

Report of
Sir John Wolfe Barry,
Lyster & Partners on the
Ports of Tuticorin,
Nagapatnam, Mangalore
etc
1920

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MADRAS PRESIDENCY.

Report

OF

SIR JOHN WOLFE BARRY, LYSTER & PARTNERS,
on Suggested Developments at the Ports of
TUTICORIN, NEGAPATAM, MANGALORE, MALPE
AND COCANADA.

To HIS EXCELLENCY,
THE GOVERNOR OF MADRAS,
MADRAS, INDIA.

28th FEBRUARY, 1920.

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28th February, 1920.

To HIS EXCELLENCY,
THE GOVERNOR OF MADRAS,
MADRAS, INDIA.

YOUR EXCELLENCY,

1. In accordance with instructions conveyed to us by the Secretary, Public Works Instructions, Department, India Office, in letters of various dates between October 1st, 1918, and May 27th, 1919, we have the honour to report in detail on the possibilities of development combined with the future prospects of the following five ports situated in the Madras Presidency, namely, Tuticorin, Negapatam, Mangalore, Malpe and Cocanada.

2. As arranged through the above-mentioned correspondence, Lt.-Col. DuCane, O.B.E. R.E., was deputed by us to proceed to India, in order that he might visit the five ports mentioned and collect on the spot the detailed information which it was necessary for us to have with regard to their physical features and prospects of development. Colonel DuCane accordingly left this country on April 16th, arrived in Bombay on May 8th, and reported himself on May 12th at Madras to Capt. C. B. Henley, R.I.M., in whose hands all the arrangements for the inspection of the ports had been placed. Colonel DuCane left India early in August, but in accordance with the permission granted to us he subsequently also visited China on our behalf and Canada on his own private affairs. In consequence of this detour he did not reach England until the middle of November.

3. In view of the fact that we had not been able to give Col. DuCane before he left England exact information with regard to the scope and extent of the enquiry desired by the Madras Government, his first step was to ascertain from Capt. Henley whether he had any definite information on this point. In consequence, Col. DuCane received on June 6th a copy of the following memorandum:—

"MEMORANDUM."

No. 742—IV—2 dated Ootacamund, the 31st May, 1919.

"The Presidency Port Officer is informed that Col. DuCane should limit his investigations of each port by the consideration that any scheme to be offered must be of such a scope as is justified by the prospects of future trade and is likely in the course of time to pay for itself. Local commercial opinion should be consulted on this point.

Any doubt which Col. DuCane may have as to the scope of his investigations regarding a particular port should be referred to Government.

The Presidency Port Officer is requested to suggest to Col. DuCane that if he does not receive instructions from his principals in time in regard to Cocanada and is in doubt regarding his authority to investigate that port he should cable to them for orders.

The Government consider that it would be useful if the Presidency Officer and Col. DuCane can arrange to come up to Ootacamund on their way from Mangalore to Madras after they have visited all the ports.

(By Order)

(sgd) S. WADSWORTH,
Under Secretary to Government.

(sgd) C. W. HENLEY, Capt. R.I.M.,
Presidency Port Officer.

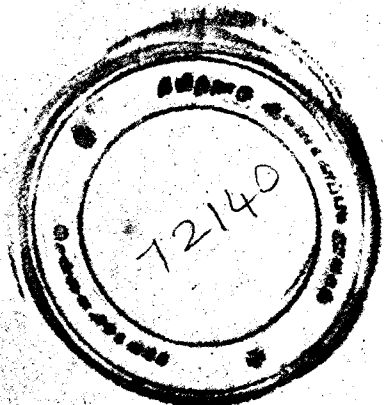
Tras, 6th June, 1919.

Presidency Port Officer, Madras."

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General consideration of Port Development.

4. Before dealing with the individual ports and their possibilities for development it is necessary to consider generally the present situation with regard to the main ports in the Madras Presidency and their relative situations with regard to Railway communications and other facilities. For this purpose we attach to this report Plan No. 1 which shews roughly the situations and distances from each other of the different ports together with the Railway connections, starting from Vizagapatam at the N.E. corner of the Presidency, thence to the southward, up the West coast to Malpe and beyond the borders of the Presidency to Bhatkal and Marmagao. The two latter ports are included in the general survey as, although not situated in the Madras Presidency, they form outlets for the trade of the Presidency and also of the Mysore State—Marmagao belonging to the Portugese Government and Bhatkal being within the boundaries of the Bombay Presidency. It is particularly necessary to consider Bhatkal in relation to the Madras Ports, as there is at present under consideration a scheme for its development by the Government of the Mysore State which has no coast line of its own.

