

Public Works (1895) Department.

G.O., No. 576R

DATED 13th September

[Despatch Abstract.]

Survey of the Palk Strait - Letter from the Govt. of India stating that the results of the new — will be communicated in due course and forwarding copies of certain reports, by Mr. F. J. Waring. - Recorded.

[illegible]

G.O.	No.	Department.	Data.	G.O.	No.	Department.	Data.

*All communications
should be addressed
to the Secretary.*

GOVERNMENT OF INDIA.
PUBLIC WORKS DEPARTMENT.
RAILWAY CONSTRUCTION.

To

The Joint Secretary to the Government of Madras,
(Railway Branch), Public Works Department.

Similar, the 2nd September 1895.

Sir,

With reference to your letter No. 392 R., dated the 7th June 1895, I am directed to inform you that the results of the new survey of the Palk Strait, which, it is expected, will be ready sometime during this month, will be communicated to you in due course.

2. I am to enclose for your information a copy of the following papers which have been received from the Colonial Secretary, Colombo.

(i) Report of an inspection of the route from Paumen to Taladi by Mr. F. J. Waring.

(11) Report and estimates for a railway from Kurunegala to Kankesantural and Jaffna by Mr. F. J. Waring.

I have the honour to be,

Sir,

Your most obedient servant,

Under Secretary.

~~Documents accompanying:-~~

Copy of papers referred to in paragraph 2.

- N. R. G. t

6892 ✓

Rd 10-9-95
Enc 2

98.10.15

✓

Print

Order
12576. 2. 2/13. 2. 2/13. 2. 2/13.

Recorded.

F. R. Upcott.
Secretary.

R

Subject
Improvement of the Public Health
- Recd. 10-9-95
of the letter from the
Govt. stating that the results

17/9
2/11/9

E.R.

XI.—1895.

PROPOSED INDO-CEYLON RAILWAY..

Waring REPORT

UPON

AN INSPECTION OF THE ROUTE FROM PAUMBEN
TO TALADI, NEAR MANNAR.

By F. J. WARING, Esq., C.M.G.

(Chief Resident Engineer, Ceylon Railway Extensions.)

Ordered by His Excellency the Governor to be Printed.



Colombo:
PRINTED BY H. C. COTTLE, ACTING GOVERNMENT PRINTER, CEYLON.
To be purchased at the GOVERNMENT RECORD OFFICE, COLOMBO, price, with tracings, 50 cents.

1895.

PROPOSED INDO-CEYLON RAILWAY.

The CHIEF RESIDENT ENGINEER, Railway Extensions, to the Hon. the COLONIAL SECRETARY.

No. 108.

Pattipola, April 10, 1894.

Report upon an inspection of the route for the proposed Indo-Ceylon Railway from Paumben to Taladi near Mannár, and of the alternative routes by which such a railway, if made, might be connected with the Ceylon Railway System.

SIR,—I HAVE the honour to state that in accordance with the instructions contained in your communication No. 14 of the 15th January last, I have inspected the country lying between Madawachchi, a station on the proposed Northern Railway 86½ miles distant from Kurunégala, and Mannár, Mannár channel and island, Adam's Bridge, Ramisseram island, the Paumben channel, and the country lying between Mannár and Puttalam, and beg to submit the following report upon this visit of inspection.

2. I left Nuwara Eliya on the morning of the 22nd February last, and reached Madawachchi on the 24th of that month. I left Madawachchi the following morning and arrived at Mannár on the morning of the 27th February.

3. In the afternoon of the 27th I visited Captain Donnan, the Master Attendant of Colombo, on board the barque "Sultan Iskander," which was then at anchor off the South Bar, Mannár, who by previous arrangement had kindly offered to assist me in the examination of Adam's Bridge and to place the barque, the pearl fishery boats and boatmen, and the steam tug "Active" at my disposal for this duty before he proceeded to his inspection of the pearl banks, and who had also given a passage from Colombo to Mr. H. Erskine of the Survey Department, who had just finished the Gandara Railway survey, whose services I felt might be useful, and of which therefore, with your permission, I had determined to avail myself. At that visit I arranged with Captain Donnan that he should proceed with the barque and other vessels to an anchorage off Nadukkuda on the south shore of Mannár island, where I would meet him the following day.

4. Accordingly on the 28th February I travelled with Mr. Erskine to Pésalai on the north shore of Mannár island, and thence across the island, thus obtaining a good general idea of its features to Nadukkuda, where we embarked and at once proceeded to an anchorage off Talaimannár, where we landed in the evening and examined as much as we then could of the islands and sandbanks in the neighbourhood.

5. The only chart of Adam's Bridge I was able to obtain was one made from surveys by Lieutenants Powell and Ethersey, of the Indian Navy, in 1838-1839, and I found that the islands and sandbanks above water level had so much changed from those shown thereon that a fresh flying survey of them was necessary before I could arrive at any opinion as to the practicability and cost of constructing a railway along it.

6. This flying trigonometrical survey occupied us until the 8th March. The following day was occupied in a careful examination of the Paumben channel, and on the 10th we returned to Mannár.

7. I landed at Mannár on the morning of the 11th, and having bidden farewell to Captain Donnan, who then proceeded with the barque, the "Active," and the boats to the pearl banks, I devoted the morning of that day to examining, in company with Mr. Erskine, Mannár channel near South Bar, which had been already partly examined by him on the 27th February before my arrival at Mannár.

8. On March 12 I left Mannár with Mr. Erskine and arrived at Puttalam on the morning of the 16th of that month.

9. My report upon this tour can, I think, be conveniently subdivided into the following sections, viz.:—

Section I.—From Paumben to Taladi, comprising: (a) the Paumben channel; (b) Ramisseram island; (c) Adam's Bridge; (d) Mannár island; (e) Mannár channel.

Section II.—The first alternative route for a connecting railway, viz., from Taladi to Madawachchi on the proposed Northern Railway.

Section III.—The second alternative route for a connecting railway, viz., from Taladi to Puttalam, the terminus of the proposed Chilaw and Puttalam Railway.

SECTION I.

(a)—The Paumben Channel.

10. From my examination of this channel I have no doubt but that the best route for a line of railway across it would be along what is called the "Great Dam," which consists of a natural straight reef of sandstone rocks 2,260 yards in length, extending in a direction almost due west from Tonitorai point in India to Paumben on the island of Ramisseram. This sandstone is not very hard, it contains numerous fossil sea-shells, and sometimes masses of coral. The rocks composing this reef are not uncommonly rectangular in shape, and the dimensions of two I measured were 15 ft. by 10 ft. and 13 ft. by 17 ft., with respective thicknesses of 3 ft. and 1½ ft. The small channels between these rocks are often not more than 1 ft. to 1½ ft. in width. The upper surfaces of the rocks, which on the "dam" or reef are often level or nearly so, are generally less than a foot below water level, but sometimes stand above it. In the deeper water, on each side of the reef or dam, these rocks lie very irregularly.

11. The centre of the navigable channel through this reef, which was artificially widened and deepened in 1829 by Major Sim and Lieutenant Cotton, and has perhaps been since further improved, is situated 1,700 yards from the western end of the reef at Tonitorai point, and is stated by Captain Donnan in his memorandum of the 16th June last* to be 130 ft. wide.

12. From the Tide Tables for 1895, compiled by Lieutenant Colonel J. Hill, R.E., Superintendent Survey of India in charge of tidal and levelling operations, and Mr. E. Roberts, F.R.A.S., F.S.S., of the Nautical Almanac Office, published by the Government of India, I have learnt that the mean range of the greatest ordinary spring tide at Paumben is 2.6 ft., and that the highest high water and lowest low water observed at Paumben between 1873 and 1882 were respectively 3.4 ft. above and 0.5 ft. below the datum of soundings on the Admiralty charts.

13. To the north of the reef, should water, having nowhere a greater depth than about 8 ft., extends for a distance of 800 yards, and it is at this distance from the reef itself that heavy breakers are said to occur during the north-east monsoon. The reef is protected from the south-west monsoon by Musel, Manauli, Pulli, Pullivansel, and Kirisuddi islands and by the shingle islets and their extensive surrounding shoals and reefs, which for the most part are dry at low water spring tides. These islands and shoals lie to the south of Paumben channel, and at a least distance of barely 2 statute miles from the reef, and thus form a natural breakwater, which must effectually prevent any heavy sea breaking on the reef itself during that monsoon.

14. The current through the Paumben channel is said to be in the direction of the prevailing wind, that is, it is from north to south during the north-east and from south to north during the south-west monsoon. At my visit in March last Captain Donnan and I estimated the velocity of the current, which was then from north to south, to be about two knots per hour, but on passing through on previous occasions I have noticed a much more rapid current than this.

Mr. James Stenart, then Master Attendant of Colombo, in a letter dated 26th September, 1837, addressed to His Excellency the Right Hon. Sir Robert J. W. Horton, Bart., then Governor of Ceylon, states that during "the north-east monsoon the water is at times 15 in. higher on the north side of the dam than on the south." This, though I have myself noticed an apparent slight difference of elevation, I can hardly credit, for the velocity of the current in that case would, I think, be so great as to effectually prevent the passage of even a full-powered and fast steamer. Mr. Stenart further states in the same letter that "the south-west monsoon does not increase the rise of the water on the south of the dam in so great a degree: it probably rarely exceeds 6 in. above the level of the water on the north side," and he further adds that during both monsoons "the water rises sufficiently to cause a current through the passage at Paumben, which (in the absence of proper warping buoys and assistance) prevents vessels passing through for several days together."

On the chart of Paumben Pass, tracing No. 733, which I enclose with this report,† it is remarked that during the north-east monsoon a strong current sets through the channel to the southward at the rate of three knots per hour, and I should be disposed, from my own observations when passing through the channel on several occasions by steamer, to think that the velocity was at times considerably more than this. The frequent existence of a very strong current in both monsoons, but stronger in the north-east than in the south-west monsoon, may thus, I think, be fully accepted.

15. On my visit on the 9th March last, I landed at Tonitorai point, which I found to be largely of rock for at least half mile west of the extreme point, similar to that occurring in the reef or dam. The coast on the north side of the point is a low cliff from 6 to 8 ft. in height above the sea, the strata dip to the south at an angle of about 15°, and are covered with sandy soil and vegetation. The rock, where exposed to and undermined by the waves, has a tendency to break into roughly rectangular blocks of varying thickness, exactly similar to those in the reef. Similar rock is also found on Ramisseram, at Paumben, and round the north and north-western coast of the Island, as far as the village of Ramisseram, where it disappears.

16. There being thus abundance of rock available, I think the best means to carry a railway across the Paumben channel would be by a rock embankment formed upon the dam or reef. The height of this embankment, which, as I have pointed out, would be on both its sides protected from any heavy seas, need not, I think, be more than about 6 ft. above high water level spring tides, its top breadth might be 18 ft., and the slopes say 2 to 1. In its formation care would of course be taken that the largest available stones were deposited on the slopes, the hearting being of those of smaller size.

17. For the navigable channel through which, were the railway made, it might be advisable to warp all vessels, whether steam or sailing, a swing-bridge would be required with suitable leading walls on each side of the channel, and on both sides of the bridge, say about 120 ft. in length; these walls might be somewhat splayed, so that the distance between them at their extremities might be greater than the span of the bridge. They should be provided with suitable bollards and with fender pieces, and would be thus very similar to those at a dock entrance.

18. Were the embankment formed as I have just described, although a certain amount of water might possibly pass under it and between the rocks forming the reef as at present, yet it would very seriously obstruct the current, and would therefore tend to increase its force and velocity through the navigable channel. This would be very objectionable, for the current through this channel is even now sufficiently strong to form at times a serious obstacle to the passage of vessels.

