The results of the fresh, which ^{2004 of 11' 13" x 15'}
 was occasioned by the heavy rains falling on the ^{September 1958}
 western portions of the extensive basin of the river * 13000 ^{See Plans No. V. N.} ^{liters} of rain
 at the close of the South West monsoon, were
 particularly unfortunate, as not only was the work
 stopped at this critical period for a fortnight, but in
 addition to the extensive damages done to newly com- ^{* valued at 5 to 6000}
 pleted parts of the Aprons and Retaining walls, the
 level of the river was afterwards never low enough
 to admit of the 2nd or lowest cut stone apron being
 gone on with, and it became necessary to endeavour
 to secure the 1st apron and its retaining wall
 with

with rough stone. To accomplish this the people
 of the villages under the annicut channels were
 called upon to subscribe labour and for a few days
 about 800 coolies were, in addition to the usual
 supply kept at work and no portion of the 2nd
 wall was left unsupported. The repairs of the 1st
 retaining walls & of the 2nd apron was pushed on
 with the greatest possible rapidity, & at the commence-
 ment of October not more than a week was
 required to complete all that could be done that
 year, with the exception of continuing to strengthen
 up to the last moment the lowest portion of the
 work with rough stone.

See also plan
 marked O

16 Such was the condition of the annicut when on
 the night of the 8th 9th October the river rose to 2 feet
 on the crown, and on the subsidence of this fresh to 1
 on the evening of the latter day, it was found that the
 damage sustained was very slight, and that only
 to work which had been completed within the 48
 hours preceding the rise of the river. The cessation
 of the fresh however was but of short duration
 for on the evening of the 11th a further rise took
 place & on the morning of the 12th a flood of 12 feet
 on

larger

on the crown or 21 feet on the floor of the under sluice had been reached. It was very soon evident that part of the annicut near its centre had given way bodily, and hour by hour the width of the breach continued to increase, while the slowness with which the river fell showed that ere the subsidence of the freshes, the damage sustained would be very great. Notwithstanding that by the 13th of the annicut had been swept away, the river was on that day 5 feet above the crown of the remaining portions of the work, but after this date the river fell rapidly to 2 feet on the 14th, and to the level of the annicut by the 20th.

17 The results of this flood as well as its character, the appearance of the overfall &c. have been already detailed in the letters as per margin. I regret that not having a copy of sketch of the appearance of the overfall which was submitted with the first named letter I have been unable to add it to the other plans & sections, but should you consider advisable perhaps you will allow a copy to be added in the Central Office. The effect of the flood may be summed up in a few words. Two thirds of the annicut were swept away by it, and to this nothing even now can be added, beyond

2227	13	October	1858
2308	14		
2326	18		
2332	20		
2745	11	December	
3 January 1859.			

the fact, that some materials remain below the level of the bed of the river, but as even since the subsidence of the flood, repeated small freshes have altered the position of this material, and caused much of it to sink still lower, it must depend a good deal on circumstances, and more particularly on the interval that may elapse before the work is recommenced, how much of this debris will eventually become available in the reconstruction of the work.

18 As regards the cause of the damage amounting to the almost entire ruin of the work there can be no doubt that its unfinished state was the reason why it fell so easily a prey under the force of the water, still looking at its condition a day or two before the flood, i.e. at the beginning of October, I think it may fairly be supposed that an ordinary monsoon fresh would not have caused any damage of moment, for the 1st Apron was all but complete, a small portion of the 2nd Apron was finished, the whole of the 3rd retaining wall had been put down many weeks before, and the site of the unfinished 2nd Apron was covered in to more than a yard in depth with rough stone, in order to support the 2nd retaining wall. The character of the flood was however

however, if the usually received theory of the amount of obstruction offered by dams across rivers be correct, a very exceptional one. From the observations contained in para 7 of my letter No 2765 of the 11th December, it will be seen that the level of the flood waters was raised not far short of 5 feet by the obstruction caused by the Annicut, while the theoretical increase of elevation does not exceed 2 feet. On the other hand as will be seen by the diagrams referred to at the commencement of para 17 of this letter, the difference of level between the waters above and below the work was very unusual, and the force of the fall enormous. This great difference must be attributed to the fact that the river rose suddenly and rapidly, and that consequently the bed below the Annicut filled much more slowly than was the case above, but when by the breaching of the work and the greater length of time the fresh had lasted, the river below had had time to fill, the overfall on the remaining portions of the work became very gentle, and harmless, and all extension of damage ceased. This occurrence would seem to point out the advisability of providing a greatly increased capability of discharge in the undersluices of the future annicut, as the season of 1857 and many freshes at various times, have shown that