Effect of Western Ghats.

5. The natural trend of carriage of goods to the seaboard is materially affected and will probably always be so by the physical feature of the Western Ghats. This range of hills runs through the Mysore State and Madras Presidency in a direction generally parallel to the Western Coast and with a watershed at a distance from the coast varying from 40 to 80 miles. Except for the Palghat gap through which the Madras—Mangalore Railway runs with a summit elevation at Podanur of about 1,200 feet, there are we understand no other passes of an elevation much less than 2,000 feet, thus involving somewhat steep gradients for railways projected over the Ghats. The result is that the greater portion of the South Indian territory must be considered as tributary to the East rather than to the West Coast, as goods will always tend to go "with the grade."

Trade Statistics.

6. The following Table shews the value of the import and export trade of the more important ports for the year 1913-14 together with the increase in the previous ten years and the relative percentage which the trade of each port bears to the total trade of the Presidency. These figures are taken from the report on Tuticorin Harbour included in G.O. No. 1087 of 20th July, 1916.

PORTS.	Value of trade in 1913-14.	Increase in 10 years.	Relative proportion of trade of whole Presidency.
	Rs. Lakhs.	Per cent.	Per cent.
Madras	2,350	68	40.4
Tuticorin	989	134	17
Cochin	701	118	12
Cocanada	278	56	4
Calicut	270	27	4
Mangalore	209	18	3
Negapatam	216	84	3
Cuddalore	160	18	2
Total trade of Presidency, including Government Stores and Treasure	5,816	65	100

Throughout this report in considering the Trade prospects of the various ports we have taken the figures for 1913-14 and the preceding years, as owing to the war the figures of the subsequent years are abnormal and not reliable as a basis of future prospects.

Ports on East Coast.

7. On the East Coast Madras is at present the only port with deep water wharves and shelter for vessels during storms. It is, however, probable that Vizagapatam will be developed as a deep water port in the near future. This being so, we do not consider that there will be scope for another first class port between Madras and Vizagapatam for many

years to come. Apart from this consideration, the physical difficulties at Cocanada, as will be seen when we come to describe it in detail, are such that we do not consider the expenditure of a large sum of money at this place would be warranted. Southward of Madras, there are only open roadsteads, cargo being carried between ship and shore in native boats varying in size from 15 to 100 tons capacity.

Competition with Colombo.

8. The Ports of Southern India are to some extent in competition with Colombo by means of the Dhanushkodi route which has been developed by the South Indian Railway. It appears, however, that this route has not affected the trade of the Madras ports to the extent which might have been anticipated. We therefore think that if good facilities are provided on the mainland, at which vessels can load alongside deep water wharves, the trade attracted by the Dhanushkodi route is likely to be inconsiderable except as regards passengers and mails and part of those goods which have Ceylon as a final destination. This opinion is based on the following facts:—

(i) The distances by rail from Erode, the junction of the S. I. R. broad gauge line, with the metre gauge system, are as follow:—

Erode to Dhanushkodi	289 miles.
„ to Negapatam	123 miles.
„ to Tuticorin	277 miles.

The distances from Madura, the junction for Dhanushkodi and Tuticorin are:—

Madura to Dhanushkodi	110 miles.
„ to Tuticorin	98 miles.

There is therefore no advantage for the Dhanushkodi route on a shorter length of haul except for traffic arising between Madura and Dhanushkodi.

(ii) On the Dhanushkodi route goods have to be loaded into the steamer and carried about 22 miles to Talaimannar, then reloaded on to rail and hauled a little under 200 miles to Colombo. This involves two additional handlings of goods as compared with direct loading at a deep water wharf on the main land.

(iii) Provided the capital cost of construction is reasonable, the mainland ports would have a distinct advantage in rates chargeable since labour is more expensive in Colombo than on the mainland.

(iv) The supply of labour is more assured on the mainland, as we understand that the coolie labour of Colombo and Ceylon is largely recruited from South India.

9. An examination of the trade figures for the more important ports given above shews that at Tuticorin there has been an increase of trade during the ten years to 1913-14 amounting to 134 per cent., while in the year 1913-14 the trade passing through this port represented 17 per cent. of the total trade of the Presidency. Looking generally at the hinterland, railway connections and other features, combined with the trade prospects, it would appear that there is scope for an additional deep water port at Tuticorin where ships could lie in shelter alongside a wharf and could load or unload direct into or from the railway trucks. We have, therefore, prepared a plan and estimates for improving this Port which will be described later in detail.

