Com

Public Works (1896) Department.

RAILWAY BRANCH.

G.O., No. 1076 R

DATED 26th Dec, 1896.

940 R Dy 14.11.96.
1000 R Dy 25.11.96.
1055 R Dy 17.12.96.

[Despatch Abstract.]

Kistna anicut and Bridge.

Letter to the Govt of India forwarding a note by Mr Francis J. E. Spring on the —— at Bezwada

=.

[P. W. Ry. 500—8-5-00.]

Indexed.

BACK PAPERS.

G.O.	No.	Department.	Date.	G.O.	No.	Department.	Date.
	1017	- D. -	8-8-96				
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FURTHER PAPERS.

G.O.	No.	Department.	Date.	G.O.	No.	Department.	Date.

Code Class. XS INDIAN TELEGRAPHS Monthly Number. 383

To (Office) Ootacamund From (Office) Bezvada

SERIAL No. 6

Words	Day.	Hour.	Minute.	Official Instructions.
37	7.	7.	5	Urgt-

To (Person) Madras works. Ray

From (Person) Supt Eng 2. Circle

Nezams line breached in four places between Kondapille and Bezwada owing to breaching of Kistna left flood bank above anicut East Coast may also breach near Bezwada.

32 Word Form.

F. CL.

8 am 7/8/96

Recd. from LN. At Hrs. Mts. by

Sent to LN. At Hrs. Mts. by

J. Mason
fo Telegraph Master.

U G P—No 494 T—27 4 96—4000000

OOTACAMUND 7-8-96

Code Class XS

INDIAN TELEGRAPHS

SERIAL No. 8 Monthly Number

To (Office) Ootacamund | From (Office) Bezvada

Words 14 0/2 | Day 8 | Hours 10 | Minute 38 | Official Instructions urgt

To (Person) Madras Works
Railways
Ootacamund

From (Person) S. E. 2nd C.

The contraction of the Kistna by the railway bridge and training bank on left margin causes most of the damage to the flood banks below the bridge and unless steps are taken to add additional spans to the bridge it is certain that the Kistna anicut will some day be breached at the under sluices bezvada side and this will almost certainly carry away

64 Word Form.

Recd. from L.N. At Hrs. Mts. by

Sent to L.N. At Hrs. Mts. by

Telegraph Master.

OOTACAMUND 8 8 33

Code Class.

INDIAN TELEGRAPHS.

Monthly Number.

To (Office)				From (Office)	
Words.	Day.	Hour.	Minute.	Official Instructions.	

To (Person)

2

From (Person)

the head works and
wipe out the eastern
delta system with its
three hundred thousand acres
the water passing over
the anicut cannot get
away as it did
before construction of bridge
consequently cross currents
and whirlpools produced matter is
most urgent and an
inspection should be made
before the flood subsides
I can fully explain
everything to officer sent
and he should come soon

64 Word Form.

F. C. 2.

Recd. from I.N. At Hrs. Mts. by

Sent to I.N. At Hrs. Mts. by

Telegraph Master.

OOTACAMUND 8 8 93

(R). Form No. 9.

300 –16-4-95.

SERIAL
No. 9

PUBLIC WORKS SECRETARIAT,
RAILWAY BRANCH.

Urgent

Station__________ date__________ 189

OFFICE NOTE.

From ~~M~~ R

To I.

[illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible]

(1. Please see attached telegram, and let me know your views.

(2. I do not understand ~~the~~ how the constriction caused by the bridge can endanger the anicut or its undersluices. It appears to me that the fact that the water ~~[illegible]~~ passing over the anicut cannot get away, must raise the level and diminish the velocity of the water ~~at~~ below the bridge & the anicut and thus diminish the cross currents and whirlpools which would otherwise exist there. It would also diminish the scour at the undersluices. I know what it might be if the

The training bank above the bridge on the left bank is what is likely to cause eddies and undermine the under sluices. A large scour has been formed here every season since the training bank was constructed.

I think Kneeler ought to be wired to to meet Baddeley at once. The Kistna is going down very slowly.

8/8/96

fall at the anicut were greater, as it must have been before the bridge was built

(3. How then can the construction endanger the anicut or its undersluice?

(4. It ~~plan~~ might endanger the river embankment between the anicut & the bridge, by heading up the water till it tops them but the remedy for this is to raise and strengthen them, rather than lengthen the bridge.

(5. I can also understand that the great rush of water through the bridge may cause eddies which may attack the banks below the bridge. but the remedy for this is to protect them and to extend the training walls downstream till these eddies wear themselves out.

(6. Do you consider that it is necessary for any one to go from here to see the state of affairs? Probably the flood would have gone down before he could arrive. (It would also be particularly inconvenient for me to go. as I was about to go on leave).

(7. I therefore propose to write ~~request~~ ~~the~~ to the Manager E.C.R. (Mr. Brereton, who is a good railway engineer, with a practical knowledge of big rivers) to meet Major Baddeley and to report in due course.

C W Hodson

8/8/96

R

1,000—5-8-96.

Form No. 20.

No 1017 D. 8/8 August 1896

TELEGRAM Urgent ~~Ordinary~~ ~~Deferred~~

From R ~~E.R.~~ To Manager ECR.

SERIAL No. 10

No. 17.A/ — Major Baddeley writes that the constriction caused by Kistna bridge causes ~~#~~ much damage below bridge and unless additional spans added anicut will ~~soon~~ some day be breached at undersluices and endanger headworks. ~~and he~~ He asks that an inspection be made before flood subsides. Matter is being reported to Simla and shall be obliged if you will ~~be~~ meet him personally and report in due course.

8/8

Telegram despd 8/8

Send [illegible] copy [illegible]
Depot 8/8

1,000—5-3-96.
FORM No. 20.

SERIAL
No. 11

TELEGRAM ~~URGENT~~ ORDINARY ~~DEFERRED~~

FROM ~~E.R.~~ R

TO S.E. Second circle
Bezwada

A/16. Your wire - Mr. Brereton asked to meet you to inspect ~~Kistna~~ Kistna flood and report.

C

8/8

Despd 8/8

1,000—5-3-96.

FORM No. 20.

SERIAL No. 12

TELEGRAM ~~URGENT~~ ORDINARY ~~DEFERRED~~ Deferred

FROM R ~~E.R.~~

To GOVT. India

18 A Major Baddeley Superintending Engineer Bezwada writes thus - the Contraction of Kistna ~~[illegible]~~ by railway bridge and training bank on left margin causes most of damage to flood banks below the bridge and unless steps are taken to add additional spans it is certain that Kistna anicut will some day be breached at undersluices Bezwada side and this will almost certainly carry away the headworks and wipe out eastern delta system with its 300000 acres. The water passing over the anicut cannot get away as it did before construction of bridge. Consequently cross currents and whirlpools produced. Matter is most urge[illegible] and an inspection should be made upon flood subsides - I can fe[illegible]y explain everything to officer sent and he

should come soon. Wire Ends.

Mr. Brereton has been asked to meet Major Baddeley and report to you in due course. It is understood that he is ~~well qualified~~ as Engineer well qualified to do so

C

8/8/96

Despd 8/8/96

Copied by E.P.T

SERIAL
No. 13

Telegram from Super-intending Engineer 2nd Circle dated 8th August 1896 & subsequent papers.–

—

1) His Excellency the Governor
2) Hon'ble Mr. Bliss. C.I.E.
3) Hon'ble Mr. Grose C.I.E.

Forwarded for information of His Excellency the Governor and Honorable members.

[illegible] 9.8.96

WP
10/8/96

JG
10/8/96

C.W.
R
8/8/96

Special

Anticipated damage by floods to Kistna anicut owing to contraction of the river by the construction of the Railway bridge

P.W. }
Irrn. } 8/8/96 R 1078

Code Class. S	INDIAN TELEGRAPHS	Monthly Number. 498	SERIAL No. 157
To (Office) Ootacamund	From (Office) Rajahmundry		

Words.	Day.	Hour.	Minute.	Official Instructions.
32	9	8	50	

To (Person) Works Railway

From (Person) Manager

Have just returned from Kistna there was no indication of water being headed up by the bridge have instructed exec Engineer to meet Major Godely and report

32 Word Form.

F. C. I.

Recd. from ______ I.N. ______ At ______ Hrs. ______ Mts. by ______

Sent to ______ I.N. ______ At ______ Hrs. ______ Mts. by ______

W. Bonason
Telegraph Master.

OOTACAMUND 9-8-96

C S P—No 494 T—37 4 96—400000

Code Class.

INDIAN TELEGRAPHS

Monthly Number. 5

SERIAL No. 18

To (Office) Ootacamund From (Office) Siml

Words.	Day.	Hour.	Minute.	Official Instructions.
42/6	11.	14	7.	

To (Person) Madras. Works Rwy

From (Person) Works.

1177. R. C. Your
telegram 18 / A eighth
inst please send orders
to meet mr Upcott on
arrival at Bombay to
proceed immediately to
Bezvada and report on
contraction of Kistna river by railw
bridge +

32 Word Form.

Recd. from LN.
At Hrs. Mts. by

Sent to LN.
At Hrs. Mts. by

Telegraph Master.

G S P—No. 494 T—27 1 96—4000000

OOTACAMUND 11-8 96

Form No. 10.

Railway Department.

SERIAL
No. 19

P. W. D. Ry: Branch

~~Office of the Consulting Engineer for Railways,~~
~~Madras,~~ Ooty 11th August 1896

To

Fras R Upcott Esq
passenger per S.S. "[illegible]"
c/o Secy: to Govt: P.W.D.
Ry: Branch
Bombay

No. Reply No. , dated

No 1037 Da/11 August/96

Reminders.

Sir,

The Government of India has ~~asked~~ directed me to send orders to meet you on arrival at Bombay to proceed immediately to Bezwada and report on contraction of Kistna river by railway bridge. Will you kindly do so.—

2. Copies of the telegrams noted in the margin are forwarded for your information

From S E 2d Circle of 8.8.96
To Manager East Coast Ry from R No 17 A of 8.8.96.
To S E 2d Circle No A 16 of 8/8/96
To Works Simla No 18 A of 8/8/96
Telegram from Manager E.C.Ry of 9/8/96
" " Works Simla 1177 R.C. of 11/8/96

(3) It is understood from Col. Blake Brockman that the source of danger is the violent whirlpool caused

by the rush of water through the left bank undersluices impinging on the left bank protection works of the bridge, and causing a serious hole to be formed of great depth just below the apron of the anicut.

C

11/8

No 1037 D of 11 August 96

SERIAL
No. 22

Telegram from the Gover
ment of India P.W. Depar
ment No: 1177 R.C. of 11th
August 1896.-

—

A.S.K.
14.8.96

Forwarded to
Excellency the Governo
for information.-

C.

13/8 R

H.S.
13/8 R 14/8

90

SERIAL
No. 28

No: 1191 Da/ 1st Septr/

To,

The Chief Engineer and
Secretary to Government
Irrigation.

In order to report on the alleged danger to the Kistna anicut caused by the Railway bridge at Bezwada, I request I may be favoured with a -- copy of Major Baddeley's report and the annual plans of the sand banks and scour holes taken by your Department. I should also be glad to have those of this year as soon as ever the river subsides and it is possible to take soundings.

I annex a copy of the orders -- received from the Government of -- India and my reply thereto.

Telegram from Colonel T. Gracey dated 11th August/96.
Telegram to Colonel T. Gracey dated 22nd August/96.

/ Ind/ F. R. U.
1/9/96.

Despd. 1/9/96.

No. 1191 D a/ 1st Septr/96.

SERIAL

No. 31

Public Works (1896) Department.

(1)

ERs **CURRENT No.** 4323

2 currents

Order

From

The Chief Engineer
for Irrigation

No. 425 In.

Dated 28th Septr 1896.

Received 3.10.96

Enclosures

Spare copies

SUBJECT.

Protection bund on the north side of the Kistna bridge—Forwards for consideration copies of Supdg. Engineer's letter and connected correspondence on the question of raising the—

BACK PAPERS.

G.O.	No.	Department.	Date.

FURTHER PAPERS.

G.O.	No.	Department.	Date.

Letter NO:1275.K.dated 15th August 1896,from the Superintending Engineer,Second circle,to the Manager and Chief Engineer,East Coast Railway.

I have the honour to request that the protection bund on the north side of the river above the Kistna Bridge may be raised to 6 feet above the level of the recent flood.

2. During the flood the bank was nearly topped in the upper length,and at the bridge the water flowed over the top of the bund but was stopped by the revetment round the abutment.

3. A failure of this bank in two places during a high flood would be a serious danger to the river bank which is low in the neighbourhood.

4. So long as there is still water between the river bank and the protection bund there is no danger,but two breaches some distance apart in the protection bund,would soon cause a current, and more-over the bank if topped would in a short time be washed away entirely.

(True Copy)

(sd) J.Upshon,Manager,

Supg:Engr's Office,II circle.

Letter NO:7130 dated 7th September 1896,from the Manager East Coast Railway,to the Supg:Engineer,Second circle.

In acknowledging receipt of your letter NO:1275.K.dated 15th August 1896,in which you ask that the protection bund on the north side of the river above the Kistna Bridge be raised 6 feet above the level of the recent flood, I have the honour to offer the following remarks:-

With reference to para 2 of your letter,this part of the bund was constructed at a lower level to admit of cart traffic passing under the bridge,and it has always been known that a high flood would top it,but it is backed by a very strong pitched bund, so that at this particular point (near the abutment) the water was not I am informed within 6 feet of the top.

On the other hand the rest of the bund was about 3 feet above the highest level of the water. This bund is of sand faced with a 3 ft: thickness of hand packed stone.