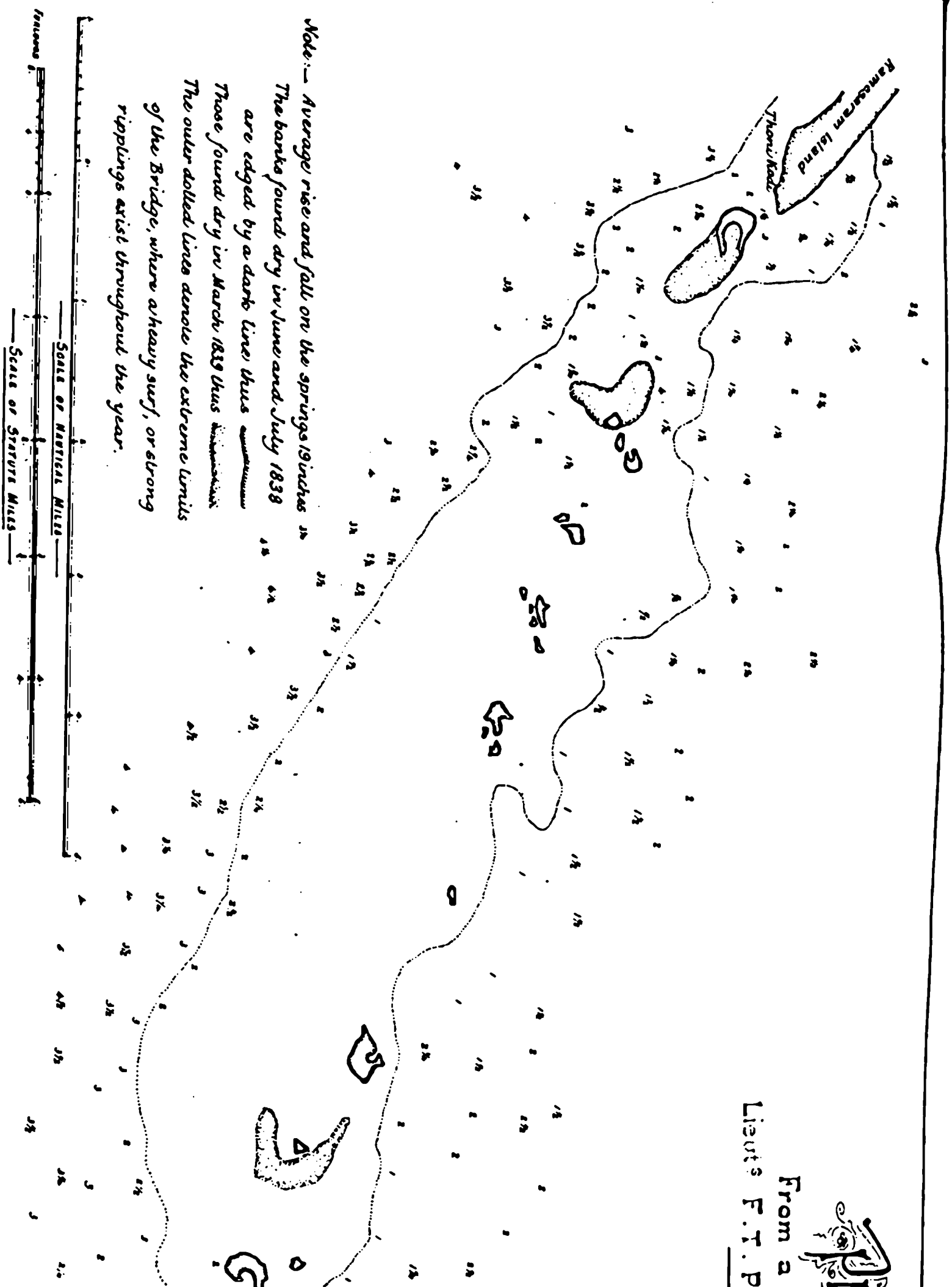
19. To obviate this I would propose to blast away the dam or reef at certain suitable points and to provide bridges at them, so that at least a waterway equal in area to the present area of waterway above the reef and through the navigable channel would be maintained even after the construction of the railway embankment.

20. Assuming the average depth of water over the reef to be 6 in. throughout its length, and that in the navigable channel over its whole width of 130 ft. the depth be 12 ft., the present area of waterway would be 4,884 square feet. If then the clear opening of the swing-bridge be 100 ft.—and this I should consider more than ample to safely and conveniently warp through vessels

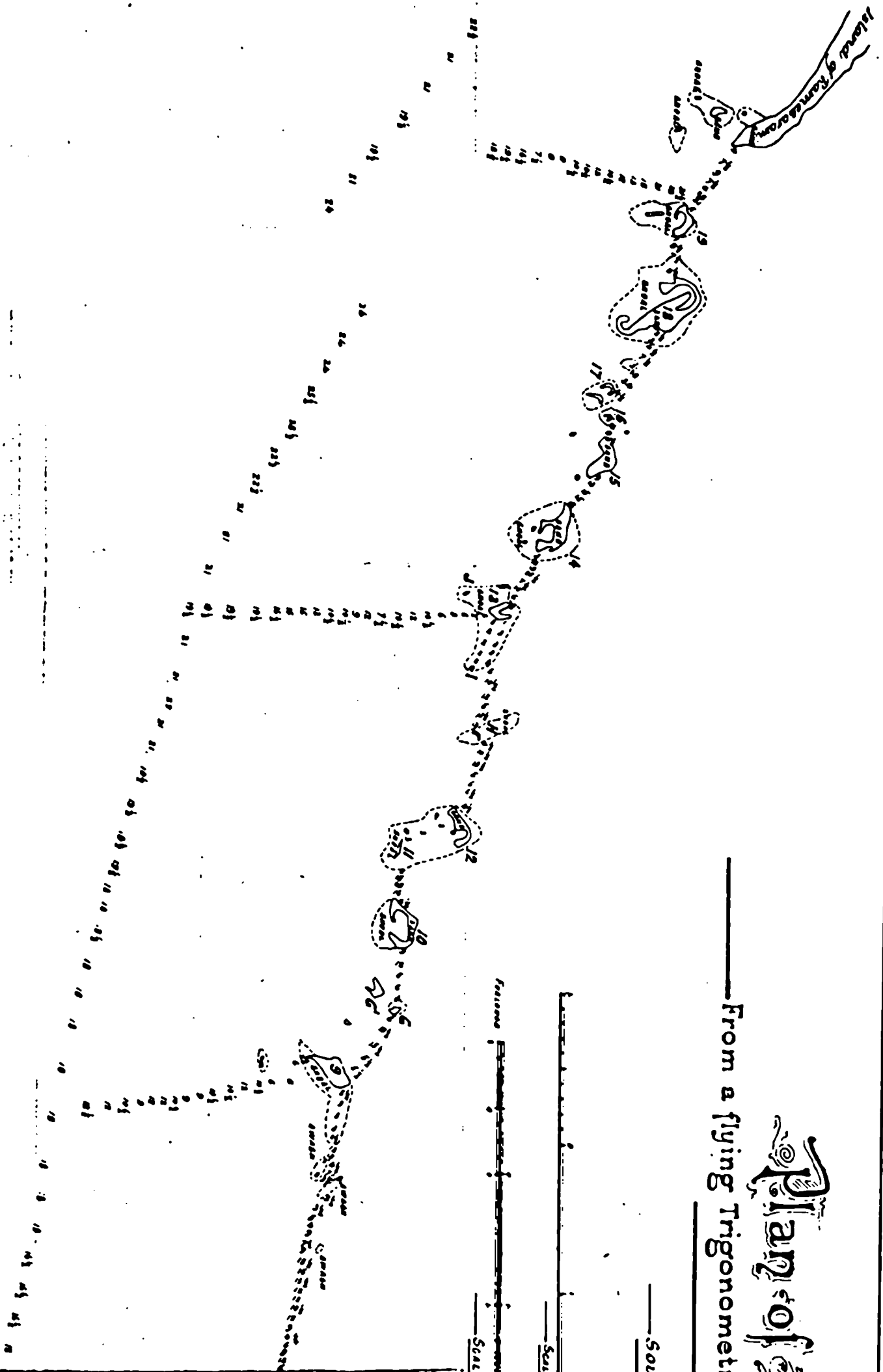
* See Papers relating to a Railway to connect Ceylon with India, printed by the Government of Ceylon in August, 1894, page 7.

† Not published.

From a
Lieut's F. T. P.



Plan of
From a flying Trigonometi



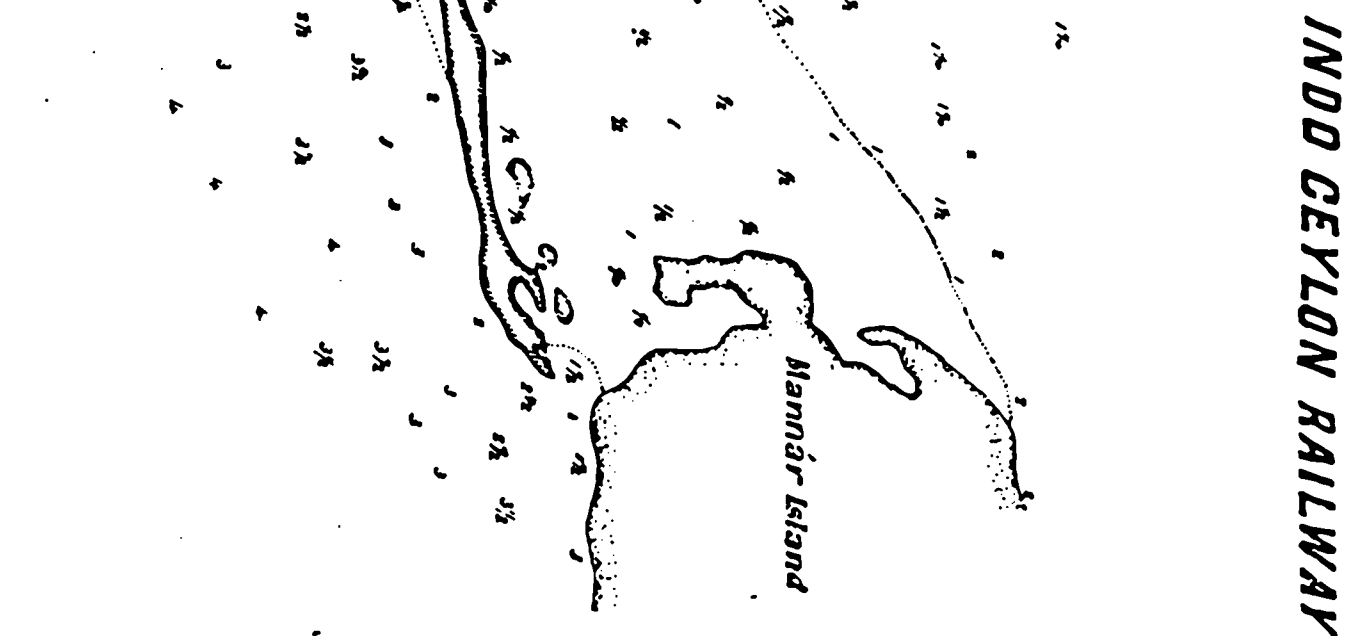
Enclosure to letter 4th 10th of 10th April 1836
To the Honble the Colonial Secretary

With Surveyor General's Office Circular, 18th 1836.

100

INDO CEYLON RAILWAY

INDO CEYLON RAILWAY

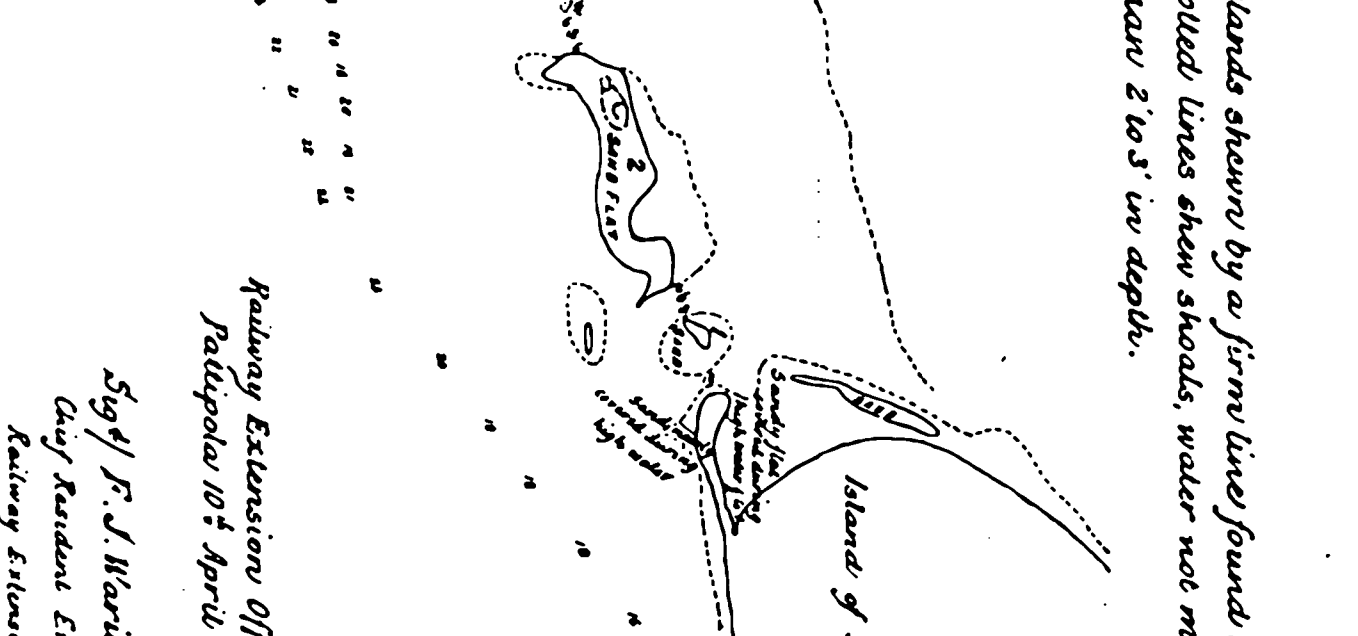


lands sheen by a firm line found

lands shown by a firm line found
colled lines show shoals, water not more
than 2' to 3' in depth.

lands shown by a firm line found
colled lines show shoals, water not m
ran 2' to 3' in depth.

lands shown by a firm line found
colled lines show shoals, water not more
than 2' to 3' in depth.