10. It is possible that in the future, as trade develops further, it may be necessary to consider the provision of another good port in the neighbourhood of Negapatam; but the natural advantages at this place are so poor that a large expenditure would be necessary to convert it into a first class port, and we consider that at the present moment it would be unwise to attempt anything further than an improvement of the existing facilities for barge traffic between ship and shore.

Cochin.

11. Passing round to the West Coast there is at present no fully developed port in the Presidency on this side and, owing to the physical obstacle presented by the Western Ghats, the railway situation is not favourable. The most important port is Cochin, with an import and export trade in 1913-14 amounting to Rs. 701 lakhs and representing 12 per cent. of the total trade of the Presidency. Although this port is not included in the present reference, we had the honour of reporting upon it to the Under Secretary of State for India on January 18th, 1918, and of submitting proposals for its improvement and development which, we understand, are likely to be proceeded with in the near future.

Cochin to
Marmagao.

12. On the assumption that Cochin will be developed there will remain a stretch of nearly 350 miles of coast between Cochin and Marmagao upon which no deep water harbour or wharves exist—Calicut, Tellicherry, Mangalore and Malpe all being open roadsteads. Traffic arising on the Erode—Shoranur Railway and country to the south of this line will find its natural outlet at Cochin and there does not seem likely to be sufficient traffic tributary to the line along the coast from Shoranur to Mangalore to justify any large expenditure on port development. To justify such expenditure it would seem to be essential that the port to be developed should have railway connection with the Mysore hinterland. We, therefore, consider (and our opinion is confirmed by Col. DuCane's conversations with the various merchants and planters) that within a reasonable period there is only likely to be room for one deep water port between Cochin and Marmagao and this must be considered in close conjunction with the future railway connections and due regard to certain business concerns already firmly established.

Mangalore,
Malpe and
Bhatkal.

13. The choice appears to lie between Malpe and Bhatkal, since Mangalore, as will be seen from our detailed report on this port, does not lend itself to deep water development owing to its physical characteristics. Malpe on the other hand appears to be more favourably situated for development if a suitable railway connection is constructed and, as will be seen later, we have prepared a scheme showing how in our opinion this development could best be effected.

Bhatkal.

14. As your Excellency is no doubt aware, our partner, Mr. A. G. Lyster, has recently prepared plans and estimates for the development of Bhatkal involving the extension of the Mysore State Railway to that port and should that scheme be proceeded with we do not think that the future trade prospects would at present warrant another deep water port between Cochin and Bhatkal.

General
Summary.

15. Briefly summarising the general remarks and opinions expressed above, we consider:—

(i) That the development of the Madras Ports must be considered as a whole and not individually.

(ii) That Tuticorin, both from its physical advantages and future trade prospects, is the most promising of the five ports upon which we are asked to report.

(iii) That viewing the situation generally, Tuticorin, Cochin and possibly one port between Cochin and Marmagao could be advantageously developed.

(iv) That of the two ports Mangalore and Malpe the latter offers the better natural possibilities for deep water development provided that further surveys and borings shew that the scheme which we are outlining can be economically constructed. Should however, the improvement of Bhatkal be proceeded with we do not think that it would be a commercially sound proposition to develop Malpe.

(v) That although the present facilities at Negapatam, Mangalore and Cocanada can probably be improved, these ports do not offer any natural advantages for deep water development.

16. We now proceed to describe the individual ports, taking first in order the most important one of the five, viz. :—

THE PORT OF TUTICORIN.

17. Colonel DuCane visited the Port of Tuticorin with Capt. Henley and there met the Port Officer, Mr. C. Heard White, and Mr. Dillon, the Executive Engineer, P.W.D., of the Tinnevely District. He also had the advantage of meeting many of the principal merchants, besides attending an official conference with the members of the Landing and Shipping Fees Committee, at which the various questions connected with the port were fully discussed. Col. DuCane's Visit.

18. The coastal region is very flat for some miles inland and the coast itself is only slightly elevated above high water. The land is to a large extent irrigated, and the hinterland is a large cotton growing district from which the produce mainly finds its way to Tuticorin for export. The islands in the vicinity are low-lying, sandy and surrounded by coral reefs. At the present time vessels visiting the port lie out at the anchorage some five miles from the shore to the east of Hare Island. Cargo is handled over side and is carried between vessel and shore in native boats of various sizes, mostly of from 40 to 60 tons capacity. Inshore there are two piers each about 400 feet long with tram-lines and hand-trucks, one pier being used for imports and the other for exports. A depth of 6 feet of water is maintained by dredging alongside the piers and also in the approach channel to the piers. General description of present Harbour.