On the top there is a 30 ft: metalled road way with cross drains 50 ft apart and this is the principal road for people and cattle using the Kistna bridge, it is necessary to keep it up. Roughly the cost of raising the bund 3' for a distance of 1500 ft: will be Rs 4000 as per details given below:-

Pitching 20,000 C.ft: at 7 per 0/0 cft:-----	Rs 1,400
Earthwork 1,50,000 c.ft: at 7- DO ----------	" 1,050
Road metalling 30,000sq:ft: at 3/8/0 per o/o	1,050
Drains under road (20. NO:) at 25 each--------	500
Total	4,000.

The estimate will have to be sanctioned by the Government of India before the work can be put in hand, and I cannot recommend the work being undertaken at the expense of the railway, as I do not think there would be much danger to the canal spoil bank if the bund were topped and did breach. The high flood level is quite 10 ft: below the wide part of this spoil bank where the cutting was made for the approach to the Kistna Bridge. I am quite prepared to recommend that all the training works be made over to the Irrigation Deptt: but before taking any action in the matter, I would suggest waiting till Mr: Upcott, the Consulting Engineer for Railways Madras, has submitted his report on the alleged injurious effect of the Kistna Bridge on the irrigation works during the late exceptionally high flood.

(True copy)

(sd) J-Upshon, Manager

Supg: Engineer's Office,

Second circle.

Letter

Letter NO:1600. K. dated 15th September 1896, from the Superintending Engineer, Second circle to the Chief Engineer for Irrigation.

I have the honour to forward copies of my NO:1275. K. of 15-8-96 to the Manager and Chief Engineer, E.C. Railway and that Officer's reply NO:7130 dated 7-9-96. With reference to para 2 of my letter and the Manager's rejoinder I have only to remark that during last few days, the Railway Department have put up a pitched bank for a length of 30 feet along the top of the existing bund. This was the place near the bridge which I referred to as being too low. The strong pitched bund alluded to by the Manager was not carried sufficiently far above the bridge and a slight rise in the river would have breached the protection bund at this point. The action of the Railway Dept in strengthening the bund at this point confirms what I said in my letter to the Manager East Coast Railway.

2. As regards the level of the rest of the bund being 3 ft above the flood level, I have to observe that there is always considerable scour action at this part, the river flows with great velocity and as the bund is not pitched in rear it would go at once if topped.

3. There is no necessity to widen the road all that is required is a bund along the top of the bank of sufficient thickness to prevent wave action from scouring away the top of the bund.

4. The supposition that there would not be much danger to the canal spoil bank, if the protection was washed away, is altogether incorrect. The spoil bank for a length of 350 feet is in places not more than 4 or 5 feet above the level of the recent flood. It is composed of ordinary black cotton soil and river silt and in my opinion it would not last 24 hours with a current of 6 miles an hour against it. Under very similar circumstances with a lower velocity, the river has been known to cut away 100 feet of lunka during a single flood.

5. Floods have a tendency to increase, not to decrease, the

Railway bridge is steadily narrowing the river below the anicut and it is essential that we should have no weak places in our head works. I consider it very unadvisable to delay the exceution of what is really a very small, but necessary work & I beg that the Ry:Dept: may be directed to carry out the work as soon as possible leaving the question of incidence of cost to be decided hereafter. As regards the training works of the bridge being handed over to this circle I cannot agree to the suggestion, for in my opinion the protection bund should never have been constructed on its present alignment and should only be maintained until arrangements can be made for increasing the water way of the bridge.

6. In conclusion I have to remark that the bund requires general repairs, including the removal of the white ants' nests; which if neglected would most certainly cause dangerous leaks.

I have &c
(sd) M. Loam, Exe: Engineer
for Supg: Engineer, Second circle.

NO: 425 M

True copy forwarded to the Consulting Engineer for Railways for consideration with reference to the report alluded to in para 3 of G.O. NO: 789x. I. dated 29 th Septr/96.

x Read 13/10

For Chief Engineer for Irrigation.

MADRAS.

28th September 96.

SERIAL
No. 36

From
F. R. Upcott Esquire,

To
The Consulting Engineer for Railways,
Madras.

Simla, the 6th October 1896.

Sir,

I have the honour to forward my report on the Kistna Anicut and Railway bridge at Bezvada for the information of His Excellency the Governor in Council and through the Madras Government to the Government of India.

I request a copy be also sent to Mr. Walch Ootacamund and Mr. Spring Consulting Engineer to the Government of India for Railways, Assam, in due course.

I have the honour to be,
Sir,
Your most obedient servant,
F. R. Upcott

action as requested
HB 17/10

Documents accompanying:-

2 plans.

Major Baddeley's report paragraphs 8 to 12.

Letter No.7130 from Manager, East Coast Railway, to Superintending Engineer Bezvada.

S. No. 4436
Recd. 12/10/96

SERIAL
No. 36

Kistna Annicut and Railway bridge at Bezvada.

--------ooOoo-------

On my return from furlough at Bombay on 17th August I received orders from the Government of India to inspect the above works the river being then in high flood.

2. On the 20th and 21st August I made such inspection as was possible – no boat or steamer launch was available and the Superintending Engineer was too ill to accompany me but Mr. Keeling Executive Engineer of that length explained the views of the Irrigation Engineers on the alleged danger to the Anicut caused by the position of the bridge and the contraction of the waterway.

3. The Superintending Engineer's report so far as it relates to the Kistna bridge and plan is put up for reference. I also append a plan showing the direction of the main stream and the backwaters on 20th as seen by me.

4. At the Annicut the water was flowing over the Annicut proper in a uniform and unbroken curve – the undersluices were (I was informed) open and at the junction of these sluices and the Anicut the water was broken and confused with high waves. There was a back current on both sides as shown on plan most pronounced on the left bank, but the velocity was not great. There was also a slight settlement on the left retaining wall as marked on plan.

5. Between Anicut and bridge the river was flowing as shown – the velocities were estimated but the direction of ~~of~~ the current is accurate.

6. The high flood level on the right bridge abutment up stream was 65.77 and that on the left abutment 65.82 (the levels were taken by Mr. Eaglesome for me)

I also observed a water mark on one of the bridge piers showing a wave of afflux of about 20 inches during the maximum flood.

The current through the entire bridge was not uniform but the levels show that there was no greater heading up of water on the left than the right bank.

7. Passing now to the Superintending Engineer's report it will be gathered that he attributes the scouring action going on below the left undersluices to the back currents and whirlpools to be produced by the obstruction offered by the left training bank to the free flow of water and the resulting silting up of that side and considers additional 3 spans on that side imperative so as to give a fan shaped channel below the Anicut which is an axiom of irrigation works.

8. In the first place it is desirable that the position and extent of the alleged scour hole should be surveyed as soon as possible. I am informed by Mr. Walch, who with Mr. Spring, fixed the position of the bridge that scour holes of 50' have occurred before the bridge was built.

9. Again any contraction of the waterway would check the velocity between the Anicut and bridge and thereby prevent the eddies and whirlpools spoken of in the report.

10. It appears also that last year a wall 2' high was built across the Anicut in addition to a 1' wall built in 1892 and that the stone apron has not been brought up to the top of the wall. This alteration of the shape of the Anicut coinciding with the highest known flood will in my opinion explain the eddies and whirlpools at the junction of the Anicut and undersluice where the two bodies of water, one flowing horizontally through the 90 feet opening under a great head of water and the other falling over the submerged Anicut, will cause rotation and scour that coming through the undersluice being of a higher velocity than that falling over the Anicut and the higher the Anicut is raised vertically the greater difference will there be in the 2 velocities and the greater consequent scour.

11. Lastly the Superintending Engineer asks the Manager of the East Coast Railway paragraph 1 of letter No. 7130 of 7th September 1896 from Manager, to Superintending Engineer, to raise the protection bank on the north side of the river above the Kistna bridge to 6 feet above the recent flood level. I cannot reconcile this request with his contention that this very bank is doing all the mischief.

12. My conclusion is that, while I cannot foresee what effect 3 additional spans on the Kistna left bank would have on the course of the river and the stability of the Anicut and head works and therefore cannot advise it. It appears expedient in the very great interests involved in the delta irrigation that the irrigation officers should state their case supported by plans and charts to enable the matter to be calmly discussed when the present state of the river bed has been examined and plotted in plan and section.

B.C.

SERIAL
No. 36/2

Extract paragraphs 8 to 12 from a letter No.1244 K. dated 13th August 1896 from Major W.L.C.Baddeley R.E. Superintending Engineer 2nd Circle Bezwada to the Chief Engineer for Irrigation Madras.

X X X X X X

8. I now come to a question which requires much consideration. The effect of the Railway bridge is to contract the waterway, as can be seen from the survey, and unless the bridge is lengthened by 3 spans of 300′ on the Eastern side, I fear that the anicut will some day be breached near the Bezwada undersluices. The fall in the level of the river is revealing signs of damage to the anicut on the Bezwada side; but we cannot find out anything for certain for some months.

9. The Survey I attach to this letter shows how very much the river has been contracted by the bridge and North training bank and when it is considered that the bulk of the water passes through the nine spans commencing from the Northern side, the reason for the heavy scouring action that now is going on, below the apron, near the Bezwada undersluices, is not far to seek. The bridge has 12 spans, the spans 1,2.3, commencing from the right bank do comparatively little work. 4,5,6,7 and 8 pass the bulk of the water. 9,10,11 and 12 do more than 1,2 and 3 but much less than the centre spans.

10. It is an axiom for the proper situation of an anicut that there shall be the freest possible escape for the water in rear; but what is the case at Bezwada? The original spread of the river has been throttled by the bridge and training bank, and during the flood, the velocity of the water passing through the centre spans of the bridge was so great that, looking down upon it from the bridge, the effect was not that of water passing rapidly under a bridg but more like the effect observed when water is discharged

through an undersluice.The effect of this contraction is to produce back currents and whirlpools,which last year scoured out a hole 50 feet deep in the place referred to,and this scour hole will have increased this year,for,during the flood, the back currents and disturbance near the undersluices were most marked.As a proof of the evil effect produced by the bridge and training bank,I may observe that,since the construction of the bridge,a shoal of sand has been steadily increasing in size close to the North protection bund.

11. I must also point out that if the scour I allude to works back and takes down the undersluices it may cause a breach into the Canal,which disaster would be equivalent to the failure of head works and the consequences would be most serious,as the Eastern delta System would be destroyed.

12. It appears to me from an examination of the Survey that the water passing over the anicut which is 3,700 feet,average length during floods,passes into a basin which is contracted at its mouth by the fact that the centre spans of the bridge pass the bulk of the water.How far this tends to raise the level of the water above the anicut I cannot say,but about the back currents and disturbance and consequent danger it causes to the anicut,there is not a shadow of a doubt in my mind.I may remark that this is no new theory of mine.I have considered the protection bund a danger to the anicut ever since I have been in charge of the Circle,and the state of the river below the anicut on the Bezwada side,during the flood was such as to convince me that the interests of the anicut demand a freer escape of water in rear of it.The matter in my opinion,is one that must be decided chiefly from the point of view of the responsible Irrigation Officers.To allow the bridge to continue in its present state is to court disaster to the Eastern Delta System.I must also state my earnest convicion that the danger is one that will increase every year so long as the bridge is allowed to remain as it is.

* * * * * * * * * *

B.D.B.

No.7130

SERIAL No. 36/3

From

The Manager,

East Coast Railway.

To

The Superintending Engineer,

II Circle Irrigation Department,

Bezwada.

Dated Waltair,the 7th September 1896.

Sir,

In acknowledging receipt of your letter No.1275 K., dated 15th August 1896,in which you ask that the protection Bund on the north side of the river above the Kistna Bridge be raised 6 feet above the level of the recent flood, I have the honour to offer the following remarks.

With reference to paragraph 2 of your letter this part of the bund was constructed at a lower level to admit of cart traffic passing under the bridge,and it has always been known that a high flood would top it,but it is backed by a very strong pitched bund,so that at this particular point (near the abutment) the water was not I am informed within 6 feet of the top.

On the other hand the rest of the bund was about 3 ft. above the highest level of the water. This bund is of sand faced with a 5 feet thickness of hand packed stone.

On the top there is a 30 feet metalled roadway with cross drains 50 feet apart and this is the principal road for people and cattle using the Kistna Bridge;it is necessary to keep it up.

Roughly the cost of raising the bund 3 feet for a distance of 1500 feet will be Rs.4000 as per details given below viz:-

Pitching

Pitching 20000 cft at 7 per 100 cft	Rs.1400
Earthwork 1,50,000 cft at 7 per 1000 cft ..	Rs.1050
Road metalling 30000 sft at 3-8-0 per 100 sft	Rs.1050
Drains under road 20 No.at 25 each	Rs. 500
Total Rupees ...	4000

The Estimate will have to be sanctioned by the Government of India before the work can be put in hand, and I cannot recommend the work being undertaken at the expense of the Railway as I do not think there would be much danger to the canal spoil bank if the bund were topped and did breach. The high flood level is quite 10 feet below the wide part of this spoil bank where the cutting was made for the approach to the Kistna Bridge. I am quite prepared to recommend that all the training works be made over to the Irrigation Department but before taking any action in the matter, I would suggest waiting till Mr.Upcott the Consulting Engineer for Railways Madras has submitted his report on the alleged injurious effect of the Kistna Bridge on the Irrigation works during the late exceptionally high flood.

I have &c.,

(Sd) A.Brereton.

Manager, East Coast Railway.