[illegible]

Island of .

Sandy flat

Hard mud / 10

Apprentice

2

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

19

20

21

22

23

24

25

26

27

28

29

30

31

32

33

34

35

36

37

38

39

40

41

42

43

44

45

46

47

48

49

50

51

52

53

54

55

56

57

58

59

60

61

62

63

64

65

66

67

68

69

70

71

72

73

74

75

76

77

78

79

80

81

82

83

84

85

86

87

88

89

90

91

92

93

94

95

96

97

98

99

100

Railway Extension Of

Pattipola 10th April

Sgt J. J. Warr

Capt Resident E

Railway Station

11. The centre of the navigable channel through this reef, which was and deepened in 1829 by Major Sim and Lieutenant Cotton, and has perhaps been since further improved, is situate 1,700 yards from the western end of the reef at Tonitorai point, and is stated by Captain Donnan in his memorandum of the 16th June last* to be 130 ft. wide.

12. From the Tide Tables for 1895, compiled by Lieutenant Colonel J. F. Hill, R.E., Superintendent Survey of India in charge of tidal and levelling operations, and Mr. Roberts, F.R.A.S., of the Nautical Almanac Office, published by the Government of India, I have learnt that the mean range of the greatest ordinary spring tide at Paumben is 2.6 ft., and that the highest high water and lowest low water observed at Paumben between 1878 and 1882 were respectively 3.4 ft. above and 0.5 ft. below the datum of soundings on the Admiralty charts.

13. To the north of the reef, shoal water, having nowhere a greater depth than about 8 ft., extends for a distance of 800 yards, and it is at this distance from the reef itself that heavy breakers are said to occur during the north-east monsoon. The reef is protected from the south-west monsoon by Musel, Manauli, Pulli, Pullivansel, and Kirisuddi islands, and by the shingle islets and their extensive surrounding shoals and reefs, which for the most part are dry at low water spring tides. These islands and shoals lie to the south of Paumben channel, and at a least distance of barely 2 statute miles from the reef, and thus form a natural breakwater, which must effectually prevent any heavy sea breaking on the reef itself during that monsoon.

14. The current through the Paumben channel is said to be in the direction of the prevailing wind, that is, it is from north to south during the north-east and from south to north during the south-west monsoon. At my visit in March last Captain Donnan and I estimated the velocity of the current, which was then from north to south, to be about two knots per hour, but on passing through on previous occasions I have noticed a much more rapid current than this.

Mr. James Stuart, then Master Attendant of Colombo, in a letter dated 20th September, 1837, addressed to His Excellency the Right Hon. Sir Robert J. W. Horton, Bart., then Governor of Ceylon, states that during "the north-east monsoon the water is at times 15 in. higher on the north side of the dam than on the south." This, though I have myself noticed an apparent slight difference of elevation, I can hardly credit, for the velocity of the current in that case would, I think, be so great as to effectually prevent the passage of even a full-powered and fast steamer. Mr. Stuart further states in the same letter that "the south-west monsoon does not increase the rise of the level of the water on the north side," and he further adds that during both monsoons "the water proper warping buoys and assistance) prevents vessels passing through for several days together."

On the chart of Paumben Pass, tracing No. 733, which I enclose with this report,† it is remarked that during the north-east monsoon a strong current sets through the channel to the southward at the rate of three knots per hour, and I should be disposed, from my own observations at times considerably more than this. The frequent existence of a very strong current in both monsoons, but stronger in the north-east than in the south-west monsoon, may thus, I think, be fully accepted.

15. On my visit on the 9th March last, I landed at Tonitorai point, which I found to be largely of rock for at least half mile west of the extreme point, similar to that occurring in the reef or dam. The coast on the north side of the point is a low cliff from 6 to 8 ft. in height above the sea, the strata dip to the south at an angle of about 15°, and are covered with sandy soil and vegetation. The rock, where exposed to and undermined by the waves, has a tendency to break into roughly rectangular blocks of varying thickness, exactly similar to those in the reef. Similar rock is also found on Ramisseram, at Paumben, and round the north and north-western coast of the island, as far as the village of Ramisseram, where it disappears.

16. There being thus abundance of rock available, I think the best means to carry a railway across the Paumben channel would be by a rock embankment formed upon the dam or reef. The height of this embankment, which, as I have pointed out, would be on both its sides protected from any heavy seas, need not, I think, be more than about 6 ft. above high water level spring tides, its top breadth might be 18 ft., and the slopes say 2 to 1. In its formation care would of course be taken that the largest available stones were deposited on the slopes, the hearting being of those of smaller size.

17. For the navigable channel through which, were the railway made, it might be advisable to warp all vessels, whether steam or sailing, a swing-bridge would be required with suitable leading walls on each side of the channel, and on both sides of the bridge, say about 120 ft. in length; these walls might be somewhat played, so that the distance between them at their extremities might be greater than the span of the bridge. They should be provided with suitable bollards and with fender pieces, and would be thus very similar to those at a dock entrance.

18. Were the embankment formed as I have just described, although a certain amount of water might possibly pass under it and between the rocks forming the reef as at present, yet it would very seriously obstruct the current, and would therefore tend to increase its force and velocity through the navigable channel. This would be very objectionable, for the current through this channel is even now sufficiently strong to form at times a serious obstacle to the passage of vessels.

19. To obviate this I would propose to blast away the dam or reef at certain suitable points and to provide bridges at them, so that at least a waterway equal in area to the present area of waterway above the reef and through the navigable channel would be maintained even after the construction of the railway embankment.

20. Assuming the average depth of water over the reef to be 6 in. throughout its length, and that in the navigable channel over its whole width of 130 ft. the depth be 12 ft., the present area of waterway would be 4,884 square feet. If then the clear opening of the swing-bridge be 100 ft.—and this I should consider more than ample to safely and conveniently warp through vessels

much larger than any now passing through the channel—an additional waterway of 3,684 square feet would be required; and if therefore the reef, having regard to free influx and efflux of water that would pass through the opening proposed to be made in it, could be blasted away to the depth of 10 ft., seven spans of say 60 ft. each would be required. Of these openings five might be made through the reef between Tonitorai point and the navigable channel and two between this channel and Paumben.

21. The approximate cost of the works as above described necessary for a railway across the Paumben channel, including permanent way of the Northern Railway type with steel rails weighing 46½ lb. per lin. yard, I should roughly estimate at Rs. 450,000.

22. Before concluding my remarks on the Paumben channel I should state that I had a boring taken near the north-east monsoon landing place mentioned by Captain Donnan in his memorandum of the 16th June last quoted above. The position of this boring, where 21 ft. of sand were passed through before reaching the rock, is marked on the enclosed tracing No. 733*; and the general absence of rock between this spot and Tonitorai point confirms me in the conclusion that, notwithstanding the somewhat greater breadth of the channel at the Great Dam, its course forms undoubtedly the best route for a railway.

(b)—*Ramisseram Island.*

23. The length of this island from Paumben on the west to Thanikodi, its eastern point, is about 17½ miles. I landed at Thanikodi and walked about 1 mile westward. I sailed close along the northern coast from Thanikodi to Ramisseram village, and also landed about 1 mile east of Kandugal point near Paumben and went a short distance inland. I also ascended the lighthouse at Paumben, whence a good view over much of the island was obtained, and thus made myself acquainted with the main features of the island.

24. In the western portion from Paumben to Ramisseram village, through which the line would pass for a distance of about 7 miles, sand hills, sometimes as much as 100 ft. in height, occur in places, with stretches of level, and sometimes low-lying ground, doubtless becoming swampy in seasons of heavy rain, between them. Much of this part of the island is covered with jungle, the principal tree being the *Acacia planifrons* (odai in Tamil), but groves of palmirahs and coconut trees are also common. Just beyond Ramisseram village a group of high wind-blown sand hills without vegetation, perhaps 100 ft. in height, occurs, beyond which to the eastward, as far as Thanikodi, the island is merely a long gradually tapering sandy spit. As I have already mentioned, sandstone rock, similar to that at Paumben, extends along the northern coast from that place to Ramisseram village, where I also found massive coral similar to that of which Jaffna and Mannar Forts are built.

25. The island is one of the holy places of the Hindus, and at festival times is visited by thousands of pilgrims, who, before visiting the celebrated temple at Ramisseram village, should proceed to Thanikodi and perform certain ceremonial ablutions in the sea.

Lieutenants Powell and Ethersey, of the Indian Navy, in their Memoir on the Survey of Paumben Pass and Adam's Bridge, dated 1837, state that on any of the principal festivals the number of devotees amounts to upwards of 50,000, and I imagine, therefore, the erection of railway stations at Ramisseram village and Thanikodi, as well as at Paumben, would be desirable.

26. I do not consider that the construction of a railway through this island would present any peculiar difficulties, though the passage of the line through the sand hills, and keeping it when built clear of the sand, would be troublesome and attended with some expense. I think, however, the movement of the sand might be checked by planting suitable plants, among which I would mention the convolvulus (*Ipomoea biloba*), the creeping grass known as Rama's beard (*Spinifex squarrosus*), and belts of screw pine (*Pandanus odoratissimus*), which I noticed growing on the island. The erection of hurdles might also be of service.

27. I am of opinion, therefore, that the rough approximate cost of a railway of similar type to that recommended by me for the Northern Railway might not perhaps exceed say Rs. 55,000 per mile, and this for 17½ miles would amount to a total sum of Rs. 950,000.

(c)—*Adam's Bridge.*

28. The enclosed tracing No. 732* shows on a scale of 5 in. to a mile our flying trigonometrical survey of the sandbanks and islands, as well as the position of six borings taken, their depth, and particulars of the material passed through. It also shows the soundings in feet taken by us, and by a red line the route recommended for a railway. For convenience of reference I have distinguished each important island or sandbank by a number or letter.

Tracing No. 734 is an enlargement of the Admiralty chart of Adam's Bridge based upon trigonometrical surveys made by Lieutenants Powell and Ethersey, of the Indian Navy, in 1838-1839. It shows the various islands and the alteration in their position between June, 1838, and March, 1839; and below it, for convenience of reference, I have reproduced to the same scale our survey of these islands as made in March last and as shown in tracing No. 732.

29. As our survey was commenced at Talaimannar, the eastern end of Adam's Bridge, it will I think be convenient that my explanatory remarks on the survey should also begin there.

30. The sandbank at the western end of Mannar island is nowhere more than 3 or 4 ft. above the sea; in the channel between it and island No. 1 a depth of 18 ft. of water was found. Island No. 1 is also low and flat; shoal water extends for some distance to the east, but to the west deep water is found close to the island. In the channel between islands Nos. 1 and 2 the greatest depth was 15 ft. Island No. 2 is more than a mile long, and towards its western end sand hummocks, about 20 ft. high, covered with a scanty vegetation of *Ipomoea biloba* and Rama's beard (*Spinifex squarrosus*), occur. On this island I found a temporary settlement of fishermen from Negombo, who make a living by catching, drying, and salting the fish, with which the sea positively teems. Shoal water stretches for a considerable distance to the north of this island. The channel between islands 2 and 3 is about ½ mile wide, its greatest depth near island 3 is 20 ft., but shoal water occurs in its centre. Island No. 3 is generally less than 4 ft. above water level, but sand hummocks with vegetation as on island No. 2 occur at its centre and in its western portion. In

* See Papers relating to a Railway to connect Ceylon with India, printed by the Government of Ceylon in August, 1894, page 7.
† Not published.

the centre of the channel between islands 3 and 4 a depth of 24 ft. of water was found, with a shoal wash to the north of it. Island 4 is uniformly flat, and is nowhere more than 4 ft. above the sea; in the channel between it and island 5 the greatest depth was 12 ft. Island 5 is about 1 mile in length; it is also generally flat, and about 4 ft. above the sea except at its centre and western end, where sand hummocks, about 20 ft. high, with vegetation as on island No. 2, occur. At the western end of this island are also a few fishermen's huts and a cadjan building used as a church or oratory, near which were two small palmirah seedlings. The channel between this island and island No. 6 is upwards of 3½ miles across. The small sandbanks marked B, C, D, E, and F, the last two of which are surrounded by an extensive area of shoal water, lie to the southward of the general direction of the chain of sandbanks. In this very wide channel the depth of water found nowhere exceeded 13½ ft., and this depth was found close to island 5. Island 6 is but a small one, and is about 2 ft. only above sea level; very shoal water extends, however, for a considerable distance both to the south and north of it. In the channel, less than half mile wide between it and island 7, a depth of 25 ft. of water was found.