7 nearly 16 ft. -

See also para 5

letter No 2293 of the

13th October 1858

See Section L

that it is a characteristic of the Pennair, to be almost dry in the morning, and several feet over the crown of the annicut before night. —

19 The section adopted would, I believe if complete and allowed time to dry, have stood even with such a flood as that experienced this last monsoon. The two ends which were completed early in the season have stood without injury, and though they may not have been quite so severely tried as other parts, still the diagrams were taken at the South end, and it is certain that that the trial was sufficiently severe to test the strength of the work. Taking however the character of the river into account, it may well be worthy of consideration whether any section requiring such a state of entire completeness to endure its stability, is looking to the future, adapted for the annicut at Nellore, for letting alone the interruptions to the work in progress which must be frequent, and might occur so often as to render completion in one season impossible, it would seem necessary, in order to prevent the chance of any part becoming uncovered, and thus proving the commencement of extensive damage, to provide for a large

large surplus of strength both in the aprons and retaining walls, and this would make the section a particularly expensive one, from the amount of masonry work it would require, and a particularly difficult one, from the necessity of collecting a very large amount of skilled labour.

20 The statement of work estimated and performed ^{a sent by hand by}
from the first commencement of the annicut up to January ^{with book of entries}
1859 which was in the order as per Margin directed to be
submitted is enclosed. ^{Letter from the}
^{Off. Sup. Engr. C. C.}
^{107053 - d/15 January 1859}

Dist Engr's Office
Camp Engrs
7th March 1859
(d/12 March 1859)

I have the
hon John Bullard Esq
District Engineer, Tellico

A True Copy.

Charles H. Orr Captain
Supt. Engr in ch. of C. C.

Central Office of C. W.
Fort Saint George,
23rd March 1859.

Revenue
N. 8923
From
The Chief Engineer.
The Secretary to Government
O. W. D.
Sir,
With reference to the promise contained
in the Officiating Chief Engineer's letter of the
1st December 1858 N. 5933, to forward a
detailed report from the District Engineer of
Madras on the subject of the failure of the
Pennar Aqueduct, I have the honor now to submit
a review by that Officer of all the circumstances
connected with that work, from the time it was
first reported as a project for construction
the close of the year 1858, with a detailed
Statement of the expenditure upon it, and
illustrative sections.
As Government is in possession of

Enclosed in a letter
from
The Chief Engineer
to the Secretary to Government
Copy of letter to
the Secy to Govt 1859. 1858

(Dated 23rd March 1859)
Received
0000888/59 1: 8923
Copy of a letter from the
Engineer of Madras
Reviewing the circumstances
connected with the construction
from the time it was first reported
as a project for construction until
the close of the year 1858.

the views of Colonel A. I. Cotton, it is needless
for me to say more than that I believe the
failure of the Anicut may be attributed, first
to far too slight a section having been adopted,
and secondly - to insufficiently massive materials
having been used in its construction.

3 Meanwhile however the detailed
narrative so frequently called for seems to have
nothing further to be desired, as it conveys all
information that is likely to be considered
necessary.

I have the honor to be,
Sir,
Your most Obedt Servt
Wm. Lister Colonel
Chief Engineer

Central Office of C.W.
Fort Saint George
23rd March 1859

To
The Secretary to Government
C.W.D.

Concurrence de
Ch. B. de Jaurès 25/4. 1895

Mr. Henry D. Brown

Feb 23rd Home & away
Games 23

30.41

1789
In Journal of Catts.
June 27-89

of the various learned societies
with the Librarian & visit
the good-looking young ladies
at a private school.

the State of Maryland.
No 816. D. April 1859.
Waltham order

ordered that the
history of the Pennine Mount
was submitted to printed and
the illustrated drawings of

little report of the document
promised so long ago our
December 1858 having been
so long delayed, the Govern-
ment were under the ne-
cessity of causing a narrative
to be compiled and their own
office which has been lately
printed and copied free-
and sent to the Society.

62 Oct 1899
 100 to 1000
 100 to 1000