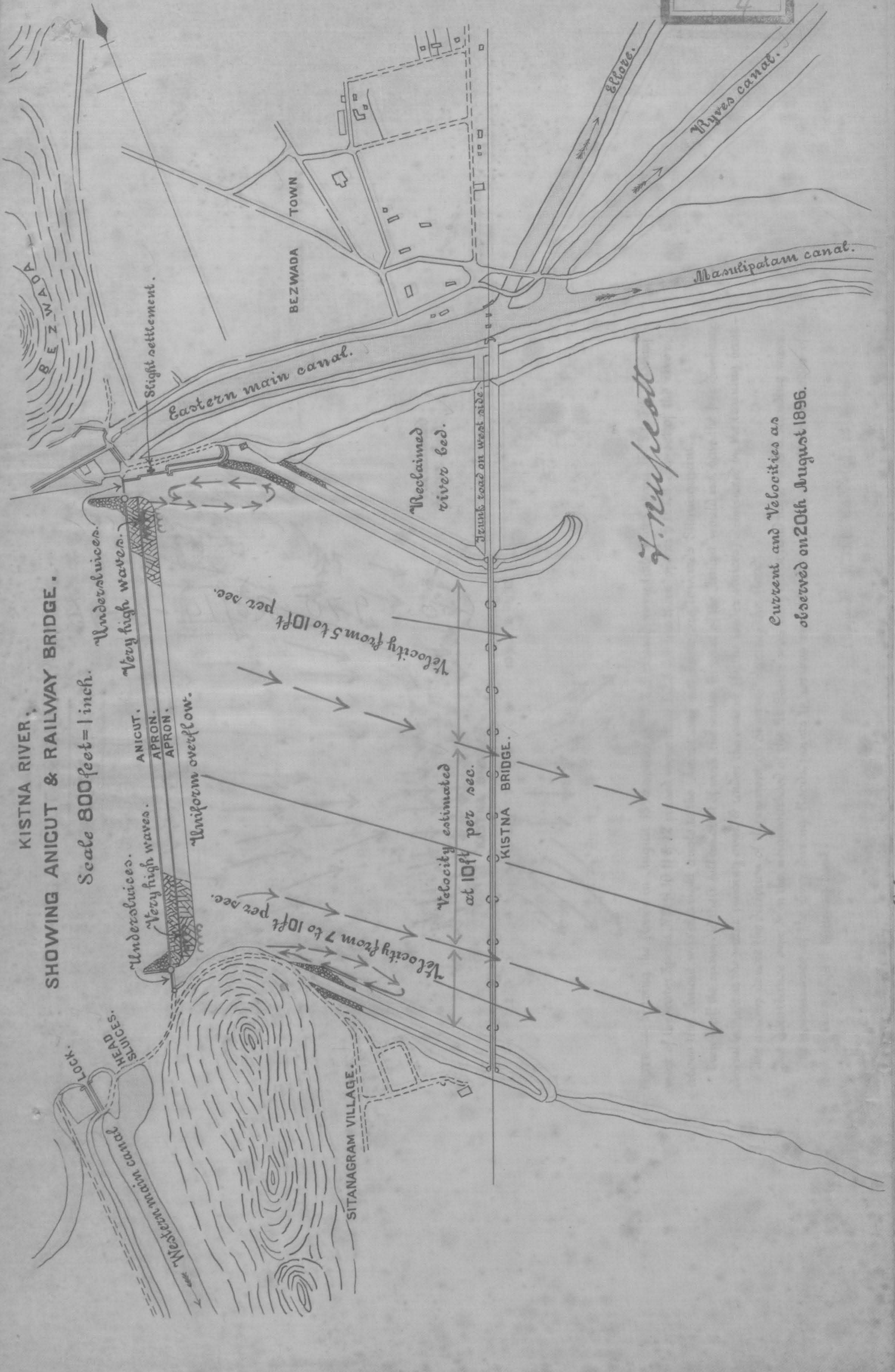
No.7131 dated the 7th September 1896.

Copy forwarded to the Consulting Engineer for Railways Madras for information.

(Sd.) A. Brereton

Manager, E.C.Railway.

SERIAL No. 36/4



KISTNA RIVER,
SHOWING ANICUT & RAILWAY BRIDGE.
Scale 800 feet = 1 inch.

Current and Velocities as observed on 20th August 1896.

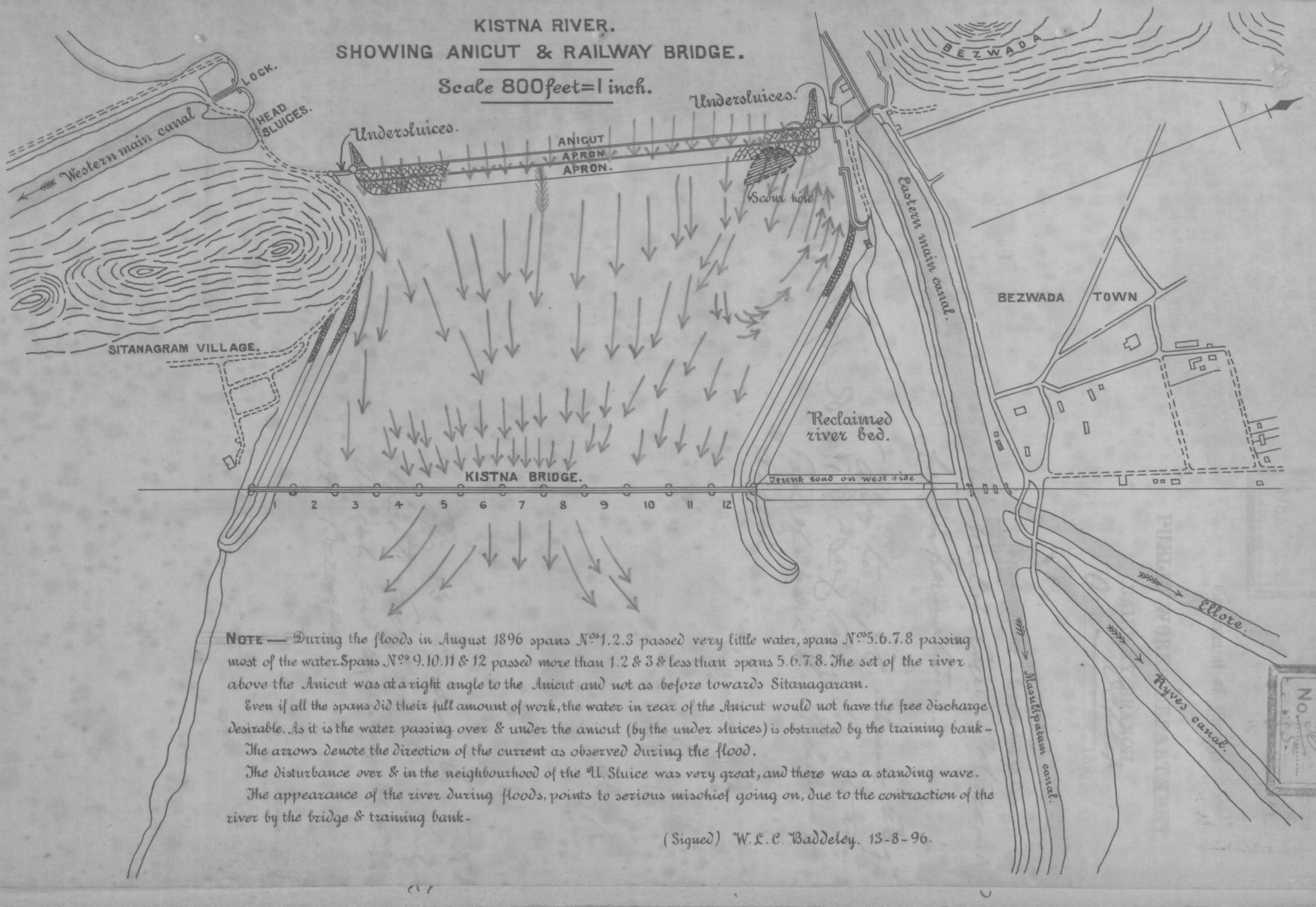
F. Upcott

8.0. 970 Rd/14-11-96

SERIAL No. 36

KISTNA RIVER.
SHOWING ANICUT & RAILWAY BRIDGE.

Scale 800 feet = 1 inch.



NOTE — During the floods in August 1896 spans N^os 1.2.3 passed very little water, spans N^os 5.6.7.8 passing most of the water. Spans N^os 9.10.11 & 12 passed more than 1.2 & 3 & less than spans 5.6.7.8. The set of the river above the Anicut was at a right angle to the Anicut and not as before towards Sitanagaram.

Even if all the spans did their full amount of work, the water in rear of the Anicut would not have the free discharge desirable. As it is the water passing over & under the anicut (by the under sluices) is obstructed by the training bank.

The arrows denote the direction of the current as observed during the flood.

The disturbance over & in the neighbourhood of the U. Sluice was very great, and there was a standing wave.

The appearance of the river during floods, points to serious mischief going on, due to the contraction of the river by the bridge & training bank.

(Signed) W. L. C. Baddeley. 13-8-96.

8.0 970 R d/14-11-96

R. 24.

SERIAL
No. 37

No. 4236 C

Government of Madras.

PUBLIC WORKS DEPARTMENT,

RAILWAY BRANCH.

10th ~~November~~ October 1896.

The following is forwarded to ~~the~~ G T. Walch Esqr Ootacamund for information.

also to F. J. E. Spring Esqr, M.I.C.E, Consg Engr to the Govt of India for Railways, Assam.

also C.E.T., Madras for favour of opinion.

19/10

0069 R

Copy of a report by F R. Upcott Esqr on the Kistna Anicut and railway bridge at Bezwada.

Despatched on 18.11.96

P.T.O

19/10

R. Form No. 12.

SERIAL
No. 38

No. 970. R

Government of Madras.

PUBLIC WORKS DEPARTMENT,
RAILWAY BRANCH.

To

THE SECY. TO THE GOVT. OF INDIA,
P. W. DEPARTMENT.
Calcutta

Madras, the 14th Novr. 1896.

SIR,

With reference to your telegram No. 1177 R.C., dated 11.8.96, I am directed to forward herewith, a report by Mr. F.R. Upcott on the Kistna anicut and railway bridge at Bezwada.

F.W.H. 19/10

1) His Excellency the Governor ✓
2) Hon: Mr H.W. Bliss C.I.E. ✓
3) Hon: Mr J. Grose C.I.E. ✓

A.S.H.
21.10.96

A copy shd. also be sent to the C.E. Irrigation Madras.
A.S.H. 21.10.96

Yes, and the C.E. I.'s opinion asked, I should say
H.B.
24/10/96

30/10

J.G. 28/10/96

Documents accompanying:-
1- Report by Mr. Upcott's with 2 plans.
2- Extract from letter from Supdg. Engr II Circle No. 1244 K dated [illegible].8.96
3- Letter fr[illegible] Manager, E.C.Ry No. 713 dated 7.9.96

Despatched on [illegible].11.96

H.W.B. 23/10 R 29/10.
H.E. 20/10 R 23/10

B.R. 19/10

B/f
No 970.R dated 14.11.96

H.E. 19/10

BUILDINGS AND ROADS.
CIVIL WORKS.

Government {1896} of Madras.
PUBLIC WORKS.

Recd. } 1896. *Enclosures*
Regd. *Spare copies*

G.O., No. 3378 W., 24th November 1896.

NOVEMBER.

Floods in the Kistna River

Orders of the Revenue Department on Proceedings of the Board of Revenue submitting report from the Collector of Kistna on the recent —, communicated to officers concerned, with remark.

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

Buildings and Roads.
Civil Works.

Read—the following paper:—

G.O., Mis. No. 4395, Revenue, dated 7th November 1896.

Read—the following Proceedings of the Board of Revenue (Revenue Settlement, Land Records and Agriculture), dated 5th October 1896, No. 259:—

Read—the following letter from J. N. ATKINSON, Esq., Collector of Kistna, to the Secretary to the Commissioner of Revenue Settlement and Director of the Department of Land Records and Agriculture, dated Masulipatam, 12th September 1896, Dis. No. 3940-Ver.:—

I have the honour to report on the recent floods in the Kistna river. I had been in hopes of being able to send complete information as to loss of property, public and private, and for that purpose have delayed the report; but it is impossible to procure complete lists of such items as cattle lost and fallen houses; while it is altogether premature to refer to loss of crop, since the ryots are striving vigorously to repair their losses, and will probably replant almost the whole area that was destroyed.

2. I append a statement showing the readings of the river-level at the gauge above the anicut on the Bezwada side; and in examining these readings, it may be borne in mind that in the present floods, the water has been at a uniform level both at the Bezwada and the Sitanagaram head-sluices, whereas in the floods of 1882, the previous highest recorded, the greatest height attained at Bezwada was 40·05 feet and at Sitanagaram 40·70 feet.

3. The rise commenced on July 27th, and from that day steadily continued till the maximum flood-level of 41·30 was reached on the evening of 6th August, for three whole days the river standing at a higher level than the maximum in 1882. It happened that during the earlier stages of the flood, almost all District officials were absent from Bezwada; the Superintending Engineer and Executive Engineer, Kistna Eastern Division, being on tour in different parts of the Gudiváda taluk; the Executive Engineer, Northern Division, having proceeded to the Upland taluks, whilst I myself had gone to Chinna Ganjám on the south-west confines of the district. Only the Head Assistant Collector, Mr. Cumming, who had been a bare week in the district, remained at Bezwada. Information that a flood of unusual height was expected was, however, soon communicated, and all hurried back to the scene of action.

4. The following is approximately a complete list of breaches in the river flood-bank, with the dates on which they occurred:—

Western Delta.

1.	Ravi Anantavaram, hamlet of Penumudi ...	31st July, at night.
2. 3.	Kollur (two breaches)	
4.	Pedapulivarru (one breach)	1st August.
5. 6.	Pallepalem (two breaches)	
7.	Turpupalem (one breach)	
8. 9. 10.	Penumudi (three breaches)	
11.	Kaytepalli (one breach)	
12. 13. 14.	Pedapulivarru (three breaches)	5th ,,

Eastern Delta.