Islands 7 and 8 are both low and flat sandbanks; shoal water extends for a considerable distance to the south of the former, and in the comparatively narrow channel between them the depth does not exceed 13½ ft. The channel between islands 8 and 9 is about 2 miles across, but its western portion is very shallow; the greatest depth found in this channel was 13½ ft. Island 9 is also low and flat without vegetation, and has extensive shoals to the east and south-east. The depth of the channel, about ½ mile wide between islands 9 and 10, does not anywhere exceed 19½ ft. Island 10 and the patches to the south-west and south-east of it occurring in the centre of this channel are sandbanks barely 3 ft. above the sea. Island 10 is very low, barely 2 ft. above the sea; it is very irregular in shape and has an extensive shoal to the south. In the comparatively narrow channel between islands 10 and 11 a depth of 28 ft. of water was found. Islands 11 and 12 are also mere sandbanks, and the water between them is nowhere more than 3 ft. in depth, and at many places much less. In the centre of the channel, about 1½ mile wide between islands 12 and 13, a small island II, having extensive shoals to the north, occurs; in this channel the greatest depth of water found was 13½ ft. Island 13 is irregular in shape, low, and flat, and extensive shoals connect it with island I to the east and with island J to the south, and also with a sandbank to the west. In the channel between islands 13 and 14, about ½ mile wide, the greatest depth of water found was 25½ ft. Island 14 is of considerable size and very irregular in shape; it is generally flat and about 4 ft. above sea level, though low hummocks of sand covered with creeping vegetation occur on its north side; it is on the north, east, and south surrounded with shoal water extending for some distance.

In the channel between islands 14 and 15, about ½ mile across, the greatest depth of water was found to be 15 ft.

The islands 15, 16, and 17 and their outliers are all low and flat, and lie near to each other; the greatest depth of water in any of the dividing channels was 9 ft.

In the channel between islands 17 and 18, which at the narrowest point is about ½ mile wide, the maximum depth in any channel, viz., 34 ft., was found at a short distance to the west of island 17.

Island 18 is a large one of very irregular shape though generally low and flat; low hummocks with grass and creeping vegetation occur on its north side; it is surrounded by shoal water of considerable width, especially to the south and north-east. The channel between islands 18 and 19 is about ½ mile wide, and nowhere more than 9 ft. deep.

Island 19 is low and flat, and has extensive shoals to the south. The channel between island 19 and Thanikodi point is upwards of half a mile wide, and its greatest depth of water, viz., 31 ft., was found near island 19.

31. The length of Adam's Bridge from the edge of vegetation on Mannár island to Thanikodi point is by our surveys 22 statute miles. Its general direction for the first 7 miles is west by south, it then gradually curves to the north, and at Thanikodi it is nearly north-west by west. Though deep water is often found in the channels, and especially the narrower ones between the islands, yet their approaches are intricate and often very shallow, rendering it sometimes difficult for even a boat drawing 2½ ft. of water to enter them. Between the 1st and 8th of March last, when the survey was being carried on, there was often a moderate swell from the south, causing the waves to break in about 9 ft. of water, and this line of breakers was in some places almost continuous for several miles, and at a distance of about a mile or a little less to the south of the general line of sandbanks. Although the wind was from the north the sea on that side of the sandbanks was smooth, and no breakers were at any time observed; the water is nevertheless, as upon the south side, generally shallow for about ½ mile from the chain of islands.

32. The current was in March last always from the north to south, and generally was estimated to be less than a knot an hour, the exception being in the channel between island 19 and Thanikodi, where Captain Donnan and I estimated its velocity at fully one and a half knot per hour; but I should imagine that during the full force of both monsoons a much more rapid current than this is found in every channel. Messrs. Powell and Ethersey state in their Memoir on the Survey of Adam's Bridge that the current through the channels "flows with great rapidity."

33. There was no sign of rock, coral, mud, or quicksand on any of the islands, which in every case were of clean gray sand; and the borings taken, the positions of which are indicated on tracing 732, show that the same material extends to a depth of from 25 to 30 ft. below sea level.

34. Owing to the existence of shoal water for a considerable distance on both sides, I am of opinion that a line of railway following the red line shown on tracing No. 732 can never be exposed to any heavy seas in either monsoon; and there being no navigation, except for small canoes, I consider that to fix formation level at 8 ft. above high water spring tides will amply suffice.

35. Looking at the change in the islands between June, 1838, and March, 1839, as shown on Messrs. Powell and Ethersey's chart, and at the entire change in the islands since that chart was published, as disclosed by our recent survey, it is evident that they all must be considered as mere sandbanks liable perhaps to considerable alteration in every monsoon.

36. It is of course a question whether and to what extent changes in the islands could be arrested and the channels maintained in their present positions artificially; but even if this could be done, I am of opinion that the erection of an aggregate length of 54,300 ft., equal to 10·28 miles of bridging, would be required. In arriving at this length I have considered that it would not be safe to attempt to form an embankment at any spot where the water had a greater depth than

3 ft., for to unduly restrict the waterway would tend to increase the strength of the current through the openings provided, and this to an extent which would produce a dangerous scour.

37. The following table shows the approximate distribution of the bridging:—

Description of Channel.		Approximate Length of Bridging.
		ft.
Between Mannár Island and Island No. 1	...	400
Do. Islands 1 and 2	...	700
Do. do. 2 and 3	...	1,800
Do. do. 3 and 4	...	1,100
Do. do. 4 and 5	...	1,500
Do. do. 5 and A	...	16,000
Do. do. A and 6	...	700
Do. do. 6 and 7	...	1,900
Do. do. 7 and 8	...	600
Do. do. 8 and 9	...	8,600
Do. do. 9 and G 1	...	2,700
Do. do. G 1 and 10	...	1,000
Do. do. 10 and 11	...	1,500
Do. do. 11 and 13	...	5,000
Do. do. 13 and 14	...	1,200
Do. do. 14 and 17	...	3,700
Do. do. 17 and 18	...	1,600
Do. do. 18 and 19	...	1,200
Do. do. 19 and Thanikodi point	...	3,100
Total lineal feet		54,300

38. I think from my present limited and necessarily incomplete information that the average depth to which it might be necessary to sink the cylinder piers which I would recommend for these bridges would be about 50 ft., and on this assumption my calculations show that, having regard to facility of erection, spans of 100 ft. would be cheaper than those of larger dimensions, and that the cost of the bridging would be about Rs. 22,720,000.

39. The formation of the intervening embankments, which could, I think, for the most part be made up with sand from the sandbanks on which they would be situate, but which would require a casing of clay brought from the mainland, and also stone pitching up to a height of 4 ft. above high water mark, including provision for widening at 3-mile intervals for a short distance to allow room for the erection of quarters for the maintenance coolies, and for a siding at a point about the centre of Adam's Bridge to allow trains to pass, and including also an allowance for their ends, where abutting on the bridges, to be of stone, so as to resist any possible scour, would, I estimate, cost Rs. 800,000.

40. I estimate the cost of permanent way of a type similar to that proposed to be adopted on the Northern Railway would cost Rs. 550,000. To the above amounts should be added say Rs. 1,430,000 to allow for smaller works, contingencies, administration, engineering, &c., thus raising the approximate total cost of a line across Adam's Bridge to Rs. 25,500,000, equal to Rs. 1,159,091 per mile without rolling stock.

41. All the above calculations are made on the assumption that bridges will only be needed across channels where the depth of water exceeds 3 ft., and that the sandbanks can be maintained in their present state and embankments formed upon them. Should, however, it become necessary to bridge the whole of the 22 miles from Thanikodi to Talaimannár, I should roughly estimate the cost of the work, including permanent way, but without rolling stock, at about from Rs. 48,000,000 to Rs. 50,000,000.

(d)—Mannár Island.

42. This island is perfectly flat, and except for the absence of stone and scarcity of good clay for brickmaking, and the absence of any material other than sand suitable for ballast, presents no engineering difficulties whatever to the construction of a railway. Much of it is covered with thorny acacia jungle, but there are also extensive groves of palmirah palms. I presume it would be desired that the line should pass near Pésalai, the population of which is 1,149, where there is a large and, I am informed, much-frequented church, and that stations would be needed there as well as at Talaimannár and Mannár. On approaching Mannár the line should pass to the southward of the town so as to cross the Mannár channel about half a mile from the sea at South Bar, where a sand ridge exists well above flood level, of which full advantage should be taken.

43. The length of the line through Mannár island would be about 17½ miles, and I should roughly estimate that it could be constructed, if made on the type of the proposed Northern Railway, for about Rs. 55,000 per mile; its total cost would therefore be about Rs. 960,000.

(e)—Mannár Channel.

44. This, the last section of the Indo-Ceylon Railway, comprises the line across Mannár channel, and to the east of it, as far as Taladi, where the point of junction of the alternative connecting lines to Madawachchi and Puttalam is situate, and is about 3 miles in length.

45. The point selected for crossing the channel is about 1½ mile to the south-west of Mannár Fort and the road causeway, and where two islands occur in it. In the causeway (unfinished), which will ultimately connect Mannár island with Ceylon, there are several openings aggregating 450 lin. ft. of waterway, and I consider that about 200 ft. more will be required for the navigable channel near Mannár Fort, over which the causeway is not yet built. Although the current through the openings in the causeway was not, when I saw it, very rapid, I have no doubt but that at times it is so, for I noticed that considerable scour had occurred. The general height of the causeway above water level varies from 3 to 5 ft., and I am informed that during stormy weather the road metalling suffers damage from the waves breaking over it. Navigation through the strait from the south towards Mannár is restricted to dhonies and boats of very small draught owing to the shallow water at the southern entrance, where the sandy bar (South Bar) has barely 2½ ft. of water over it, and the passage is very intricate and shifting. I understand the conditions are very similar at the North Bar, which, however, I did not visit. Inside the bar the depth of water varies generally from one

to two fathoms, obtaining its maximum opposite Mannár Fort, where the depth, at one spot only, is stated to be three fathoms.

46. For the railway bridges over the channels I think an aggregate waterway of say about 760 lin. ft. should suffice, and I would propose to subdivide this as follows. For the north-western channel, which is most used for navigation, and which has at the point of crossing of the railway an extreme breadth of about 1,000 ft., the deep water channel being about 400 ft. wide, the remainder being sand or mud flats, almost, if not quite, dry at low water, I think about 4 spans of 100 ft. with a swing-bridge for the passage of vessels of 40 ft. span should amply suffice. Across the island of Govativu or Pullaiaddi, which is covered with scrub jungle, and is about 3 ft. above ordinary high water level spring tides, the line should be carried on an embankment. Across the channel, principally used by fishing boats, between Govativu and the next island, the name of which I could not ascertain, which has a maximum width at the point of crossing of about 350 ft., and is shallow, except in the centre, where the depth is from 3 to 6 ft., I think two spans of 100 ft. should suffice.

The island beyond this channel is about 2 ft. above high water level, is covered with grass, and across it the line might also be carried on an embankment. For the last channel between this island and the mainland of Ceylon, which is I think almost dry except at high water and seasons of heavy rain, I think an opening of about 120 ft. should suffice.

About a mile over low flats would then take the line to the junction of the alternative routes to Madawachchi and Puttalam.

I think formation level on this section should be at from 6 to 8 ft. above high water level.

47. I had a boring taken to a depth of 25 ft. on Mannár island near the end of the sandy ridge mentioned in paragraph 42 of this report, and on the edge of the navigable channel, which traversed the following strata, viz., for the first 15 ft. gray sand, followed by 3 ft. of dark clay and 4 ft. of red sand, the last 3 ft. being through very stiff light-coloured clay.

48. I should approximately estimate the cost of this section of the line at Rs. 520,000, without rolling stock.

49. The following is a summary of the foregoing estimates, exchange having been in each case calculated at Rs. 18-33 per pound sterling:—

	Ra.
A.—Paumben Channel ...	450,000
B.—Rameswaram Island ...	950,000
C.—Adam's Bridge ...	25,500,000
D.—Mannár Island ...	960,000
E.—Mannár Channel ...	520,000
Total ...	28,380,000

SECTION II.

The connecting Railway, Taladi to Madawachchi.

50. As far as I could judge from the road along which I travelled, the works on this line would be generally light and similar in character to those on the Northern Railway between Anurádhapura and Elephant Pass.