1. 2. 3. 4. 5. 6.	Kottapalem and Kokkiligada breaches, six in all	1st August.
7.	Avanigadda	1st ,,
8.	Pulipaka	2nd ,,
9.	Puligedda	2nd ,,

Northern Division.

1.	Ibrampatnam	6th August.

Complete information has not been received from the Divi Island (Avanigadda Division), and it is probable that other breaches occurred below Avanigadda village; but as that part of the country is sparsely inhabited, any damage that may have been caused would by comparison be insignificant. The highest breach on the western side was at Kollur about 25 miles below the anicut; and on the eastern side, omitting the Ibrampatnam breach, at Pulipaka only about 7 miles below the anicut. It was these two that caused the greatest danger and devastation, sending a huge volume of water over the greater portion of the Répalle and Bandar taluks, respectively, so that spreading out fanwise, the flood eventually covered about 1,000 square miles of country, widening the actual mouth of the Kistna to something like 50 miles from Masulipatam to Perali in the Bápatla taluk.

5. I cannot enumerate the various breaches to canals, nor will I attempt to write the history of the struggle to save the head-works at Bezwada and Sitanagaram. We, laymen, were told by the Engineers that for some time the head-works were in great danger; and what we saw was the platforms of the head-sluices covered by some inches of water, so that a rise of less than a foot would have brought the water over the top of everything into the canals; we could feel the masonry quivering to the enormous pressure of water; and we saw, as the water fell, how alarming had been the erosion of revetments and the subsidence of solid masonry walls. What would have happened had the water breached the head-works, no man can divine; but that there must have been appalling loss of life and property seems certain, and it is not impossible that the present system of irrigation would have had to be almost re-constructed. A deep debt of gratitude is due to the Engineers, especially the Superintending Engineer and the Executive Engineer, Kistna Northern Division, whose watchfulness and forethought never flagged for a moment. For several nights all officers of the Public Works Department were without sleep. Every thing was done that could be done, and it may be well surmised that but for the precautions taken, the works would have been unable to withstand the enormous strain that was thrown upon them.

6. The Commissioner of Revenue Settlement had come to Bezwada on 2nd August, and to him I am indebted for having organised the first arrangements for rescue of life and property. Before this on the 1st, Mr. Cumming had proceeded in company with Mr. Keeling, taking the Public Works Department steam-launch and some boats, to bring off the inhabitants of the villages on the right bank above the anicut, where the flood-water speedily submerged a tract measuring 90 square miles. On the morning of 2nd August, Mr. Cumming had to hurry back to his own division which was being inundated through the Pulipaka breach. The work of rescue from the submerged villages above the anicut was continued day by day by the Executive Engineer, Kistna Northern Division, and the Sub-Collector till the 8th by which time about 2,000 persons and many cattle had been placed in safety.

7. Mr. Cumming had proceeded on the 2nd, as just stated, to the neighbourhood of the Pulipaka breach, where he commenced an active crusade in such boats as he could pick up, to bring off people and property from villages in danger. In all about 425 persons were brought off.

8. On the 4th, the Commissioner directed Messrs. Kearns (Assistant Commissioner, Salt and Abkári) and Haden (Inspector, Salt and Abkári) to work through the low-lying country between Kankipad and Tsallapalle. These officers had a most laborious task and did it to perfection. For a considerable part of the distance, boats either

could not be procured, or could not be taken in the desired direction: and it was necessary that most of the work should be done on foot, for hours and hours at a time, in mud and water reaching from the knee to the chest, with scanty meals snatched at irregular intervals; and once without any food for a whole day. I have learnt that part of the work was done in uniform, and the wear and tear of clothing and shoeleather was very serious.

9. On the 5th, the Commissioner wired to the Superintendent of Police to proceed to the tract of country between Tsallapalle and the sea. On the same day, the Headquarter Deputy Collector arrived in Masulipatam from a tour in Gudiváda; and these two officers, after encountering the most vexatious opposition and obstruction from boatmen and others, started on the morning of 6th to visit all the low-lying tract between Masulipatam and the river-bank near Tsallapalle. As it turned out, this was the place where danger and distress were greatest, and the relief operations had to be continued till the 21st. Mr. Hasted's experiences were only little less trying than those of Messrs. Kearns and Haden. Once he was twenty-eight hours without food or drink. For days together he had not a rag of dry clothing. Messrs. Kearns and Haden joined Mr. Hasted at Challapalli on the 11th and thence forward, the partly of four, including the Head-quarter Deputy Collector, worked in concert throughout a tract having its centre at Tsallapalle, with a diameter of about 20 miles. The number of people rescued from danger of drowning by the Superintendent of Police was about 350. I am glad to add that long before the arrival of Superintendent of Police or Divisional Officer, and without any instructions from any one, the Tahsildar of Bandar, K. Muktesvara Row, had, from the first appearance of danger, been working most energetically and indefatigably in preventing loss and damage and in succouring the distressed. By his sole exertions he preserved some miles of flood-bank from being overtopped and breached; and he succeeded even in closing several small breaches before the rush of water exceeded control.

10. I was myself at Chinna Ganjám, when late on the night of 2nd August, I got the first news of the expected flood. I started back the next day and reached the right river-embankment about 12 miles above Kollur at daybreak on the 5th. The Executive Engineer, Kistna Western Division, and the Sub-Division Officer were both at Kollur, and just before my arrival there, the Public Works Department Overseer arrived from a visit of inspection to villages lower down. Nothing could possibly be done to existing breaches. The duty at hand was to put people and their belongings in safety, and to take all possible steps to prevent further breaches. I spent the 5th and 6th in seeing that the large Mala and Madiga population of Kollur were rescued from a very perilous position, and in making the flood-bank as safe as practicable for 10 or 12 miles above Kollur. On 7th August, I proceeded to Sitanagaram, crossing to Bezwada the next morning.

11. On the 7th, the Commissioner of Revenue Settlement had accepted an offer from the Revd. Mr. Harrison and Revd. Mr. Peachey of Bezwada, to proceed on a relief expedition in the track of Messrs. Kearns and Haden. Like all others similarly employed, these gentlemen underwent much exposure and privation, and were instrumental in relieving some 330 persons who had no food. The Revd. Messrs. Goodman and Wathen of Masulipatam, also volunteered to carry help to those in the Budameru valley; but before they could reach the spot, all danger was over.

12. On the 6th, the Commissioner had wired to the Assistant Superintendent of Police saying that nothing could be heard of me, that I was probably cut off somewhere in Répalle taluk, and advising him to go to my relief. Mr. Dene did not go. On the 8th, I wired to Mr. Dene to proceed to Kollur and work through the worst parts of Répalle. He did not go, but sent me a letter on 9th asking for further instructions, and stating that he proposed to come to Sitanagaram on 10th to get a house-boat in which to travel. I sent him urgent orders the same day (9th) to start at once by road for Tenali. As it was raining, however, he found it impossible to start till the next day. I am glad to say that this was the only case that came to my notice in which orders issued were not at once obeyed.

13. I was very anxious about the state of the Divi Island from which I could get no information, and had wired to the Port Officer, Masulipatam, on the afternoon of 7th to send boats thither. The same night at 11 o'clock five large dhonies were

despatched to traverse the island in all directions. These boats rescued 117 persons, most of whom were found sitting on their house tops; and gave food to many more who declined to leave their homes. I was still much concerned for the villages along the long line of inundated seaboard, and on 8th, wired to the District Forest Officer in Masulipatam to visit them. He misunderstood the first message; but a second on the morning of 9th set matters right, and at noon on that day, he and the Assistant Conservator, Mr. Fischer, and the Forest Surveyor, Mr. Le Tang, started off in separate boats and separate directions, arranging at the same time to keep touch of one another. It was well they went; they found villages probably in worse plight than any hitherto visited; in one case the whole population had been 5 days without food, one boy having in consequence lost his reason; in another there was not an inch of dry land anywhere, and four poor women had been prematurely confined as they lay in six inches of water.

14. The day after my return to Sitanagaram, *i.e.*, on 8th August, I had despatched the Sub-Collector, still dependant on his crutches, to visit the worst parts of Répalle taluk; having already left the Tahsildar, an energetic and reliable officer, busy in the same good work.

15. The preceding paragraphs give the briefest outline of how the work of rescue and succour was organised, and being carried out. Every tract where danger was believed to exist was visited, and the worse parts not once or twice but constantly. The area on the east of the river was roughly about 600 square miles, and that on the west about 400 square miles in extent; but apart from this the intensity of the distress was much greater in the former. In the Répalle taluk I found, during the height of the floods, that all those who were washed out of their homes had saved ample stores of food; indeed so far as my inquiries went, no grain at all was lost on that side. The Sub-Collector, who continued my inquiries and who visited the worst parts of the taluk, as well as the Tahsildar and other local officers, reported that no relief was needed except materials to re-build fallen houses. In the way of food therefore, no relief was given in the Répalle taluk, except a meal apiece to 279 persons whom Mr. Dene found to be temporarily destitute.

16. In the Bezwáda, Nuzvid and Bandar taluks, matters were very different, The people apparently had not foreseen what was coming; and their stores of grain were in many of the villages entirely destroyed. Those who thus suffered were almost all of the lowest and poorest classes—Malas, Madigas and poor Muhammadans; and it may be mentioned, as further explaining the difference between the two sides of the river, that there is a much larger proportion of poor Panchamas on the east than on the west of the river, at any rate in the Delta. Of those who were flooded out in the Guntúr taluk above the anicut, 711 were fed on different dates, these having been caught by the flood unawares.

17. The breach in the left or east flood-bank above Bezwada occurred on the morning of 6th August. It seemed to possess capabilities for mischief even greater than any of those in the Delta. Fortunately the land falls from the very site of the breach naturally and rapidly in and alongside an old drainage channel to the Budameru river, and the water that poured through the breach followed this course, leaving the adjacent villages unaffected, but submerging and breaching the Nizam's Guaranteed State Railway in its progress to the Budameru channel, which luckily was dry. The water followed the Budameru to the Colair lake, and though it threatened at one time to breach the East Coast Railway, and did actually submerge three or four villages in Gudivada taluk, and breach many of the Government channels, the damage done was comparatively insignificant and certainly much less than was expected.

18. Considering all the circumstances, the loss of human life so far as reported has been extraordinarily small. I have inquired in all directions from private as well as official sources, but I can find no reason to suppose that reports of deaths have been suppressed. Every endeavour was made to systematise the work of rescue, but exact instructions are impossible, and would probably be risky in such abnormal circumstances. To a very large extent officers must be left to rely on their own judgment and initiative; and when it is remembered how many there were that came within measurable distance of not being succoured in time, the 50 persons whom Mr. Lushington relieved from a 5 days' fast; the many hundreds that were brought off

in scores of different villages when the water was on the point of submerging everything; the unfortunates whom Mr. Hasted released from the tops of palmyra trees, their only coign of safety, by means of the Chellapalli elephants; the two men whom Deputy Collector Muhammad Aziz-ud-din Hussain Saheb found long after night-fall up to their necks in water crying for help; when these and the innumerable other narrow escapes are remembered, one can regard it as nothing less than marvellous that the death-roll is so small. In all, seven deaths have been reported, but it is at least uncertain whether two of them were due to the floods. Two children were drowned at Pedda Yadara, Bandar taluk; and two men at Pedaprolu in the same taluk while trying to cross a deep and rapid channel were swept away. One old man was crushed by the fall of a house at Pesarlanka in Répalle taluk. Besides these the body of a man was found stuck in some bushes within 5 miles of Masulipatam town; and another male body very much decomposed was found by the Répalle Tahsildar caught in a babúl tree not far from Kollur. But these two last may be bodies of those who had died from natural causes. Mr. Harrison saw a dead body in a tree, but whether of a human being or an animal he could not say.

19. The death-roll of cattle is not yet made up, nor do I suppose that exact figures will ever be procurable. Detailed reports will, however, be obtained from every village as early as possible. I anticipate that, as in the case of human beings, the numbers will be found surprisingly small. Thus in the 90 square miles of submerged country above the anicut in the Guntúr taluk, from which the statistics are almost complete, it is reported that only 66 beasts have been drowned, and that though these villagers were taken by surprise and cut off by a broad sheet of deep water almost before they knew the flood was approaching. Some animals were seen as they were swept over the anicut. For these there was little hope; but one particularly fine bull struggled ashore, and with difficulty clambering up the steep railway bank, stood to rest himself on top; the next moment an engine rushed along, and the scarce-rescued animal was its victim.

20. Both men and cattle, however, ran a risk of starvation almost as great as that of drowning. As noticed above, all supplies of food-grain had been completely destroyed in scores of villages, and the poorer classes, livers from hand to mouth, unable to obtain employment while the water covered the ground, had only State aid and private charity between them and death. Private charity here and there did much. The Zemindar of Chellapalli fed many hundreds of destitute persons in his estate so long as the floods continued; the late Huzur Sheristadar, M.R.Ry. K. Narayanaswami Naidu, gave food for some days to a large number of refugees from villages near the seaboard; in many of the inundated villages the wealthier classes, whose houses were on a safe elevation above the floods, distributed food to their less fortunate neighbours. But there was no organization of private charity, even the many local branches of the District Association having failed to seize this opportunity for tangible public beneficence. It therefore fell to the State to relieve the great destitution in which so many hundreds were plunged.