51. From Taladi to about the 7th milepost from Mannár the road traverses flat sandy soil; thence to the 18th milepost black clayey earth, somewhat like the black cotton soil of the Dekhan in India, is met with; and thence to Madawachchi the road, somewhat undulating in parts, passes through the usual red and at times gravelly soil so prevalent in Ceylon generally.

52. The principal bridges on the road, which from the 11½ miles to 15½ miles is on the bund of the Giant's Tank, and which in certain places approaching Mannár is not fully bridged, are the following:—

- At 22½ miles 28½ ft. span, headway 12 ft.
- At 23½ miles 11½ ft. span, headway 8 ft.
- At 23½ miles 11½ ft. span, headway 9½ ft.
- At 23½ miles 11½ ft. span, headway 10 ft.
- At 24½ miles 16 ft. span, headway 7 ft.
- At 25½ miles 40 ft. span, headway 16½ ft.
- At 26½ miles 20 ft. span, headway 7½ ft., over Mullikallatu Alavaka.
- At 27½ miles 40 ft. span, headway 15 ft., over Karamottai Alavaka.
- At 28½ miles 15½ ft. span, headway 10 ft., over the Periakattu Alavaka.
- At 30½ miles 40 ft. span, headway 15 ft., over Uralavaka.
- At 34 miles 100 ft. span, headway 21 ft., over Cheddikulam-ár. This stream is known in the upper part of its course as the Bu-oya, and the Kalkandamadua-oya and other streams passed on the Northern Railway between 94 and 96 miles flow into it.
- At 49½ miles 10 ft. span, headway 3 ft.

There are on the road many other culverts of smaller dimensions for flood water and for irrigation channels.

53. Besides openings for these streams any railway running near the road would require openings for the following, for which bridges on the road are not yet built:—

At about 1½ mile from Taladi a tidal channel, for which I consider a bridge of 20 ft. span should suffice. This is crossed by the road at 4½ miles.

At about 16½ miles from Taladi, 20½ miles by road from Mannár, a bridge of 100 ft. span for the supply channel (Alavaka) to the Giant's Tank.

At about 42½ miles from Taladi, 46½ miles by road from Mannár, a flood opening of about 20 ft. span.

54. I learn that fair bricks have been made on the banks of the Aripu-ár near Murankan, about 14 miles from Mannár, and that good clay exists and that bricks have been made also near the 25th and 34th miles by the road from Mannár. I was also informed that there is an outcrop of limestone near Kombasayindakulam, about 18 miles from Mannár, and that coral for lime burning can be obtained from Kondachchi near Sillavaturai. I do not think much if any gneiss rock for building purposes can be found within say about 20 miles from Mannár, but beyond that I think sufficient can be obtained, though in places it may have to be brought from some distance. I noticed

* Subject to remarks in paragraph 41 of this report.

PROPOSED INDO-CEYLÓN RAILWAY.

gravel near the 24th milepost, and think it is abundant and of good clean quality at several places nearer Madawachchi.

55. I think from Taladi the line should be to the south of the road, and run in as direct a line as possible towards Murankan near the 14th mile; it will thus at the 9th milepost from Mannár be about a mile to the south of the road. It should continue on the south of the road as far as 20½ miles from Mannár, where it should cross it. It would thus interfere as little as possible with the Giant's Tank and its supply channel, thence it should run on the northern side of the road to its junction with the proposed Northern Railway at Madawachchi.

56. By this route the line to be constructed would, I think, be about 46 miles in length, and on it Mr. Jackson, the Assistant Government Agent, Mannár, has suggested the following stations:—At Uyilankulam, near the 8th mile from Mannár, and at Pariyanalankulam, near the 26th mile from Mannár, to be, when the repairs of the Giant's Tank are completed, supplemented by a station in its neighbourhood.

57. Before concluding my remarks on this railway, I should mention that, were it to connect with the Northern Railway at Vavuniya instead of at Madawachchi, the length of new line to be constructed would be reduced by about 5 miles, and the bridges over the supply channel to the Giant's Tank and over the Cheddikulam-ár would not be required. There would be by this route a saving in distance of 19½ miles for passengers and goods going to or coming from the direction of Jaffna, but the distance for traffic from Kurunégala or Anurádhapura would be increased by about 9½ miles. Should this route, which I have not however examined, but believe it to be free of any serious obstacles, be ultimately adopted, the line should, I think, cross the Madawachchi road near the 1st mile from Taladi, pass near the extreme northern edge of the Giant's Tank instead of to the south of it, and thence run as direct towards Vavuniya as the nature of the country will permit.

SECTION III.

The alternative Route for a connecting Railway, viz., from Taladi to Puttalam.

58. I should premise that the road between Mannár and Puttalam is, south of Sillavaturai, and until within 5 miles of Puttalam, a mere track on the natural surface of the ground, unimproved beyond being kept clear of jungle; it is thus doubtless liable at certain places, especially when approaching streams, to be flooded in the rainy season; and it is of course impossible for me, from a mere hasty inspection of the country at the driest season of the year, and with the scantiest information, the country being for miles together without any resident population, to state the height of embankment necessary to keep the line above flood level, and the sizes of the openings which would be required to allow free discharge of the flood water. I have, however, made notes of and taken sections across the main rivers and places where unmistakable evidence of the road being under water at times were apparent, and to these I will refer in their proper order.

59. From Taladi to Vankalai (Bengalli), 5½ miles from Mannár, the country is perfectly flat, and near the 5th mile is liable to be flooded to a depth of about 1½ ft. I think an opening of 40 ft. span might be required here. At 5½ mile sand 6½ miles tidal backwaters occur; for these, spans each of 40 ft. should I think suffice. At 6½ miles, 7½ miles, and 8½ miles, backwaters also occur on the road; for these, if crossed by the line, which would be to the east of the road, openings of 10 ft., 20 ft., and 20 ft. span respectively should, I think, be sufficient.

60. Near 9 miles from Mannár the line should leave the main road, and curving towards the east and south should follow generally the direction of a minor road passing near the village of Achchankulan, so as to avoid, as much as possible, the delta of the Arivu-ár. One branch of this stream is crossed by the minor road at a point about 10½ miles from Mannár, for which an opening of 40 ft. span would, I believe, suffice.

61. At about 12 miles from Mannár the minor road just mentioned crosses the Arivu-ár at a point where its bed of coarse quartz sand is 808 ft. wide and the lowest part of it about 9 ft. below the general level of the country. In floods the water in this river is reported to be 10 ft. in depth. I was told that about a mile higher up the stream it was narrower and the banks higher. I should not consider it safe to estimate for anything less than a bridge of 700 ft. in length across this river.

62. Opposite Arippe, at 13½ miles from Mannár, the line should, I think, be about 1½ to 2 miles to the east of the road, and proceeding southwards would gradually approach it. At 14½ miles and 14½ miles the road crosses tidal estuaries, into which flood waters flow; for these, if they extend far enough to the east to affect the railway, bridges, each of about 40 ft. span, would be required.

63. Near Sillavaturai, 17 miles from Mannár, the railway will, I think, be near the road again. At 16½ miles there is on the road a culvert of 15 ft. span; a tidal estuary, unbridged, is crossed by the road at 17½ miles, for which, I should say, an opening of 20 ft. span should suffice, and at 17½ miles and 18½ miles openings of from 20 to 15 ft. span would be required, the latter being for an outlet from a tank.

64. The road, which has from Arippe been near the sea, now begins to leave it; open grassy ground, which it has traversed all the way from Taladi, is now replaced by dense thorny bush jungle, and the soil becomes very sandy, rendering travelling up to 29th mile both difficult and slow. Near 24 miles the road passes through low ground, showing signs of much wash. This is evidently I think a flood overflow from the Kal-ár, and would, if crossed by the line, require an opening of 80 ft. span. The main stream of the Kal-ár is passed by the road at 24½ miles from Mannár; the bed of this stream is of coarse quartz sand. In floods the water is reported to be 7-60 ft. in depth, and for it a bridge, say 200 ft. in length, would be required. It is possible that the point where the flood overflow, passed at 24 miles, leaves the main stream; this matter would of course receive attention were a survey of the line ordered.

65. At 29½ miles from Mannár the road emerges from the forest and passes through Marichchikadi tank. It re-enters the forest at 30 miles, and at 31 miles the Motragam-ár, the boundary of the Northern and North-Western Provinces, is reached. This stream lies in a hollow about a mile wide extending from 30½ to 31½ miles, and about 20 ft. below the general level of the country. The bed of clean coarse sand is about 270 ft. wide, the water in floods is reported to be 9-10 ft. in depth, and to be above both banks. I think for this river, which rises near Talawa about 8 miles

south of Anurādhapura, and is known in the upper part of its course as the Talawa-oya, a bridge of 300 ft. in length would be required.

66. South of the Motragam-ār undulating country is traversed by the road, and the forest improves. I observed outcrops of limestone on the road near 41½ miles and 48½ miles, and near the latter place I also noticed good gravel suitable for ballast. The road emerges from the forest at 47½ miles from Mannār, and for about 2 miles traverses open plains. Ponparippu resthouse is at 48½ miles from Mannār.

67. From 49½ miles to about 53 miles the road traverses the delta of the Kala-oya, and low land liable to be flooded is passed at 49½ miles, 51½ miles, 51½ miles, and 52½ miles from Mannār; for these low lands, if passed by the railway, openings of 150 ft., 40 ft., 40 ft., and 20 ft. respectively would, I think, be required. The main stream of the Kala-oya is crossed at 52 miles; the bed is of coarse sand, floods are reported to rise about 7 ft. above the present water level; and for this river I should not consider it safe to estimate for a bridge of less than 300 ft. in length.

68. An attempt would of course be made, were the survey ordered, to find a crossing for the Kala-oya by the line above the head of its delta, but if, as I was informed by the Vidané of Ponparippu, the delta extends 10 miles to the east of the road, this would be impracticable, as it would involve too great a detour. I should mention that by the itinerary map the head of the delta is shown to be only about 2 miles to the east of the road. Between 50½ miles and 51 miles on the road there is an outcrop of gneiss rock with veins of quartz.

69. At 54½ miles the Kal-ār (salt river), a tidal estuary, is crossed by the road; for this a bridge of 60 ft. span would be required. The bed of this stream is of quartz pebbles, and above them, extending for say 6 ft. above present water level, is a stratum of blue clay imbedding numerous sea shells.

70. After passing the Kal-ār undulating country occurs, and the road rapidly rises to a summit of considerable elevation, possibly even 150 ft. above the sea; at 56½ miles gravel of excellent quality for ballast is abundant. Undulating country follows to 62 miles. The gradients, and perhaps the works also, on this part of the line must, I think, be steep and heavy. At 62½ and 62½ miles water-courses, for which openings of 40 ft. and 20 ft. span respectively would be needed, are passed.

71. From about 64½ miles to 68 miles from Mannār the road crosses the valley of the Mi-oya, and is at places subject to floods from that river. At 64½ miles two water-courses occur, for which an opening of 60 ft. span would, I think, suffice. At about 66½ miles a flood opening of about 60 ft. span would be necessary. For the Mi-oya itself, which is passed by the road at 66½ miles, a bridge of about 120 ft. span would be required; the bed of this stream is of sand, and it is reported to flood to a height of about 5 ft. At 67½ miles on the road there is a bridge of 2 spans of 18½ ft. with a headway of 9 ft.

72. From 67 miles to Puttalam, 72 miles from Mannār, the road is gravelled or metalled and bridged. Between Manativu village, 69 miles, and Puttalam I think the best course for the line would be close to the road on its eastern side, and in that case it would pass between the road and the Nedunkulam tank.

73. The length of the line from Taladi to Puttalam would be about 69 miles.

CONCLUSION.

74. As regards the comparative advantages and disadvantages of the alternative routes for the connecting railways described in sections II. and III. of this report I have no hesitation in stating that, apart altogether from its much greater length, the works, and especially the bridging upon a line from Taladi to Puttalam, would be very much heavier, and therefore more costly than upon a line from Taladi to Madawachchi or to Vavuniya.

75. The total distance from Colombo to Taladi *via* Puttalam would be about 149 miles, but *via* Madawachchi it would be about 190½ miles, as follows:—

Colombo to Kurunégala	...	...	54	57
Kurunégala to Madawachchi	...	...	86	5
Madawachchi to Taladi (approximate)	...	...	46	0
			190	62

while *via* Vavuniya it would be about 200½ miles.

76. The country through which both of the alternative routes pass is undeveloped, and for the most part waste land and jungle. Certain persons who profess a knowledge of the conditions favourable for the cultivation of coconut trees have informed me that the construction of a railway to the north of Puttalam would be followed by an extension of this cultivation along it; while others, who also profess similar knowledge, state that the climate is too dry, and the soil is not suitable for the successful growth of these trees.