21. The distribution of State relief commenced on 2nd August to certain of those who had been brought from the tracts above the anicut, and continued till 28th August. The numbers fed on each day, so far as ascertained, were as follows:—

August, 2nd	142	August, 14th	2,204
" 3rd	86	" 15th	900
" 4th	46	" 16th	850
" 5th	229	" 17th	400
" 6th	444	" 18th	140
" 7th	703	" 19th	137
" 8th	405	" 20th	137
" 9th	782	" 27th	6
" 10th	1,008	" 28th	13
" 11th	1,369		
" 12th	918	Total ...	11,971
" 13th	1,052		

In addition to the above, Mr. Lushington's relief party fed 2,419 persons in the five days, 10th to 14th August inclusive (the details for each day not having been furnished), making a grand total of 14,390 persons relieved from want of food. A word of explanation is necessary as to the 19 persons relieved on 27th and 28th August. The river had begun to rise again on 16th and continued rising till 23rd. On the evening of 23rd August, I got a report from a Forest Range Officer, who had just come from Divi Island, that many of the villagers were again totally submerged, and that the poorer classes were in a dangerous state of destitution. I at once despatched Deputy Collector T. V. Narayanasawmi Iyer, who, however, found that the water had already begun to subside and that only 19 persons required relief.

22. The case of the cattle was even more pitiable, if possible, than that of the human beings. Over an enormous extent of country the grass was submerged for upwards of a fortnight. Straw ricks were either submerged, swept away, or spoilt. Many animals made their way by instinct through great stretches of water, wading and swimming, to knolls and ridges of high ground which they soon stripped bare of all verdure. Some were fed by straw imported by boat across the floods; very many others were driven, so soon as opportunity served, to the Upland taluks; and some were kept alive with thatch, palmyrá leaves and any fodder procurable. All river-side and coast Forest Reserves were thrown open to free grazing, but most of these were of course under water. The total mortality among cattle is not known yet.

23. The loss of public and private property has of course been very heavy. The repairs to irrigation works and to the river conservancy works will cost many lakhs of rupees. I cannot give details of damages which will doubtless be reported by the Superintending Engineer, but a few instances will illustrate the extent of the disasters. The Bezwada-Masulipatam canal for a distance of about eight miles has been riddled. At one point, six furlongs of the left bank in a continuous line have been washed away. Passing by many minor breaches, there were, in these 8 miles, three enormous gaps from side to side of the canal 300 or 400 feet broad, where the scour-holes on either side were 10 to 15 feet below bed-level of the canal. In the Iskapalle channel, which runs roughly parallel to the coast line, for about 10 miles, between Répalle village and the sea, there were 44 breaches. Every bank in the Divi Island of Avanigedda Division has been breached. Every effort is being made to repair the damages to irrigation and navigation works; and it says much for the resourcefulness and energy of the Public Works Department Officers, that I have had hardly a single complaint of deficiency of water. In one way or another, irrigation is being supplied wherever it is wanted.

24. Local Fund works have suffered less than might have been anticipated. There are not many metalled roads in the flooded area. The Iskapalle road, which runs throughout its course, athwart the line of drainage, received the full brunt of the flood, and was under water for a fortnight. The estimate for its repairs is nevertheless less than Rs. 2,000. The Sub-Collector reports that the roads in Répalle Union have ceased to exist, and a solitary lamp-post is the only relic of Union works left. Kollur, Iskapalle, Bhattiprole and Avanigedda Unions also suffered heavily. But I do not hear of any noticeable damage to Government or Local Fund buildings.

25. Of private houses, thousands must have collapsed. In Guntúr taluk alone, which suffered but little, the number of fallen houses is given as 908. Those built of brick and mud, especially of sun-dried bricks, are in far worse plight than the mud huts of the lower classes. The former melted away into absolute ruin, but while the mud walls of the latter collapsed, the timber supports, on which the roof rests, generally stood firm, and it was only where the rush of water was great that the roofs were washed away. Assistance in the shape of building materials is being freely given to those entitled.

26. The loss of crops was very great. The floods were out for so many days that all dry crops within the water-spread perished. The chief of these were maize and cholum. Paddy was in the transplantation stage, much still in the seed beds, and the rest but a few days in the field. In either case it was too young to withstand so long a submersion; and the receding waters exposed an absolutely verdureless tract of brown mud. But it would be premature now to attempt any estimate of the ultimate effect on the crop outturn, or on the public revenue. In many villages as fast as the flood receded, the ryots braced themselves with vigour to the task of transplanting afresh. On the 21st August, I found the ryots in some of the flooded villages of Bandar taluk bringing in paddy seedlings from Gudivada taluk; and the Divisional Officer, writing to me a few days later, reported that seedlings were coming

in cart-loads. There was apparently more despondency in Répalle taluk. They talked of growing dry crops, or leaving the fields waste, and in the season report for the week ending 3rd September, the Tahsildar reports that in the southern parts of the taluk agricultural operations are at a stand still. But I do not take a gloomy view of the situation. The Répalle ryots have as much pluck and energy as their neighbours in the Bandar taluk. The irrigation works are being repaired with the utmost possible despatch; the Sub-Collector and Tahsildar are on the spot encouraging and helping the ryots, and I shall be surprised if the area under wet crop in the taluk turns out eventually to be less than that of last year.

27. In my telegram, dated 21st August, I applied to the Commissioner of Revenue Settlement for an allotment of Rs. 10,000 to meet the cost of relieving distress. One datum of my estimate was an estimated cost of Rs. 12 per bag of rice. But I subsequently ascertained that the bags which the District Superintendent of Police was purchasing were small bags, costing about Rs. 6. The allotment of Rs. 10,000 [which was provisionally sanctioned by the Board in B. P. (R. S.), dated 25th August 1896, Mis. No. 4174], will be far in excess of requirements. The actual cost, as advised up to date, is Rs. 2,640–6–7 as ascertained in my Treasury Office. But there are still bills outstanding for hire of Public Works Department steamer, punts, &c., wages of puntmen and other items. The accounts will be made up as early as possible.

28. An experience such as that the district has just gone through makes us sensitively conscious of our weak points; and these it behoves us to attend to now, lest a worse calamity happen hereafter. The principal defects are, of course, those in the works over which the Public Works Department has control; and the Superintending Engineer will doubtless have much to say on this subject. I shall venture only to trespass into his province so far as the flood-embankments are concerned. It is on the integrity of these embankments that the safety of life and property, public and private, over hundreds of square miles of country depends. The banks should be made absolutely safe against any possibility of a breach. How far removed they are from this standard of safety is attested not only by the many breaches that occurred, but by the scores of weak places and low places, where only constant watchfulness and unremitting labour prevented further breaches. I myself traversed almost the whole extent of the 15 miles or thereabouts between Kollur and Vallabhapuram not once, but three or four times during the 5th, 6th and 7th August. In this stretch there were, I should say (writing from memory) a dozen places where the bank had to be raised or strengthened by forced labour and at forced speed. Places hurriedly made safe on the 5th were found to be unsafe on the 6th. On the 7th morning, I found at Vallabhapuram a long stretch of upwards of a quarter of a mile, where the water was just lapping on to the top of the bank. The Public Works Department Overseer had done all he could the day before, which consisted in a thin crest of mud three or four inches high and a foot thick protected from wave action by palmyra leaves. Fortunately the river had begun to fall; had the rise continued, or had the wind shifted to the east, I think there must have been a breach at that point—a breach which would have inundated the whole of Répalle taluk, and would have caused lakhs of rupees of damage—and yet there were long distances between Vallabhapuram and Kollur, where the top of the bank was six or eight feet above maximum flood-level.

29. To allow such a state of things to continue is both unreasonable and criminal. It invites disaster. Government has undertaken to protect the lives and property of the people, but so long as the flood-banks remain in their present condition, the duty is left undone. I need hardly refer to the serious loss of revenue, let alone the immense damage to Government property that must ensue on any considerable breach in the embankment.

30. Nor is it enough to say that the Public Works Department Officers ought to see that the banks are properly kept up. They have neither the time nor the money. The inadequacy of the establishments and the insufficiency of the allotments to this Delta have constantly been brought to notice. I believe that the Superintending Engineer contemplates applying for a permanent increase in the superior staff; and in this he has my fullest support. Government must now face a very large expenditure to make the flood-embankments alone safe; and money cannot be economically laid out without an adequate Executive staff. During the last four years I have had very full opportunities of judging of the amount of work that the Public Works Department Officers have to get through; and my opinion, whatever it may be worth, is that two Executive Engineers are insufficient for the vast amount of work there is to be done in the Delta.

31. Returning more particularly to the flood-embankments, I would submit that they should forthwith be made up to an adequate height and section, whatever that may be decided to be; and that hereafter they be kept at that standard throughout their whole length. There is some question whether a flood-embankment should be constructed on the right bank above the anicut. At present this bank is unprotected, and, in consequence, 90 square miles of country were flooded. Opinions differ as to the necessity or expediency of now constructing an embankment. Certainly the absence of an embankment is not such a great danger as below the anicut. The area over which the flood can spread is limited, and there are no important public works to be protected. The water in floods rises gradually and the people can generally get off safely with their property, though not when, as in this year, they are surprised by an abnormal fresh. If there are no strong engineering reasons against such a course, I would recommend the construction of an embankment at this point, on the simple ground that Government should protect the lives and property of its subjects.

32. Another defect thrust very forcibly on every one's notice during the floods was the inadequacy of the present means of communicating with out-stations. At Kollur, I was only 26 miles from the anicut; yet, it took 48 hours to get a reply to any of my most urgent communications. Places lower down on the same side were almost entirely cut off. The only means of forwarding letters was by peon or lock-tappal. It was impossible to give timely warning of any anticipated disaster, or to learn what had happened elsewhere. I consider that it is a matter of prime importance that the principal lines of canal should be provided with telegraphic connection with Bezwada and Sitanagaram. If open to the use of the public, such lines would not improbably be pecuniarily profitable as they would tap many important villages.

33. The next defect is a small one and can easily be remedied. I allude to the insufficiency of the ferry-boats (ballakats) at present provided on the canals. An experience of my own will again illustrate the difficulty. I had received intelligence of a weak place in the embankment some miles above my camp on the West Bank Canal, and I hurried to the spot. The embankment formed a narrow strip of dry land between the river on one side and the canal, there about 8 feet deep, on the other. The karnam who was with me told me he had already sent for coolies; and on reaching the spot, I found three men sitting down on the flood-embankment helplessly. They had no tools and could only watch the rapidly-increasing leak through the embankment. On the other side of the canal were half a dozen men sitting down as helpless. They had tools, but there was no ferry-boat and they could not swim. The nearest ferry was 3 miles down stream. To have sent the coolies round would have meant at least 2 hours delay; and more probably the decamping of the coolies. I got them over, no matter how; but it was a critical situation. This is only one instance; there were many others, to show how inadequate are the means of crossing the canals.

34. One other matter, that I can probably myself remedy, is the imperative necessity for moving all villages from the outer or river-side of the embankment to the inner or landward side. There are several villages that have of necessity been thus left outside the pale of protection. Most of them try feebly to protect themselves by petty ring-bunds. The latter inevitably breach in any fresh of unusual height, and instantly the villagers breach the flood-embankment at the back of their village, hoping thereby to divert the whole volume of the Kistna through the breach. It was admitted to the Sub-Collector that the breaches in the embankment of Pedapulivarru were caused in this way; and he has formed the conclusion after enquiry that, with the exception of the Kollur breaches, all those in the west flood-embankment, 12 in number, were so caused. At Chilumudi, 6 miles above Kollur, the Tahsildar of Répalle, who fortunately happened to be on the spot, was able to prevent the villagers from a like act of madness. I am taking steps to have all these villages moved to the inner side of the embankment.

35. It would be impossible to mention the names of all those who deserve commendation for their self-sacrificing devotion to duty during this trying time. With scarcely an exception, all Government Officers were lavish in their self-expenditure, and always cheerful however uncomfortable and however exhausted. Messrs. Hasted, Kearns, Haden and the Tahsildar of Bandar taluk, M.R.Ry. K. Maktesvara Row may be specially mentioned for the prolonged and extreme discomfort and at times danger that they underwent. The last-named officer, I have been able in some measure to reward already by promotion in rank. Mr. Gillman, not yet recovered from a broken leg, was always on the move wherever he was wanted. The Tahsildar of Répalle taluk, M.R.Ry. G. Lakshmikanta Row, though in enfeebled health, exposed himself freely in all weathers and at all hours. It is largely due to him that what would have proved a most disastrous breach was prevented about six miles above Kollur on the west flood-blank. During the two and-a-half days I remained in the neighbourhood of Kollur, I received most energetic aid from my own Vernacular Head Clerk D. V. Subba Row and from a Sub-Inspector in the Salt and Abkári Department named Ahmadulla Khan. I desire especially to bring the latter to the notice of the Commissioner. He rendered invaluable assistance in rescuing the Malas and Madigas of Kollur, besides helping to watch and strengthen many miles of embankment. Doubtless there were many others whose work did not come under my immediate observation, but who equally deserve mention.

36. Of private individuals I have already mentioned four English clergymen, the Zemindar of Challapalli and my late Huzur Sheristadar, who were ready to aid in the good work. Mr. Hasted tells me that the Muhammadan Jemadar of the Zemindar of Challapalli was of great service. Much unostentatious charity and self-sacrifice among the villagers must go unrecorded. It is worthy of note that more than one officer found, when supplies of food were running short, that the men voluntarily and gladly gave up their portions to the women. At Kollur the men had no thought for their own safety, till the women and children had been taken off. At Ibrampatnam a wealthy boat-owner, Mallela Venkatasubbayya, was prompt to send off his boats to rescue his neighbours in danger though his own property was threatened. Gorraparti Subbayya, a wealthy ryot of Pesarlanka, an island in mid stream, sheltered and fed all the poorer people on the island for four days. It is in such great calamities as this probably that the innate kindliness of the native character shows at its best.

37. It is not my business to offer any remarks on the conduct of the officers of the Public Works Department, but I cannot refrain from mentioning again the vigilance and devotion of the Superintending Engineer and the Executive Engineer, Kistna Northern Division. Without hazarding a definite opinion on what is a matter of scientific uncertainty, I may at least say that it seems probable that but for the exertions and the watchfulness of these two officers, the head-works at one or both sides of the river would have succumbed to the strain thrown upon them.

Enclosure.

Extract from the Water Register Book of Bezwada Station from 27th July 1896.

Date.	Height of water above the anicut in feet at			Date.	Height of water above the anicut in feet at		
	6 A.M.	12 A.M.	6 P.M.		6 A.M.	12 A.M.	6 P.M.
	FEET.	FEET.	FEET.		FEET.	FEET.	FEET.
27th July 1896	29·15	29·65	30·25	14th August 1896	33 10	33·30	33·50
28th „	31·15	31·50	31·90	15th „	33·85	33·95	34·05
29th „	32·65	33·25	33·85	16th „	33·95	33·95	34·10
30th „	35·05	35·65	36·05	17th „	34·65	34·85	35·00
31st „	36·85	37·15	37·40	18th „	35·30	35·45	35·30
1st August 1896	38·25	38·65	39·05	19th „	35·20	35 25	35·35
2nd „	39 55	39·75	39·75	20th „	35·85	36·25	36·55
3rd „	39 85	39·95	39·95	21st „	37·00	37·15	37·25
4th „	40·05	40·20	40·40	22nd „	37·25	37·25	37·10
5th „	40·70	40·80	40·85	23rd „	36·55	36·15	35·65
6th „	41·20	41·25	41·30	24th „	34·45	33·95	33·45
7th „	41·30	41·16	40·95	25th „	32·45	32·15	31·75
8th „	40·55	40·35	40·05	26th „	31·25	31·00	30·65
9th „	39·25	38 65	38·00	27th „	30·00	29·75	29·45
10th „	37·05	36 65	36·30	28th „	29·10	28·95	28·75
11th „	35·65	35·25	34·85	29th „	28·50	28·25	28·20
12th „	34·15	33·85	33·50	30th „	27·95	27·85	27·80
13th „	33·15	32·95	32·85				

Resolution—dated 5th October 1896, No. 259.

The report read above on the recent floods in the Kistna will be submitted to Government.

2. The river began to rise on the 27th July and continued steadily to do so until the evening of the 6th August when it reached its highest level of 41·30 over, the crest of the anicut. The river stood at or about this height for two whole days and then gradually fell to 32·85 on the 13th August; it rose again slightly till the 21st August on which date 37·25 feet were registered. Subsequently, however, it began to fall, and on the 30th of the month it was only 27·80 above the crest of the anicut.

3. The Collector's report shows that no less than fourteen breaches occurred in the river flood-bank in the Western and nine in the Eastern Delta. In the Northern Division there was only one breach. The largest breaches were at Kollur on the western and Pulipoka on the eastern side. The large volume of water escaping through the breaches spread itself over an area of about 1,000 square miles—400 square miles on the west and 600 square miles on the east of the river. Besides this a tract, about 90 square miles in extent, was flooded on the right bank of the river above the anicut, and another, less in extent, on the left bank, caused by the breach in the flood-bank at Ibrampatnam. The canals have breached in a large number of places. The head-works were at one time in serious danger but were saved by the exertions of the Superintending Engineer and the Executive Engineer of the Northern Division.

4. None of the officers of the Public Works or the Revenue Departments were on the spot during the earlier stages of the floods, except the newly-appointed Head Assistant Collector, Mr. Cumming; but, on information reaching them, all hastened to the spot. Just before the flood reached its highest level, the Acting Commissioner of Revenue Settlement arrived at Bezwada, and, in the absence of the Collector, organized the first arrangements for relief and rescue of the people in the inundated tract (paragraphs 6 to 12 of the Collector's report).

5. The Acting Commissioner is glad to bear testimony to the extreme promptness and self-sacrifice with which, with one exception, the officers of the various departments for whose services he had occasion to apply, acquitted themselves. It is chiefly due to their exertions that several hundreds of human beings were saved from death by drowning or starvation. Before Mr. Gillman could reach the spot from Guntúr, Mr. Keeling, Executive Engineer, did valuable services in rescuing persons from the inundated tract on the right bank of the river above Sitanagaram. Mr. A. R. Cumming, C.S., worked with him. Although crippled by a recently broken leg, Mr. Gillman was on the spot as soon as possible from Guntúr, and worked night and day for several days, until all were rescued. The Acting Commissioner could not issue orders to officers of the Salt and Abkári Department; but, at the first hint from him of what he thought the Head of that Department would approve, Messrs. Kearns and Haden set off at once for the scene of distress. The Collector has, if anything, understated the zeal and energy displayed by these two officers. Mr. Hasted, the Superintendent of Police, also acted at once on the Acting Commissioner's advice, and organized and administered relief energetically in the tract to which his attention was directed. Mr. Cumming, the Acting Head Assistant, as might be expected, was active in his own division. Mr. Atkinson, coming up rapidly from Chinna Ganjám, threw himself by instinct on the exact area where he was most wanted, and to his exertions is chiefly due that the right bank of the river below Sitanagaram was saved for a length of many miles. Every available officer had already been assigned a task, and there was no one who could be spared to go to the area in which Mr. Atkinson worked. The Superintending Engineer has probably brought to notice the valuable services rendered by the officers of his own Department. He has no doubt said nothing about himself, and the Acting Commissioner begs leave to state that, in all probability, to Major Baddeley's prompt resourcefulness is due the safety of the head-works, and consequently of the whole Delta.

6. Only seven cases of death have been reported, and the Collector considers that two of them may be due to natural causes. Though the number is extraordinarily small, the Collector sees no reason to suppose that reports of deaths have been

suppressed. Several persons, as already stated, were saved by the officers above-named when within a hair's breadth of being drowned. As generally happens in such cases it was the poorer classes of villagers—Panchamas, Madigas and Muhammadan paupers—who suffered most from the calamity, and many of these would doubtless have perished from starvation were it not for the prompt and timely relief given to them in the shape of food not only by the officers of Government, but by several private individuals. Among the latter were the Zemindar of Challapalli, the retired Huzur Sheristadar M.R.Ry. K. Narayanasami Naidu Garu and Gorraparti Subbayya, a ryot of Pesarlanka. The Board has no doubt but that, prompted by what the Collector calls the "innate kindliness of the native character," many more of the well-to-do villagers in the affected tracts also contributed to the relief of their distressed neighbours. The Collector also mentions the name of Mallela Venkatasubbayya, a wealthy boat-owner of Ibrampatnam, who promptly sent off his boats to rescue his neighbours in danger, though his own property was threatened. Two English clergymen (the Rev. Messrs. Harrison and Peachey) carried help to the sufferers in the low-lying country between Kankipad and Tsallapalle, and were instrumental in relieving some 330 persons who had no food. Two other clergymen (the Rev. Messrs. Goodman and Wathen) also volunteered to carry help to those in the Budameru valley; but, before they could reach the spot, all danger was over.

7. The total mortality among cattle is not yet known; but the Collector thinks that it cannot be large, as only 66 cattle are reported to have died over an area of 90 square miles, for which reliable information has been received.

Thousands of houses, especially of the poor, must have fallen down, and the Collector has arranged for the free grant of building materials to those deserving of this form of help. In the Guntúr taluk alone, so many as 908 houses are reported to have been destroyed, though that taluk suffered least from the floods.

8. The loss of crop caused by the floods is reported to be very great. The dry crops which were on the ground at the time, chiefly maize and cholum, have all been destroyed owing to their continuous submersion; but the Collector states nothing as to the necessity for granting any dry remissions in the affected tracts. The ryots had still ten months of the fasli to work in and have no doubt, already set to work. The Acting Commissioner himself noticed large tracts, which had been submerged, covered by waving maize in his recent tour. It must be remembered that a catastrophe like the present one is largely counterbalanced by the rich deposit of silt which the floods leave behind them, from which luxuriant crops may be expected in coming years. As regards wet cultivation, the transplanting began only a short time before the floods; but the crops thus planted, as well as the seedlings in the seed-beds, have all been washed away. The Collector, however, is strongly of opinion that the whole of the wet area will soon be under crop. In the Bandar taluk the ryots have already set to work in this direction, and it is anticipated that the Répalle ryots have also set to work by this time, though they were in a desponding mood at first. There may be some difficulty in procuring the necessary quantity of seedlings; but these are being imported by the Bandar ryots from the Gudiváda taluk; and if, as the Deputy Collector reports, seedlings are coming into Bandar in cart-loads from Gudiváda, the Répalle ryots may also arrange to obtain the seedlings they require from that taluk.

As observed by the Collector, however, it is too early to attempt to form an estimate of the ultimate effect of the floods on the extent and the outturn of crops, and the probable amount of remissions that may have to be granted. A detailed report should, however, be submitted on the subject as soon as practicable.

9. From paragraph 27 of the Collector's report, the Board is glad to observe that the amount of Rs. 10,000 provisionally sanctioned for the relief of distress in Board's Proceedings, dated 25th August 1896, Mis. No. 4174, will be found to be in excess of requirements. It is stated that only Rs. 2,640–6–7 have been spent up to date, but that there are still some outstanding bills to be paid. The amount of these bills will not apparently be large.

10. In paragraphs 28 to 34, the Collector makes certain proposals based on the experience of the floods. These proposals are briefly—

(1) that a third Executive Engineer should be appointed for the Delta;

(2) that the flood-embankments of the river should be forthwith made up to an adequate height and section, whatever that may be decided to be, and that provision should be made for that standard being kept up throughout their whole length;

(3) that a flood-embankment should be constructed on the right bank above the anicut;

(4) that telegraphic connection should be established between Bezwada and the principal lines of canal;

The districts of Kistna and Gódávari are both exceedingly backward in telegraphic communications.

(5) that the number of ferry-boats on the canal should be increased; and

(6) that all villages on the outer or river-side of the embankment should be moved to the inner or landward side of the canal. The Collector states that he will himself see to the last proposal being carried out. The other proposals will be communicated to the Chief Engineer for Irrigation for such consideration as he may deem fit to bestow thereon.

11. The attention of Government will be invited to paragraph 35 of the Collector's report in which he mentions the names of officers not specially referred to above, who have rendered commendable service during this trying time and an extract of that paragraph will be communicated to the Commissioner of Salt, Abkári and Separate Revenue.

12. The Collector says nothing about the lengthening of the railway bridge at Bezwada, and the Acting Commissioner has heard with regret that the verdict of Mr. Upcott was unfavourable to Major Baddeley's recommendations on the subject. The matter is one, in the opinion of the Board, to be considered chiefly from the standpoint of an Irrigation Engineer. Mr. Upcott was not present when the flood was at its height, and no one who had not seen it could form any idea of the damages caused by the present railway bridge and its embankment. After a river passes an anicut, or even a culvert, it should be able to expand like a fan. The railway bridge is actually narrower than the anicut, and, to save two or three spans, the Railway Engineer has built an embankment, which causes the river to cannon across from the left to the right bank, and back again, the result of which is that the banks below are imperilled throughout their whole length. Even if the irrigation system should have to be debited with the cost, the Board is of opinion that Major Baddeley's suggestions should be adopted. Were it not for the parapet walls built by Colonel Hasted after the floods of 1882, the head-works would have been carried away on the present occasion, and the present flood is by no means the maximum possible. Had it not been that the south-west monsoon has been a general failure in the East Coast districts, the recent flood would have topped and carried away the head sluices. This may happen in any year.

(True Copy and Extract.)

(Signed) R. V. SRINIVASIAR,
Secretary.

Order—Mis. No. 4395, Revenue, dated 7th November 1896.

The foregoing report shows the damage caused by the recent floods in the Kistna district and the measures taken by the local officers to repair the damage and rescue the people in the flooded country. The Government notes with appreciation the valuable aid rendered by all the officers and by the private gentlemen referred to in the Collector's letter read above.

2. To prevent the recurrence of the difficulties experienced on the present occasion, the Collector makes several recommendations, of which a summary is given in paragraph 10 of the Board's Proceedings. The Collector proposes himself to carry out the last proposal, viz., to move the villages on the river side of the embankment to the inner side. The other proposals have been communicated by the Board of Revenue to the Chief Engineer for Irrigation. The Public Works Department will be requested to communicate in due course the orders that may be passed thereon.

3. Orders will be passed in the Public Works Department on the question of lengthening the railway bridge at Bezwada, referred to in paragraph 12 of the Board's Proceedings.

4. Paragraph 12 of the Collector's letter will be communicated to the Judicial Department for necessary action.

(True Extract.)

(Signed) LIONEL DAVIDSON,
Ag. Under Secretary to Government.

ORDER—No. 3378 W., dated 24th November 1896.

Communicated to officers concerned.

2. The necessary action will be taken in the Irrigation and Railway Branches on paragraphs 2 and 3 of the Revenue Department order.

(True Extract.)

(Signed) D. McNEIL CAMPBELL, Colonel, R.E.,
Secretary to Government.

To the Superintending Engineer, II Circle.
" Irrigation Branch.
" Railway "

Exd. T. K. Narayana Aiyangar.

R. Form No. 14.

SERIAL
No. 41

18/

No. 1000 R

Gobernment of Madras.

PUBLIC WORKS DEPARTMENT,
RAILWAY BRANCH.

To
The Secy. to the Govt. of India
P. W. Deptt
Calcutta

His Excellency the Governor

Madras, 25th Novr 1896.

Sir,

In continuation of my letter No. 970R of 14th November 1896, I am directed to forward herewith copy of a communication from the Chief Engineer for Madras Irrigation No. 425 M of 28 Septr 1896 on the question of protective works near the Kistna bridge.