77. I enclose a map, tracing No. 735, to the scale of 4 miles to an inch, showing in distinctive colours the alternative routes referred to in sections II. and III. of this report, and their connections with the Indo-Ceylon Railway on the one hand and the proposed Puttalam and Northern Railways on the other.

78. I have, in conclusion, to state that Mr. Erskine worked with much energy on the survey of Adam's Bridge and Mannār channel, and that his services were of much value to me in taking sections of the streams between Taladi and Puttalam; and I would also take this opportunity of tendering my best thanks to the Government Agents of the Northern, North-Western, and North-Central Provinces, and to Mr. Jackson, Assistant Government Agent, Mannār, and to their subordinates, among whom I would specially mention Mr. V. Vraspillai, Adigar of Mualali, who accompanied me during the whole of my tour in the Northern Province, for the facilities and assistance they very kindly afforded me in my journey, and for the very useful local information they so willingly gave me. I have also to tender my best acknowledgments to Captain Donnan for his very valuable assistance in the survey of Adam's Bridge, and for his kindness in placing his vessels and men at my service, without which this survey could not have been made.

I have, &c.,
F. J. WARING.

Sketch Map

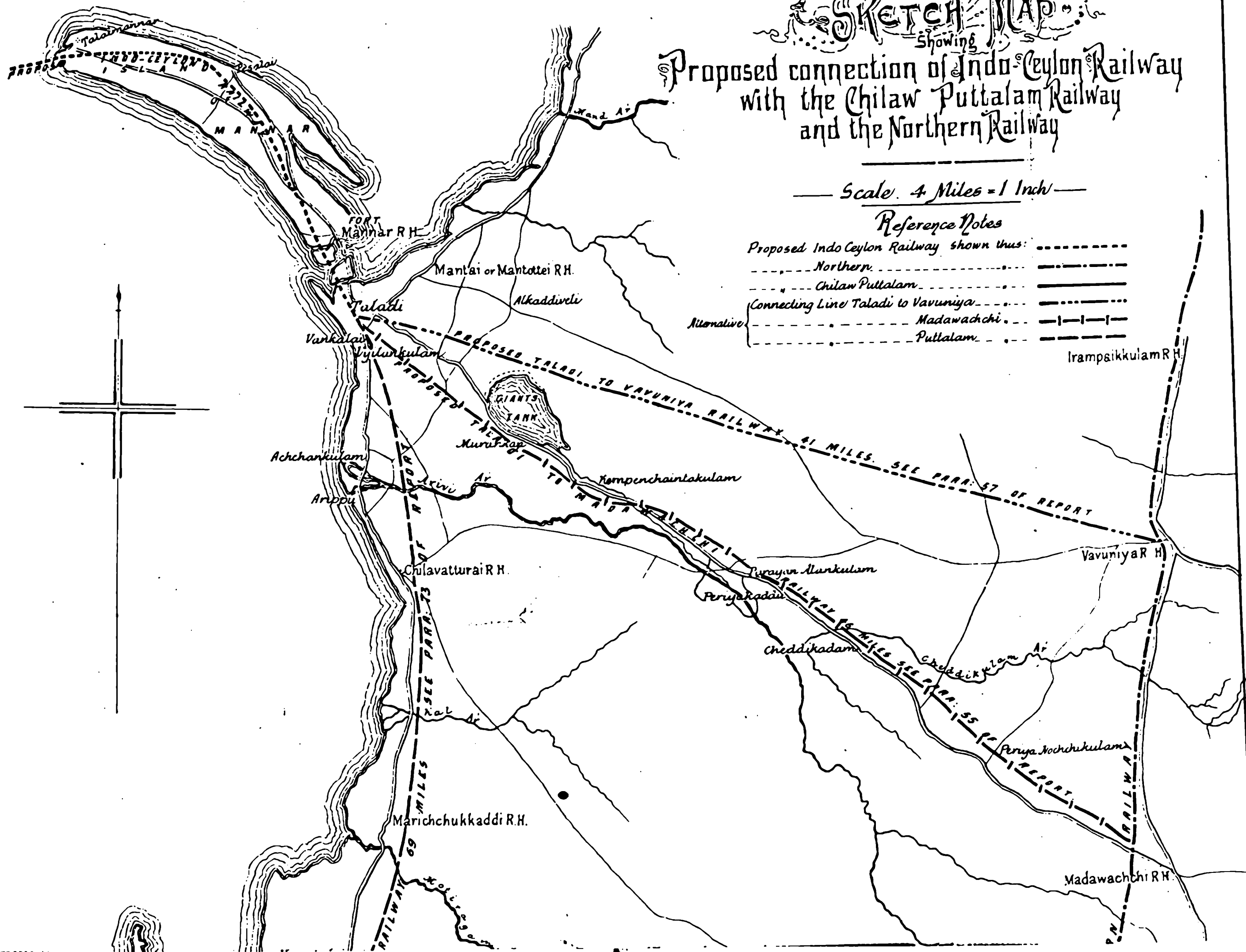
Showing

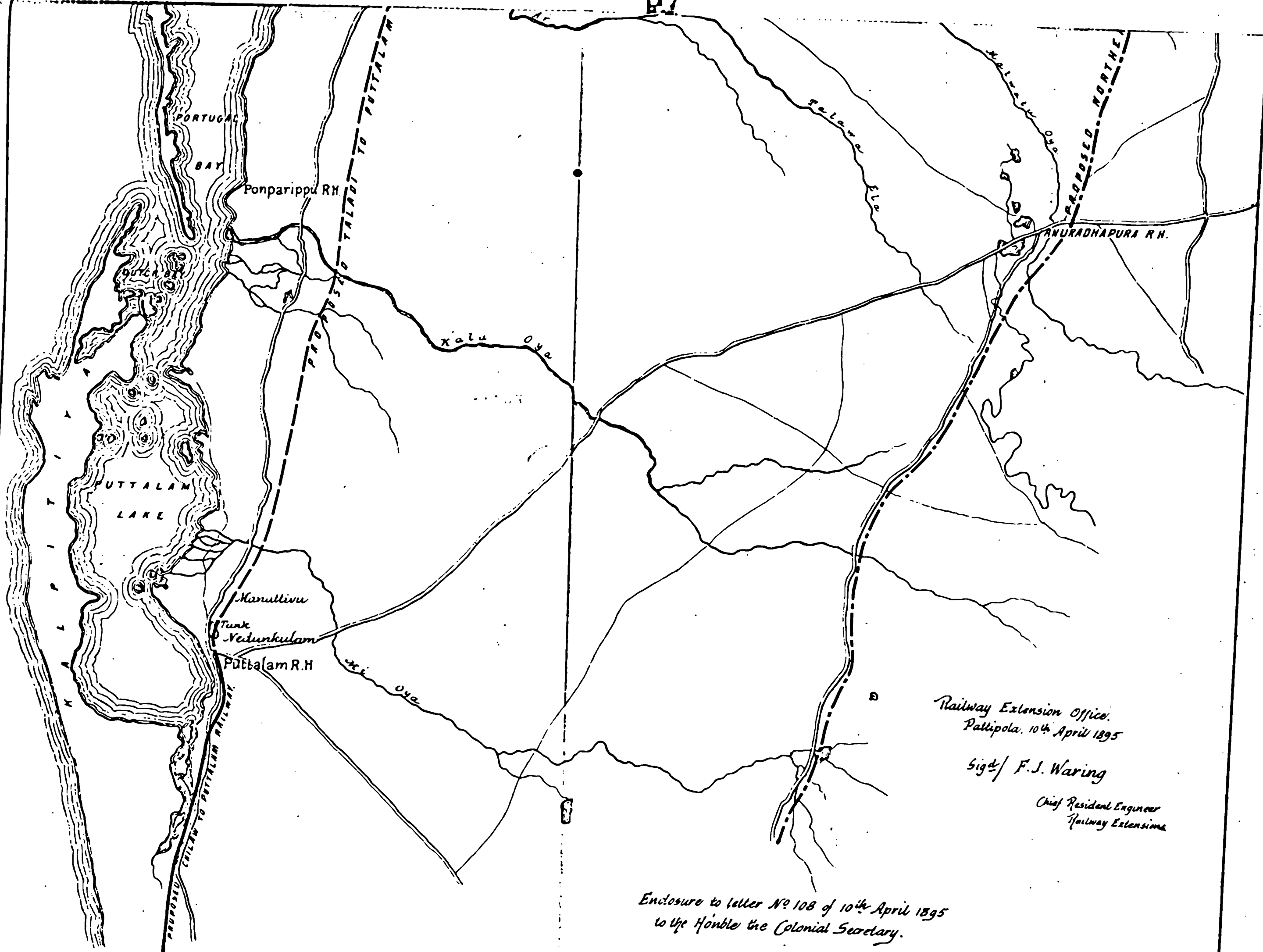
Proposed connection of Indo-Ceylon Railway with the Chilaw Puttalam Railway and the Northern Railway

Scale. 4 Miles = 1 Inch

Reference Notes

Proposed Indo Ceylon Railway shown thus:	-----
Northern	-----
Chilaw Puttalam	-----
Connecting Line Taladi to Vavuniya	-----
Alternative	-----
Madawachchi	-----
Puttalam	-----





Railway Extension Office,
Pallipola, 10th April 1895

Sig^d/ F.J. Waring

Chief Resident Engineer
Railway Extensions

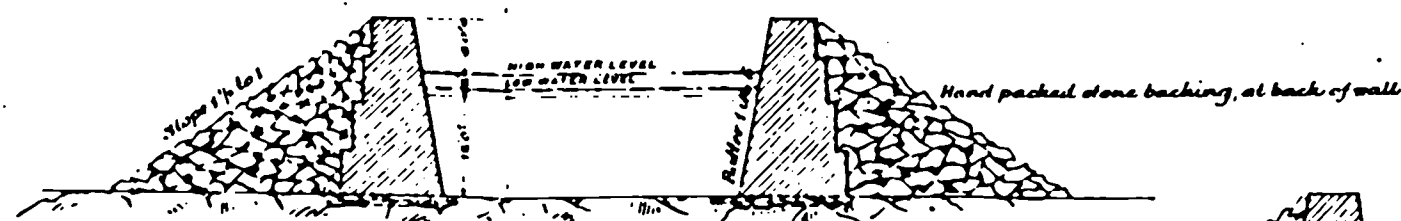
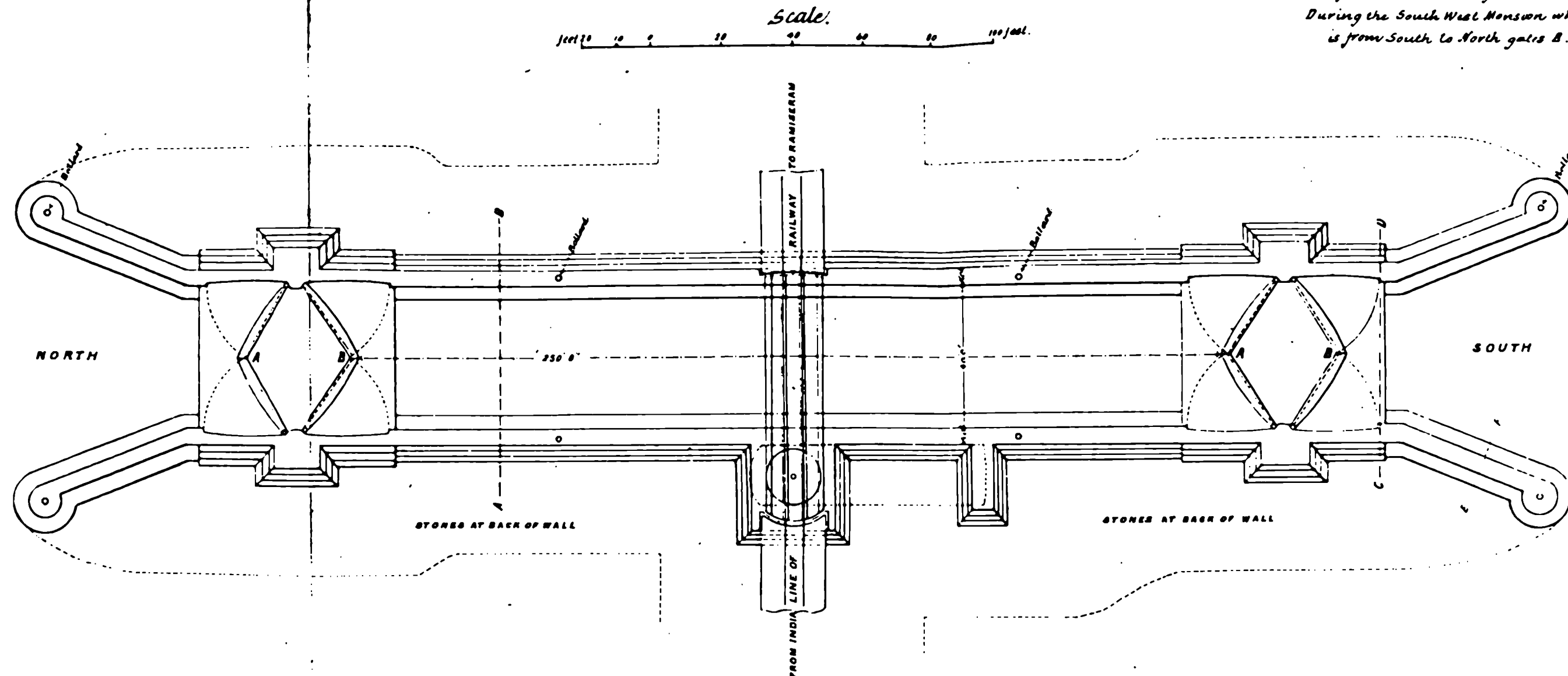
Enclosure to letter No 108 of 10th April 1895
to the Honble the Colonial Secretary.