CMM 17/11

A.S.H. 20.11.96

seen 21/11 531

17/11

Documents accompanying:-
~~Copy of Communication from the Chief Engr. for Irrign. Works~~
~~Enclosures~~ (G.O. 789.I 29/9/96)

Despatched on 25.11.96

B/

B/

No. 1000 R dated 25.11.96

Public Works (1896) Department.

CURRENT No. 11463

Order

H.E. the Governor

A.94
20.12.96

Copies may be sent to Irrigation Dept. Govt. of India : Mr. Opert Mr. Walch

17/12

From

Francis J. E. Spring Esqre.
Cons: Engr. to the Govt. of
India for Rys.,
Assam

No. 2303

Dated 10th December 1896

Received

Enclosures

Spare copies

SUBJECT.

The Kistna Anicut and Bridge and the floods of 1896.

Forwarding a copy of his note upon the subject of ——

BACK PAPERS.

G.O.	No.	Department.	Date.

FURTHER PAPERS.

G.O.	No.	Department.	Date.

SERIAL
No. 43

No. 2303.

80

FROM Francis J.E.Spring, Esq.M.Inst.C.E., M.Am.Soc.C.E., M.Inst.Mech.E.
~~THE~~ CONSULTING ENGINEER TO THE GOVT. OF INDIA
FOR RAILWAYS, ASSAM.

To

The Offg: Joint Secretary, Railways.
Government of Madras, P.W.Department.
MADRAS.

Shillong, the 10th December 1896.

Sir,

With reference to your endorsement No. 4236.C. dated the 18th November 1896, I have the honor to enclose, for the information of the Government of Madras, a Note, by me, upon the subject dealt with in the enclosures of yours under reply.

Flag M

I have the honor to be,
Sir,
Your most obedient servant.

Francis J.E. Spring
Consulting Engineer to the Govt. of India
for Railways, Assam.

Accompaniments:-
25 Copies of Note referred to.

By packet post.

10/12

G. No. 5372
Recd. 17/12/96

R. Form No. 12.

18/

No. 1055 R

Government of Madras.

PUBLIC WORKS DEPARTMENT,
RAILWAY BRANCH.

SERIAL
No. 44

To

The Secy. to the Govt. of India,
P. W. Department.
Calcutta

Madras, the 17th December 1896.

Sir,

In continuation of my letter No: 1000 R d/ 25th Novr: 1896, I am directed to forward herewith ~~a copy~~ for information ~~favour of necessary action~~ a copy of the Progs. of this Govt. No: $\overset{540}{3378}$ W, of 24 Novr: 1896, regarding the recent floods in the Kistna River.-

printer's order

15/12

Despatched on 17.12.96

Documents accompanying:-
Copy of G.O. No: 3378 W
24-11-96

17/12

18f

No. 1055. R dated 17.12.96

SERIAL
No. 46

No. 401.

Papers relating to the Kistna Railway Bridge forwarded for my opinion with the Consulting Engineers No 4236 C d/16 Nov. 1896

Hag M

I have inspected the Bridge with the Inspector General of Irrigation - As he intends to report on the subject it is inexpedient that I should express my opinion.

I need only mention that all papers on the subject and other information available were communicated to the Inspector General.

W. Hughes
I

26.12.96

Desp
26/12

P.W.C. 11463

SERIAL No. 47

No. 5057 C. d/26 Dec. 1896.

The following is forwarded for information to

1. The Chief Engr for Irrigation - Madras.

2. G. T. Walch Esq
Ootacamund

3. F. R. Upcott Esq
P. W. D. Secretariat
Calcutta.

Document end

d 5.12.96

Copy of a note by F. J. E. Spring Esq on the Kistna anicut and Bridge and the floods of 1896.

Desptd 26/12

JHF 23/12

R

FDR 21/12

2 drafts

R. Form No. 12.

No. 1076 R

18/-

SERIAL
No. 48

Government of Madras.

PUBLIC WORKS DEPARTMENT,

RAILWAY BRANCH.

write fair copies

To

The Secy. to the Govt. of India,

P. W. Department.

Calcutta

Madras, the 26th Decr 1896.

Sir,

In continuation of my letter No. 1055 R dated 17th December 1896, I am directed to forward herewith for information a note by Mr. F. J. E. Spring on the Kistna Anicut and Bridge and the recent floods.

2. Copy of this note ~~has been sent to the Chief Engineer for Irrigation Madras~~ and Messrs. F.R. Upcott and G. T. Walch.

Documents accompanying:-
Printed note referred to with 4. spare copies

F.B. 23/12

J.D. 22/12

B/c

No. 1076. R dated 26.12.96

THE KISTNA ANICUT AND BRIDGE AND THE FLOODS OF 1896.

Note by Mr. Francis J. E. Spring, M. Inst. C.E., M. Am. Soc. C.E., M. Inst. Mech. E., *Consulting Engr. to the Govt. of India for Railways, Assam.*

With his endorsement No. 4236 C., dated the 18th November 1896, I have been furnished by the Joint Secretary to the Government of Madras, Public Works Department, Railways, with a copy of Mr. Upcott's report on the subject of the Kistna Anicut and Bridge at Bezwada and the recent floods. I have also received under cover of the same endorsement a copy of an extract, paragraphs 8 to 12, of a letter No. 1244 K., dated the 13th August 1896, from Major W. L. C. Baddeley, R.E., Superintending Engineer, Second Circle, Bezwada, to the Chief Engineer, Madras. In this letter Major Baddeley paints a very alarming picture of probable future injury to the Anicut and its under sluices, and he attributes the probability of such injury to the position, and in his opinion the insufficiency of length, of the Kistna bridge which was designed and built by me.

2. Major Baddeley begs the question when he asserts that it is the bridge that is responsible, or likely hereafter to be responsible, for damage to the Anicut. He advances no arguments whatever of a scientific engineering character in support of his contention, and apparently expects his mere assertion and expression of opinion to be received and acted upon to the tune of some seven and a half lakhs of rupees, which would be the cost of the three extra bridge spans for whose immediate construction he presses. If I am rightly informed 7½ lakhs of rupees was the original cost of building the entire Anicut some 40 years ago. In referring to this figure I do not for a moment wish to be understood as mentally confusing the cost of the capital outlay on the Kistna Delta irrigation system and the value of the crop which would be lost were the system by any catastrophy to fail even for one season. I quite recognise that the Anicut and headworks must not be permitted under any circumstances to fail; but I contend that Major Baddeley has entirely missed the mark in diagonosing the probable cause of failure, and that failure can be prevented without any interference whatever with the bridge, and at an expenditure very much less than the 7½ lakhs proposed by him.

3. Major Baddeley writes of the river having been contracted by the bridge. What does he mean by this phrase? Does he mean that the breadth has been contracted or that the area has been contracted. If he means simply that the breadth has been contracted he is dealing with a factor which is no true factor of the matter at issue. The true factor is the area and not the breadth. Had the bed of the river been rocky right across, contraction of breadth would have meant contraction of area also; but, the bed being erodible sand, contraction of breadth by no means necessitates contraction of area, as during the first flood or two after contraction the cross sectional area which is available for discharge purposes becomes equal to what the contracted area had previously been. I can give a fact which illustrates this. The entire area which before contraction was available at the site of the Kistna bridge between high water level and river bed was 136,000 square feet. I blocked up 18,000 square feet of this cross sectional area, leaving 118,000 square feet to carry the flood discharge which had heretofore passed through 136,000 square feet. In other words I blocked up

nearly one-sixth of the available flood area. Now if the bed of the river had been rock the result would have been a slight heading up of the surface level at the bridge site, and as a consequence a slight local extra velocity at bridge site. But as the bed is not rock, but sand and erodible, and as indeed each grain of sand is just ready to move with each instantaneous acceleration of velocity, what I expected would happen, and what as a fact eventually did happen, was that the bed of the narrowed channel slightly deepened all over as soon as the first moderate flood occurred after contraction, the deepening being equivalent to an extra 7,600 square feet of area of discharge channel, or to an extra depth right across the bridge of over two feet. An extra depth of three feet right across would have provided an area at the bridge site equal to the unimpeded discharge of the highest known flood and the two feet that I refer to was provided by a flood which was 5·25 feet lower than the maximum flood then known, that of 1882.

4. But I may point out that, even had the bed been of rock and unerodible, instead of erodible sand, and had the narrowing actually caused a backing up or afflux, the effect of such backing up would have been actually beneficial instead of injurious to the Anicut as slightly diminishing the height of the waterfall.

5. It apparently is Major Baddeley's contention that the risk to the Anicut arises from the scouring action of a certain swirl or whirlpool which he found near the Bezwada side. He is perhaps not aware that this swirl was in existence before the river was ever contracted at all. I am positive about this because scarcely a day passed, during the whole of the flood season that I spent at Sitanagram before the training works at the Bezwada side were thrown up, without my navigating this swirl when steering my boat. I am thoroughly familiar with its existence. It has nothing whatever to do with the bridge training works. It is entirely due, now as always, and as diagnosed by Mr. Upcott, to the meeting of the very rapid current which rushes out beneath the side sluices, and the comparatively less violent current over the top of the north flank of the anicut.

6. This swirl has for many years given trouble at the rear of the Anicut near the Bezwada end just below the side sluices. Its effect has been to dig out a hole which year by year has been more or less doctored by a course of loose stone thrown into it. I have a tracing of the Irrigation Department's records of a certain year when this hole was 66 feet deep below high water level. A similar hole near the Sitanagram end was 98 feet deep below high water level. There were similar holes in the rear of the Godavari Anicut, and these also have had to be filled up from year to year.

7. I may explain here how it is that swirls cause holes. A swirl may be described as a dredging machine. As soon as its velocity at bottom becomes sufficient to permit of its lifting the particular grade of sand to be found in the bed of the river, the water of the swirl lifts the sand, and the latter is by centrifugal force constantly thrown outwards to the circumference of the swirl, thence to be carried away by the outside or passing current. As there is no source from which new sand can come in to take the place of that which is thus carried away, the hole gets deeper and deeper until such time as the river falls and the scouring machine shuts up work; or until the depth of the hole becomes so great that the bottom velocity is reduced below that requisite to lift the sand; or until a layer of harder material is reached.

8. Now of all ways of stopping the mischief the most expensive is to entirely fill up the hole with stone. No velocity of less than 18 or 20 feet per second will move a rough angular stone of about the size of a man's head by direct impact. The only way for such a current to move such a stone is to scour away the sand from beneath it and let it roll down the slope. If it is more or less spherical and rests on a smooth bottom it will doubtless roll, but I am referring to rough angular stones. Therefore if the sand can only be kept from the direct scouring action of the water such stones will not roll. The American Engineers protect their sand or silty clay with matresses of brushwood, poles, bolts, and ropes, and lay their stone on top. In India we Engineers, who have had to deal with similar problems to those so successfully dealt with by the Engineers of the Mississippi, simply cover our sand with a fair thickness of rough stone, just so thick that the water cannot attack the underlying sand through its interstices. Whenever practicable I have always endeavoured to first cover the sand surface with three or four inches of quite small quarry or brickfield refuse, and then over this to lay graduated layers of stone, the smaller sizes downwards and the larger on top. Then the movement of the water between the interestices of the upper and larger stones fails to move the lower and smaller stones and ultimately fails to move the subjacent sand. I consider that a layer of protective stone two feet thick graduated in this way, from stuff the size of figs to stuff the size of a man's head, is quite as effectual a covering over sand, to prevent scour, as would be four or five feet of stone all the size of a man's head or larger.

9. If then I had to treat holes in the rear of an Anicut I would cheaply fill them up flush to near the top at first with sand, and would then deliberately and carefully cover the whole area with two or three inches of quite small refuse, and on top of this five or six inches of larger stuff, and would finish off with 60 lbs. to 100 lbs. rough angular stone up to a total thickness above the sand of say two feet for ordinary cases, or of three feet for velocities of 12 or 14 feet per second, or four or five feet for such velocities as are to be found in the rear of an Anicut or at the bases of swirls.

10. Mr. Upcott calls attention to the alterations which have recently been carried out in the Anicut. I have no hesitation in saying, and I hope that all Irrigation Engineers who scientifically and deliberately apply themselves to the problem would agree with me in thinking, that these alterations must necessarily have an incomparably greater effect upon the scouring of pot holes below the anicut apron than anything can have that has been done in connection with the bridge. For some 38 or 40 years the level of the anicut crest has been 46·25 feet above mean sea level, and the length of its slope from 250 to I think 300 feet, the greater length of slope corresponding to lower depressions in the original or later cross section of the river. For the first 100 ft. of this breadth of tail slope the drop is I think 6 feet. The remaining drop works itself out in the remaining 150 to 200 feet of rough loose stone. This 150 or 200 ft. in breadth of rough loose stone has in the course of years been gradually pushed forward at its lower edges by annual accession of stone thrown in, with due appreciation, as I take it, of the effects, in the shape of pot holes, of the anicut wave upon the sandy bed in the extreme rear of the stone slope during the previous flood season. Thus, if I may be allowed to use such an expression, the anicut slope has in the course of all these years gradually found its own regime, and the conditions at its junction with the sand at its extreme rear edge had until recently become comparatively stable.

11. But all at once, since my time so I am not certain of my figures and can only quote Mr. Upcott, the Irrigation Engineers determined to raise the crest of the anicut 3 feet. Of this 3 feet, if I recollect right, one foot was built when I was at Sitanagram, and apparently another 2 feet has since been added. I have heard nothing of a corresponding lengthening of the stone tail slope, but my own opinion, as an Engineer who has for many years studied this subject with great care, is that an addition, all along from flank to flank of the Anicut, of fully 50 feet to the breadth of the tail of the stone rear slope, would certainly be necessary for an extra raising of the crest by 3 feet.

12. I am at some disadvantage in not being quite certain of the figure which is the basis or datum of the Irrigation Department's Anicut gauge. I am however under the impression that it is 20 feet below Anicut crest. Anicut crest referred to Mean Sea Level is 46·25, therefore an anicut gauge reading of 41·30, which was I learn, the highest reading of the flood of 1896, on August 6th, corresponds with 67·55 above Mean Sea Level. The same reading during the flood of 1882 was 66·53 at a point 400 feet above the Anicut. It looks therefore as if, in a general way, the flood level of 1896 was about a foot higher than that of the highest previously known, *viz.*, that of 1882. This would appear to show that there is nothing exceptionally formidable in the flood of 1896 as compared with that of 1882, not much more indeed than can be accounted for by the addition of three feet to Anicut crest; and that, if on the subsidence of the floods it is found on measurement that the pot holes below the Anicut are larger and deeper than usual, some special cause for this result must be searched for. It seems to me that for such a cause we need not go further than the fact of the crest having been raised three feet, for it stands to reason that there must be very much greater erosive action at the tail of a rapid with a mean slope of 17 feet vertical in 250 horizontal than at the tail of a rapid with a mean slope of 14 feet vertical to 250 horizontal. The scouring action of the swirl under the extra foot of head through the sluices would also naturally be greater than had before been experienced.

13. I have already said that my chief reason for declining to believe that it is the shape or plan of the bridge training works which has caused the swirl complained of near the down stream side of the side sluices is that this swirl existed, to my personal knowledge, before the training works were begun. Entering this swirl with my boat, I used mentally to compare it with swirls with which I had previously been very familiar on the Chenab river. It was nothing like so formidable a swirl as some of these latter; though, owing to the surface roughness of the water caused by the rapid or topple over, it seemed superficially very much more formidable. I had at the time a vivid and recent memory of a swirl in the Chenab in which the eyes of a sitter in a boat in the centre were scarcely above the surface of the level surrounding water, and of its taking four strong men all they knew to row out of it. The hole which this swirl had dug, 80 or 90 feet deep in a few hours, I was able to prevent scouring any deeper with a few boat loads of brickfield refuse, and this sufficed to hold it until I had had time to remove the projecting piece of hard land, or natural spur, that was causing the mischief. Having this in mind, and proposing to design the apron of my training works in the neighbourhood of the comparatively mild though superficially rougher swirl on the Kistna, I naturally was inclined to make somewhat of a study of the latter, so my memory cannot deceive me about its existence.

14. A swirl or whirlpool is the result of a current sweeping straight past a lump of dead water, or a comparatively slowly moving body of water, just as a peg top is caused to revolve by the acceleration due to the successive lashes of a boy's whip. Such a piece of dead water is created whenever a spur is projected out into a current. Should the spur on plan be more or less at right angles to the current there will be two such blocks of dead water, both of which will become swirls. When on the other hand the spur is at a comparatively acute angle to the direction of the current, tailing down-streamwards as usually constructed, there will be only one such lump of dead water, *viz.*, that at the downstream side. This dead water will gradually acquire a velocity which may easily become sufficient to lift the material of the bed, and fling it out centrifugalwise to be carried away by the stream current. The result of the old fashioned system of keeping rivers within bounds by the use of spurs has over and over again proved disastrous, the holes which are caused by the resulting swirls being most voracious, eating up the heads of the spurs and continually necessitating repairs thereto. This will I think be testified to by the present Superintending, Engineer of the Orissa Irrigation Circle. But if, instead of protecting a natural, or as in the case of the Kistna north training bank an artificial, bank by projecting a series of spurs out from it, the same material be applied in the form of a surface slope protection and an apron, along a straight or carefully curved river bank, the current will flow past smoothly and no swirl will be created.

15. It was for this reason that I so carefully curved the north training bank of the Kistna, leading it by easy curves tangential to the down stream masonry works of the north flank of the Anicut, in order that there might at least be nothing, in the form of the training bank on plan, which could lend colour to any suspicion that the existing swirl, which was due to the strong current of the under sluices, had been in any way aggravated.

16. It seems rather late in the day for me to repeat here my reasons, reasons already fully furnished to the Government of India some years ago and recorded in the records of the E. C. Railway, for fixing the bridge over at the Sitanagram side of the Kistna instead of midway between both sides. As however, Mr. Walch has retired, and as the present Irrigation officers may not be aware of them, I may be permitted to refer to the number for July 24th, 1896, of London "ENGINEERING," from which, I extract the following:—

> "The conditions at the Kistna were that three-quarters of a mile up-stream from the bridge site was the great Kistna Anicut or weir already described. The approach of the river to this weir from up-stream was somewhat diagonal; in other words, the local conditions were such that this weir had to be made somewhat skew to the main axis of the river current. The result was that the river, as it left the weir, had no tendency to wander about, but confined its main channel, and had done so continuously for 30 years, indeed since the weir was built, to the south bank of the bed, that is, to about half a mile on the south bank of the mile wide channel. The north half of the breadth of the channel was shallow in flood time and dry sand at other times, and had always been so since the anicut or weir was originally built. A very careful consideration of the problem led the author to the conclusion that if all risk of injury to the weir was to be avoided, that is, if the weir were to be left as far as possible in blissful unconsciousness of the river three-quarters of a mile down stream being tampered with and squeezed from one mile wide to three-quarters, it would be right to push the bridge over on the south side of the mile wide channel, and bridge the exisiting deep channel. The fear was that, if the bridge should be so located as to make it probable that in course of years the old main channel should change its position, the risk to the anicut would be very great; because the anicut consists merely of a bank of rubble 263 ft. wide at

base (with, of course, suitable crests, walls, &c., but essentially a bank of rubble), stretching across the river, and resting on the bed of sand of the date of its construction. If a new deep channel should form, and, extending back to the rear apron of this weir, should find itself opposite a place where in the old days the river was shallow and the weir consequently correspondingly weak, the consequences might be disastrous, not only for the great irrigation interests but for the bridge itself. Therefore, while one of the training banks hugs the existing south bank of the river, the other is artificial and curves outwards, cutting off a quarter of a mile of the river's breadth. Both banks and their stone covering and apron merge up stream into the permanent down-stream flanks of the anicut."

The result has been precisely what I expected. The rapid central part of the current of the river has remained where it always was and where so far as I could learn from careful enquiry it always had been, *viz.*, about spans 5, 6, 7, and 8 of the present bridge, and the current is still found to gradually slacken northward and southward from this central position as it always did. Out of the eight or nine lakhs of cubic feet per second, which pass between the river banks in full flood, the dammed up portion at the north end never carried more than 80,000 or 90,000 cubic feet per second, or about one-tenth of the whole, in the highest floods. The great stability of the river regime, and the slight degree in which it was affected by the building of the bridge, as a result of attention to the selection of the best position, is well illustrated by a series of cross sections and a detailed plan showing the cold-weather bed the year before the river was interfered with and during two years following. I have got these plans and cross sections and they afford the clearest proof that can be desired that this locating of the bridge over at the Sitanagram side was the proper thing to do.

17. If Major Baddeley's advice should be taken and seven and a half lakhs spent in adding three new spans to the bridge, and another lakh or two in throwing back the north training bank, the only result will be that these three extra spans will carry 66,000 cubic feet per second in full flood, and that the rest of the river at bridge site will silt up a little, an average of about two feet all across. The swirl near the rear of the Bezwada under sluices will in no degree be abated neither will the pot holes cease from troubling.

18. Should I be asked to advise what measures ought to be taken if it be found that the pot holes have become more formidable during the flood of 1896, I would advise as follows. Face the trouble and expense of lengthening the tail slope of the Anicut some 50 feet. Such lengthening is in my opinion the natural and proper sequence of having added three feet to the Anicut crest. But the whole of this work will probably not require to be done all at once, or perhaps not for many years, and in places not at all, because some parts of the slope are I understand already 300 feet wide and over. The immediate and pressing work is to tackle the two dangerous places, *viz.*, in the rear of the under sluices, where owing to swirls caused by the meeting of the fierce sluice current and the Anicut topple, pot holes have formed themselves for many years past. To deal effectively with these holes, if they are found to be worse than usual, all that is necessary is to fill them with sand, and then to cover them effectively with a graduated layer of rough stone, flakes below and heavy stuff above, as already explained. It may be that for the first year, and even for some years to come, this may be all that is necessary: but I think that sooner or later it will be best to add to the whole of the Anicut tail until its length is increased, as compared with what it was in 1890, in the proportion of a height of 17 feet to a height of 14 feet.

19. I am not surprised at the slight settlement of the left retaining wall in rear of the under sluice if I am right in my recollection of what I was told by the Executive Engineer of the Eastern Delta Division in 1891, *viz.*, that so far as it was possible to ascertain from the old records this wall is devoid of anything adequate in the shape of foundations. Naturally enough any slight slipping away from the front of it of the protecting apron, into deepening pot holes further out, would result in a settlement and crack. The prevention of the occurrence of holes, or of the extension of existing ones, will stop the tendency on the part of this wall to further settlement. I may note here, a matter of which the Irrigation Authorities are aware, that the under sluices have long shown signs of incipient weakness; and no wonder when it is considered that for forty years they have been subjected to quite exceptional vibration, as the result of water falling vertically over their face on to the sluice current rushing horizontally through their arches. This vibration can be distinctly felt in the neighbouring houses all through the flood season. The sluices must have been wonderfully well built originally on their comparatively shallow foundations to have stood without serious injury for so long a term of years. Indeed my chief reason for the adoption of the comparatively uneconomical 300 feet spans for the bridge, in lieu of 200 feet spans, was that I felt fully assured that there was great risk of the sluices failing at some future time, and I wished to feel safe in the possession of the larger spans, which allow far more scope for deep scour, during the several months of the existence of such a current as would necessarily be caused by a failure in the Anicut or in its flanking sluices.

20. To treat the pot holes below the Anicut as I would advise their being treated, presuming that they are found to exist on an enhanced and formidable scale, cannot I think cost half a lakh; and I think it probable that one lakh spread over several years ought to more than suffice to lengthen the whole of the rear slope, to suit the seriously altered conditions induced by the raising of the height of the crest.

21. Major Baddeley seems to think that there is something remarkable in the fact of the water through the central spans of the bridge exhibiting a greater velocity than that exhibited by that passing through the side spans. This in my experience is true in straight reaches of all great rivers, and if Major Baddeley will turn to the volumes of the old Mississippi investigations of many years ago which he will find in the Bezwada Library he will find that this is true of that river also. To obtain an uniform velocity through all the spans of a long bridge is an ideal which may be aimed at for many years by an engineer without attainment, unless he has at his disposal large sums for gradually equalising the depth of all his spans by the deposition of a layer of stone as soon as they have attained what he considers to be a fair mean depth. This would result in scour during subsequent floods occurring only in the shallower and unpaved spans; and by careful attention and much expenditure uniform depth and uniform velocity may in the course of years be attained to. The depths and velocities through the bridge now are approximately what they have always been for any time during the last forty years at the same site, except that, as I have explained, there will have established itself as much extra depth in several of the spans as will have made the present flood discharge area equal to the old one before one-tenth of it, more or less, was bunded up.

22. Major Baddeley seems to suggest, and as it seems to me without a shadow of evidence, that the contraction of breadth at the site of the bridge

is responsible for a rise in the level of the water above the Anicut. Were this the case there would be an afflux at the bridge, that is the general level of the area of water above bridge would be something distinctly higher than the general level of the area of water below the bridge. Were there any such condition as this the difference of level would be something quite appreciable, and there would be such a local increase of velocity through the bridge as would, in a very few hours or minutes, lift the sand at the bottom and scour out such an extra depth all across as to speedily abolish the afflux, the bed not being of rock. Large photographs taken at or close to the top of the flood show that there was no such afflux. There was certainly a wave, perhaps 20 inches high, at each pier; but this wave is only the same sort of wave that is formed on the sides of a ship moving through the open sea, caused by surface or skin friction. A barge 14 feet broad, with a semicircular bow and stern, forced at a velocity of 10 ft. per second through the open ocean would have precisely such a wave on her sides as was seen by Mr. Upcott and by Mr. Eaglesome on the Kistna Bridge piers, especially if the skin of the boat were as rough as that of the pier masonry. But such a wave is a merely local effect and is a very different thing from an afflux.

23. I should like to learn from the Irrigation Engineers how much they would expect the surface of the pool above the Kistna Anicut to be raised, were there no bridge at all in existence, by the addition of three feet to the height of the Anicut. I can see no reason to go beyond this recent addition, if any explanation is needed of a greater height of upstream floodmark, and of a more destructive and scouring effect at the foot of the fall.

24. Like Mr. Upcott I quite fail to reconcile Major Baddeley's demand that the north training bank should be raised six feet with his contention that it is the very existence of this training work that is causing the swirl from which he anticipates danger. To be logical he ought to have demanded the demolition of 300 or 400 feet of the training works nearest the Anicut; and if then the upstream end of what was left of the bund were properly protected with stone, as well as 100 feet in the rear of it, I would offer no objection, though the swirl would be in no way diminished by this or by any other tampering with the bridge arrangements.

SHILLONG;
5th December 1896.

F. J. E. SPRING.

A. A. Press Shillong, No.—294—8-12-96.—50

Current No. 5602

SERIAL
No. 49

(1) His Excellency the Governor
(2) The Hon'ble Mr. Bliss. C.I.E
(3) The Hon'ble Mr. Grose. C.S.I.

Note by the Chief Engineer for Irrigation No. 401 dated 24th December 1896. regarding the Kistna Bridge.

Circulated to His Excellency the Governor and Honorable Members for information.

F.B.F 4/1/97

Let us await Mr. Higham's report.
A.S.H 5.1.97

8/1/97

10/1/97

seen F.B.F 11/1/97

H.E. 4.1
R/7.1.97 Bliss 7.1.97
R/ 11/1/97