INDO CEYLON RAILWAY.

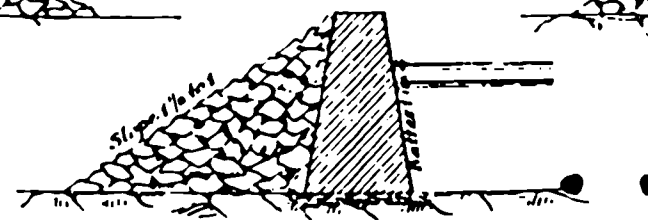
Proposed Lock for Paumben Channel.

NOTE:-

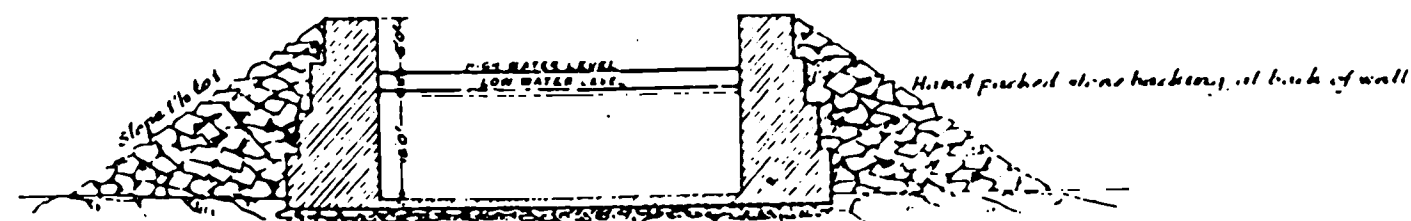
During the North East Monsoon when the Current is from North to South gates A.A will be used.
During the South West Monsoon when the Current is from South to North gates B.B will be used.



SECTION THROUGH A.B.



SECTION THROUGH E.F.



SECTION THROUGH C.D.

Enclosure to letter No 133 of 3rd May 1895.
to the Honble the Colonial Secretary.

Scale for Sections.
100 feet 20 0 20 40 60 feet.

Railway Extension Office
Pallupola 3rd May 1895.

Sig'd F.J. Waring

Chief Resident Engineer.
Railway Extensions.

The CHIEF RESIDENT ENGINEER, Railway Extensions, to the Hon. the COLONIAL SECRETARY.

No. 133.

Pattipola, May 3, 1895.

SIR,—WITH reference to my letter No. 108 of the 10th ultimo, I have the honour to state that if in the opinion of those competent to judge there would be any difficulty or danger, owing to the strong currents so often prevalent, in warping vessels through the channel at Paumben, as proposed in the 17th paragraph of that report, all objections would I think be removed by the construction of a lock with double gates at each end closing in opposite directions, as this would permit vessels to be passed through in both monsoons in still water.

2. The employment of two small tug steamers, one to be stationed on each side of the reef so as to give sailing vessels a little offing before trusting entirely to their canvas, might also in addition be advantageous as tending to remove even the remotest chance of accident.

3. I have ascertained that the length and draught of the steamers "Lady Havelock" and "Lady Gordon" are respectively 180 ft. and 10 ft. 6 in., the beam of the former being 28 ft. and that of the latter 27 ft. These vessels are, I think, among the largest that at present use the Paumben channel, and I consider therefore that a lock 250 ft. in length by 40 ft. in width by 12 ft. deep at low water would be very ample. Tracing No. 737 herewith enclosed shows generally the plan and sections of such a lock.

4. The addition of a lock would increase the cost of the work at Paumben beyond the sum of Rs. 450,000 roughly estimated for it in paragraph 21 of my above-quoted report, but the reduction in size of the swing-bridge necessary thus rendered possible would be very advantageous, as permitting it to be turned with much greater ease.

5. I would request that you will have the goodness to consider this letter as being a continuation of my report No. 108 of the 10th ultimo.

I have, &c.,

F. J. WARING.

No. 31

Colonial Secretary's Office,
Colombo. 18 June, 1895

No. _____

" Sir,

I am directed to acknowledge, with thanks, the receipt of your letter no. 373 R of the 7th instant, forwarding, for the information of the Ceylon Government, a note on the construction of a Railway to connect India and Ceylon, and to state that His Excellency the Governor will be glad to be furnished with a copy of the report of the results of the Survey of Palk's Strait to which you have referred.

amount with from
post. India 7/11/95

I am, Sir,

Your obedient servant,

[Signature]
for Colonial Secretary

The Joint Secretary
to Government of Madras.

Public Works Department, Railway Branch -
Coltacamund

PW 92
6897/11

All communications
should be addressed
to the Secretary.

No. 1504 R.C.

GOVERNMENT OF INDIA.
PUBLIC WORKS DEPARTMENT.
Railway Construction.

To

The Joint Secretary to the Government of Madras
(Railway Branch), Public Works Department.

Calcutta, the 2nd December 1895.

Sir,

In continuation of Government of India letter
No. 1050 R.C., dated 2nd September 1895, I am directed to
forward 2 copies of the complete Chart of the recent
survey of Palk's strait, together with 2 copies of the
hydrographic notice relating to that strait issued by the
Marine Department.

1. To Mr. J. C. ...
to Mr. C. ...
Colombo. 19/12/95

I have the honour to be,

Sir,

Your most obedient servant,

G. A. ...

Assistant Secretary.

Documents accompanying:-

2 copies of Chart and notice
referred to.

1 plan put in for Rent 2/ ...
22/95

300

Ends 1 (15.0)

Obs: 7.12.95

The information in this Notice is to be carefully considered, noted in the Sailing Directions, and compared with the Charts when the ship is navigating in the locality to which it refers.

Hydrographic Notice.

[No. 2 of 1895.]

PALK STRAIT.

The following remarks relating to Palk Strait are derived from the Survey in 1895 by Commander C. F. Oldham, R. N., and the officers of the Marine Survey of India.

[All Bearings are Magnetic. Variation in 1895 1° E.]

PALK STRAIT, so named after the Dutch Governor who first navigated it, separates Ceylon from the south-east part of the peninsula of Hindustan and at its entrance, between Point Palmyra and Point Calimere, is about 34 miles in width. The old Dutch navigators mention three passages through the strait, the southern one of which, between the north coast of Ceylon and the shoals to the northward, is the original Palk Strait. To the south-west, Palk Strait opens out into a considerable sheet of water, stretching about 60 miles in that direction, and about the same distance further to the south-east, known as Palk Bay, having over it depths of from 6 to 7 fathoms, with a muddy bottom. Palk Bay washes the north coast of Ceylon on its eastern, and the coast of Tanjore and Madras on its western side.

The islands of Rameswaram and Manár, with their shoal connection known as Adam's Bridge, form a broken breakwater at the head of Palk Bay, dividing its waters from those of the Gulf of Manár; the Pamban Pass between Rameswaram island and the Hindustan Coast, making a narrow connecting channel.

There are two recognized entrances into Palk Bay; one between Point Calimere and the northern end of the middle banks, has from 21 to 24 feet of water; the other (Palk Strait proper) between the south banks and the north coast of Ceylon, has a depth of not less than 30 feet at

low water when crossing the northern end of the Pedro Shoals, in the eastern part of the Strait; and near the western limit of the Strait, at about 5 miles north-westward of Karativú, there is a clear channel with a depth of not less than 33 feet at low water. There are other places where vessels might cross the banks in depth of 20 to 24 feet, but being out of sight of land there is no guide to them, and therefore they are not recommended.

JAFFNA PENINSULA, the northern coast of which borders the south side of Palk Strait, is the chief of the four districts comprised in the Northern Province of Ceylon, the others being Manár, Mullaitivú, and Vavuniya. Jaffna district had, in 1891, a population of 279,636, chiefly Tamils. Jaffna, the principal town and port, is the residence of the Agent for the Northern Province. The other ports in Jaffna district are Point Pedro, Valluvadditurai, Kankasanturai, and Kaits.

Communication.—The town of Point Pedro is connected by telegraph through Kankasanturai, Jaffna, and Manár, with Colombo and the Indian system of telegraphs.

The Steamers of the Ceylon Steam Ship Company generally make two voyages each round the Island of Ceylon in a month, one proceeding southward and the other northward round the island. They call at Kankasanturai during the south-west monsoon, or from the middle of February to the middle of October, and at Jaffna during the north-east monsoon. Point Pedro is visited at both seasons.

The British India Steam Navigation Company's steamers call generally at Kankasanturai during the south-west monsoon on Saturdays, on their return from Negapatam to Colombo. During the north-east monsoon they call sometimes at Jaffna and occasionally at Kaits.

Mail Coach.—There is a mail coach service between Point Pedro, Kankasanturai, and Jaffna, and between Jaffna, and Matali, from which place there is a railway to Kandy.

Trade.—The trade of the Northern Province is carried on through the ports already mentioned, and the ports of Manár, Pesalai, and Vankalai in the district of Manár, and Mullaitivú on the east coast.

Exports.—In 1894 the exports were valued at Rs. 15,61,148, the principal being tobacco, chanks, palmyra timber, elephants, béche-de-mer, and jaggery; other exports are coconuts, dried fish, honey and salt.

Imports.—In 1891 the imports were valued at Rs. 33,16,602, the chief being paddy, rice, cotton goods, curry-stuff, grain, earthenware, jewellery, iron bars, castor oil, and sugar.

THE JAFFNA PENINSULA is low, formed of coral and sand, its northern coast being generally protected by a narrow fringing reef; low coral cliffs and sandhills being occasionally visible. Trees from 70 to 90 feet in height line the northern coast, and can be seen from the deck of a ship, at a distance of about 14 miles.

POINT PEDRO, in latitude 9° 49' 40" N., longitude 80° 14' 50" E., forms the north-eastern point of the peninsula. The town and part of the same name, where there is a custom house and several bungalows on the beach, is situated about three-quarters of a mile westward of the point; the custom house with its red roof being a conspicuous mark near the landing place.

The port is open from about the middle of February to the middle of October. During 1894 it was visited by 360 vessels of 32,341 tons. Nineteen country craft of 1,412 tons belong to the port.

Supplies.—There is a native market, where fowls and vegetables can be procured; sheep and bullocks can be obtained by giving notice.

COAST.—From Point Pedro the coast trends West and W. N. W., a distance of 2½ miles to Point Palmyra, then W. S. W. and West 4½ miles to Tondaimanár. A fringing reef lines the coast and extends from a half to one cable from the shore; outside this the water deepens rapidly to the 5 fathom line, which is about 3 cables from the beach. The coast is lined with Palmyra and coconut plantations, and a good road leads from Point Pedro along the coast to the westward.

VALLUVEDDITURAI, situated 2½ miles west of Point Palmyra, is a port where vessels of from 30 to 250 tons are built. A break in the reef affords good entrance to boats. There is a considerable village and native market where fresh provisions may be obtained.

TONDAIMANAR, situated two miles west of Valluvadditurai, is marked by a cliff 25 feet high, half a mile to the westward of which is the entrance to a backwater which forms a gap when viewed from the northward. From Tondaimanár the coast trends W. S. W., West, and W. by N. to Kankasanturai; the reef along this coast is close to the beach, but the 5 fathom line extends half a mile from the shore; vessels should not approach within this distance.

KANKASANTURAI is the chief port of call for steamers during the S. W. monsoon; they commence calling in February or March and continue until October.

Four vessels of 233 tons are owned locally, and during 1894 the port was visited by 310 vessels of 79,518 tons, carrying paddy and rice chiefly. There is a custom house, the custom officer being Master Attendant for the port.

Two stone piers in ruins will be noticed on the beach, on the western of which is built the lighthouse. A small wooden pier, which can be used by boats during the S.-W. monsoon, has been built on the beach. Cargo boats which are anchored off the beach can be obtained for landing cargo during fine weather.

Supplies.—Water can be obtained and fresh provisions if notice is given.

Anchorage may be obtained off Kankasanturai in 5 fathoms, sand and mud, with the lighthouse bearing S. S. W., distant $3\frac{1}{2}$ cables; and the rocky point about $1\frac{1}{2}$ miles west of the lighthouse just abutting in the distant point. Vessels are recommended not to anchor to the westward of the lighthouse as the bottom is foul in that direction.

LIGHT.—On the western ruined pier is a column 73 feet in height, coloured white, from which is exhibited, at an elevation of 75 feet above the sea, a fixed green light, visible in clear weather a distance of 14 miles. The light is obscured by trees on bearings north of east.

Tides.—It is high water, full and change at Kankasanturai at 7 hours 35 minutes; springs rise 3 feet, neaps rise 2 feet, neaps range $1\frac{1}{2}$ feet.

The Coast from Kankasanturai curves to the southward as far as Karativú; it is fringed by a coral reef and bordered with Palmyra and coconut trees. One and a half mile west of Kankasanturai is a conspicuous cliff 26 feet high, and nearly a mile further is a Roman Catholic church in course of construction.

Soundings.—Westward of the church the three-fathom line recedes from the shore, and off Matakai (marked by a conspicuous sand hill) is two miles from the coast.

Rock.—A patch of coral, with 11 feet of water over it, lies off Matakai with the conspicuous sand hill bearing S. 42° E., distant $1\frac{1}{2}$ miles, and the cliff point near Kankasanturai N. 88° E.; inside the patch the bottom is uneven and foul.

The Islands off the N. W. side of Jaffna Peninsula, extending for 12 miles to the S. W., are a cluster of low coral islands separated by narrow shallow channels only navigable by boats. Farther to the S. W. is Delft Island or Neduntivú separated from the other islands by a good channel 4 miles broad.

KARATIVU, the northern island of the group, is separated from Jaffna Peninsula by a shallow passage a third of a mile broad; it is a low coral island covered with trees, the highest being on the N. W. extreme. A sand hill 20 feet high with some palms on it, situated on the N. E. point, is conspicuous when viewed from the north-westward. At the

entrance to the channel between Karativú and the mainland there are numerous shoals and rocks, closing the channel to anything but boats.

ELUVAITIVU, 2 miles in length S. by W. and N. by E. and about 3 cables broad, lies south-westward of Karativú; it is low and covered with trees about 70 feet high; between it and Karativú is the entrance to the port of Kaits.

Shoals.—A shoal with a depth of $3\frac{1}{2}$ to 3 fathoms over it lies $5\frac{1}{2}$ miles N. 21° W. from the north extreme of Eluvaitivú, in Latitude $9^{\circ}47'45''$ N., Longitude $79^{\circ}47'5''$ E.; another, with a depth of $3\frac{1}{2}$ fathoms over it, lies N. 1° E., distant $4\frac{1}{2}$ miles from the same island in Latitude $9^{\circ}47'30''$ N., Longitude $79^{\circ}49''$ E. Between these shoals and Eluvaitivú are numerous patches composed of hard sand, having depths of 2 to $3\frac{1}{2}$ fathoms over, and with 4 to 5 fathoms between them. These shoals are probably composed of coral covered with sand.

Caution.—Vessels proceeding to Palk Bay or Jaffna should steer to pass about one mile to the northward of the northern shoal.

KAITS, situated on the northern side of the island of Velani and south of Karativú, is an open port throughout the year, but the S.-W. monsoon is the busiest season, there being then sometimes as many as 30 to 40 vessels in the anchorage at the same time. The entrance lies across the flats between Karativú and Eluvaitivú. Fort Hammonheil is the quarantine station for the port. The port was visited, in 1894, by 460 vessels of 17,475 tons. Country craft are hauled up and repaired here.

Supplies.—There is a small town, and a limited quantity of fresh provisions can be obtained.

Anchorage.—The small country vessels lie in the outer anchorage in $2\frac{1}{2}$ to 3 fathoms, and discharge part of their cargo before proceeding to the inner anchorage. Steamers should anchor in 4 fathoms, sand, with the north point of Eluvaitivú bearing S. E. distant about one mile.

Directions.—Small vessels when making for Kaits harbour from the eastward, should, after passing the north end of Karativú, keep about 2 miles from the coast, until Fort Hammonheil, on the S. W. point of Karativú bears S. E. by S., when steer for it until about a mile distant; a vessel will then be in 9 feet, smooth water, and should steer round the fort at a distance of from one to three cables, care being taken, when the fort has been rounded, to keep on the north side of the harbour until past a bungalow there situated. The best anchorage is off the custom house in about 2 fathoms, mud.

ANALATIVU, lying to the S. W. of Eluvaitivú, is $2\frac{1}{2}$ miles long by one mile broad; part of the island is covered with trees 70 to 80 feet high.

On its north-east and south sides are small islets 15 feet high, which appear to be joined to it when the island is viewed from the westward.

Shoal ground, with $3\frac{1}{2}$ to 4 fathoms water over it, lies $1\frac{1}{2}$ miles west of the north point of Eluvaitivú, and extends southward off the north-west side of Analativú from half to one mile.

NAINATIVU lies $1\frac{1}{2}$ miles south of Analativú; it is $2\frac{1}{2}$ miles long by half a mile broad, and has trees about 70 feet high on it; it is bordered on its western side by a narrow fringe reef.

Shoal water, with depths of $2\frac{1}{2}$ to 4 fathoms, extends three-quarters of a mile from its western shore, but to the south-west the five fathom line approaches to within 4 cables.

DELFT or NEDUNTIVU—South-west of Nainativú and separated from it by a channel 4 miles broad, is the large island of Delft or Neduntivú. It is 6 miles long north-west and south-east with an average width of 3 miles. High trees are situated on its north-east and western sides, in the centre is grass land and low trees about 20 feet high. From a distance to the northward, it looks like two islands. It is steep-to, except on the north side where shoal water under five fathoms extends in a point 6 miles to the northward.

A beacon 40 feet high is situated on the south-east side of the island; it marks the site of the station used by the Great Trigonometrical Survey of India, when triangulating between India and Ceylon.

Channel.—Between the Neduntivú shoal and the shoal water off Nainativú is a clear channel, one and three quarters of a mile broad, having in its narrowest part a depth of not less than five fathoms.

Directions.—When clear of West Channel, and intending to proceed to Jaffna using Delft channel steer S. 5° E., fixing the position by using the tangents of the trees on the islands; when at the northern entrance to the channel, the tall trees on the north-east of Delft should be visible bearing south, when steer for them, until the south point of Nainativú bears E. $\frac{1}{2}$ N., then a S. E. course will take a vessel clear into Palk Bay.

Middle Banks.—From a position about $5\frac{1}{2}$ miles S. E. $\frac{1}{2}$ S. from the beacon on Point Calimera, the middle banks which are formed of hard sand, extend in patches in a southerly direction for $7\frac{1}{2}$ miles, with uneven soundings of from $1\frac{1}{2}$ to 3 fathoms and deeper water between. The shallowest water found was 8 feet on the northern patch, and 10 feet on the second, $6\frac{1}{2}$ and 9 miles distant respectively, S. 18° E. from the beacon on Point Calimera. On the western part of the third patch there is also a depth of 11 feet.

South Banks consist of four shoals with less than 3 fathoms on them, the northern and shallowest with $2\frac{1}{2}$ fathoms on it, lies 13 miles N. N. W. from Kankasanturai lighthouse. The others extend $4\frac{1}{2}$ miles to the southward, and have depths of from $2\frac{1}{2}$ to 3 fathoms water over them. From the south banks depths of $3\frac{1}{2}$ to 5 fathoms extend 12 miles S. W. $\frac{1}{2}$ W.; to the channel leading into Palk Bay, and to the eastward joining the northern part of the Pedro Shoals.

Middle Channel.—Between the middle and south banks is a channel 5 miles broad with a least depth of $3\frac{1}{2}$ fathoms, and in the centre of this channel in Lat. $10^{\circ} 3' 30''$ N. is a deeper passage, one mile broad, carrying not less than $3\frac{1}{2}$ fathoms; this channel is out of sight of land, therefore latitude is the only guide.

Directions—East Channel is a 5 fathom passage across the shoal water connecting the south banks and Pedro Shoals. Vessels making Palk Strait from the north-eastward should steer for a position in Lat. $10^{\circ} 3' N.$, Long. $80^{\circ} 8' E.$, the tops of the trees between Point Pedro and Tondaimanár will then be visible, and a south course may be steered for Tondaimanár gap, not less than 5 fathoms should be met with in this channel; when the depth increases a course may be shaped for Kankasanturai, or Point Pedro as necessary.

West Channel.—After passing Kankasanturai, the lighthouse must not be brought to bear east of E. by S. until Eluvaitivú is well open of Karativú, and the conspicuous sand hill at Matakai, bearing S. 36° E.; the shoal off the latter place will then be passed and a course can be steered to enter the West Channel.

At the east entrance to the West Channel with the 20 feet sand hill on the north-east point of Karativú, bearing S. 54° E., and Fort Hammonheil (which shows out clear of Karativú against the low land of Kaits), bearing S. 10° E., a vessel should steer N. 80° W. 6 miles through West Channel, when a course may be shaped for Delft Channel or Pamban.

Currents—Tides.—During the months of February, March, and April, no current was observed in Palk Strait. The tidal streams were very regular, changing every six hours, the flood setting to the eastward, and the ebb to the westward, between the shoals. From the West Channel to Delft Island the tide sets with the general direction of the coast, the flood setting northerly and north-easterly, and the ebb southerly and south-westerly; the strength at springs being nearly a knot.

Wind and Weather.—In Palk Bay, as in the Gulf of Manár, the south-west winds generally commence about the middle of April with fine clear weather. Early in May, the south-west monsoon blows fresh, and continues until about the middle of August, when it moderates, gradually

dying away about the end of September; the sky then becomes overcast, and about the 10th of October the north-east monsoon commences, with hard squalls from different quarters, accompanied by heavy rain, thunder, and lightning, which weather continues during the month. The wind then becomes steady from the north-east, but during the months of November, December, and January, there are frequent gales and much rain. In the early part of February, the north-east winds take off, and regular sea and land breezes set in, which continue until the middle of March, when calms prevail for several days, and the heat increases until the return of the south-west winds in April.

POINT CALIMERE forms the northern point of entry to Palk Bay, and the southernmost point of the Coromandel Coast. A beacon 33 feet high with two arms painted white is situated on the point, and one cable S. S. W. is a steel mast, carrying a light; $3\frac{1}{2}$ cables to the southward and surrounded by water is the ruin of a beacon. About 3 miles westward of the point are the Kodigiri bungalows, formerly much resorted to during the hot weather. At about 5 miles N. by W. $\frac{1}{2}$ W. from the point, and a mile in shore, are two dark looking pagodas, in shape like oblong haystacks, which when in line bear West. A sand bank, dry at low water, inside which trading boats find shelter in bad weather, extends about one and a half miles N. E. by E. of Calimere beacon.

The three fathom bank extends N. E. by N. and S. W. by S. at a distance of one and a half miles S. E. from Point Calimere, and 5 miles S. S. W. from the point; it then turns westward at about 4 miles from the coast.

Shoal.—In the channel between middle banks and the three-fathom line off Point Calimere, and S. 30° E., $4\frac{1}{2}$ miles from the beacon, is a shoal with a depth of $2\frac{1}{2}$ fathoms over it; it is composed of hard sand, extends 4 cables east and west, and is about 3 cables broad.

LIGHT.—A fixed pale red light, elevated about 55 feet above high water, and visible in clear weather from 6 to 9 miles, is exhibited from a steel mast (about 45 feet high) on Point Calimere. At the foot of the mast is a box painted white which contains the lantern during the day, and is a conspicuous object.

Forest Reserve.—At Point Calimere and in the vicinity is a forest reserve, apparently under the control of the Collector of the District. Here are many hundreds of antelope, spotted deer, and wild pig; they are strictly preserved, the officers employed in the survey being refused permission to either land, or shoot in the neighbourhood.

DIRECTIONS.—In rounding Point Calimere from the eastward, by the channel north of the middle bank, and immediately south of Point

Calimere, the position of a vessel may be obtained by cross bearings of the two pagodas to the northward of the point, and of the beacon or steel mast; prior to shaping a south-westerly course clear of the three-fathom coast bank on the north side, and the detached two-and-three-quarter fathom patch on the south. A depth of more than 21 feet cannot however be relied upon. Careful attention must be paid to the lead.

Sr. L. S. WARDEN, Lieut., R. I. M.,
Officiating in charge Marine Survey of India.

*Marine Survey Office,
 Bombay, 30th July 1895.*