19. We have had an opportunity of examining three charts or surveys dated 1842, 1879 and 1912. The most interesting feature on these surveys is the Devil's Pass, a channel which used to exist between the islands and the mainland. In 1842 this channel had a width of 1,200 feet at the narrowest point, with a depth of 16 to 18 feet at low water. The survey of 1879 shows the channel much decreased, the width then being only 650 feet although the depth of water was still from 16 to 17 feet. The survey of 1912, which was made by Commander Hands, R.I.M., shews that at this date the channel was completely closed. Charts and Surveys.

20. We have also been supplied with particulars of a certain number of borings which were unfortunately carried hardly deep enough for such purposes as quay wall foundations, etc. Col. DuCane inspected the materials taken from the borings, but they were of little value as the cores were so much pulverised that it was not possible to judge the hardness of the coral at the various depths. Borings.

21. The tidal ranges at Tuticorin are as follow :—

Spring tides	...	...	...	...	...	2½ to 3½ feet
Neap	„	...	...	...	...	1½ „ 1¾ „

Exceptional tides have been known to reach a height of 4 feet. Tides.

22. There do not appear to be many data available regarding currents, but from the information gathered by Colonel DuCane these appear to be unimportant. He was informed by the Captain of the British India steamer "Akbar" that there was only a slight current along shore of about 1 to 1½ knots per hour, the tidal current running North on the flood and South on the ebb. An examination of the charts shows that there used to be a considerable tidal current through Devil's Pass. The 1842 chart shows a current in this channel of 3 knots per hour on the ebb and the 1879 chart a current of 1 to 1½ knots at spring tides. Littoral Currents.

23. The strongest winds occur during the South West Monsoon, but they are off-shore and are consequently accompanied by smooth sea. The winds in the North East Monsoon are not nearly so strong and the seas, though sharp, are not heavy. The Port Wind.

Officer informed Colonel DuCane that during the four years he has been at Tuticorin there has been no day when ships lying in the roadstead have been unable to handle cargo overside. This statement has been confirmed from other sources of information. Tuticorin is generally considered to be outside the cyclone area, as the only cyclone recorded was in 1845.

Strength of Wind.

24. We have analysed the information contained in the publications entitled "Charts of the Arabian Sea and adjacent portion of the North Indian Ocean" and "The Meteorological Atlas of the Indian Seas" published by the Meteorological Department of the Government of India in 1888 and 1908 respectively. These publications cover between them a period of some 30 years and should therefore give good average results and from these it appears that the South West Monsoon does not blow true, there being a large number of off-shore winds in this season from all points between S.W. and N.W. In October about 43 per cent. of all winds are from E.S.E. and S.E. and 40 per cent. from S.W. and S.S.W. In December 50 per cent. of all winds are from N. to N.E. The highest average strength of wind occurs in July and August and is represented by 4.9 on the Beaufort Scale. It must be understood that this figure is a monthly average and does not therefore represent the maximum strength of the wind.

Sand Drift.

25. Colonel DuCane was not able to obtain much information with regard to littoral sand drift, but the general opinion seems to show that it is very small. Since the closing up of Devil's Pass the bay to the south of the Pass seems to have made up to a small extent and this may indicate a slight preponderance of drift from the South. If this be the case the bay should form a good sand trap and should assist in preventing the silting up of an entrance channel to the harbour. Rain is a rare occurrence in this district, but there is a considerable amount of wind-blown sand passing over the harbour area during the strong West and S.W. winds. The spread of vegetation is helping to lessen this and it could no doubt be further minimised by planting trees, etc., to form sand checks. We do not, however, consider that wind-blown sand need be taken into consideration as a serious factor.

River Upar Odai.

26. The only river affecting the harbour is the Upar Odai and it is to this river that the silting up of the inner harbour is attributed. This appears to be borne out by the analysis of the silt from the harbour and from the river bed. The river has now been diverted and discharges just south of the south boundary pillar of the Port some $3\frac{1}{2}$ miles South West of Devil's Pass. This work was only completed in 1918 and it is therefore too early to judge of the effects on the harbour, but the Port Officer is of opinion that the water is much clearer than it used to be before the diversion. The maximum flood discharge is estimated at 30,000 cubic feet per second.

Waves.

27. No observations of the heights of waves appear to have been made, but it may be safely inferred, from the fact that cargo can be worked overside throughout the year, that heavy wave action need not be anticipated.

Railway Access.

28. The only Railway connection at present is to the South Indian Railway metre gauge system and we do not anticipate that there will be any difficulty in arranging railway access to a new deep water Quay, as no heavy bridging or other expensive work would be involved.

Land.

29. A large area of land is already in the hands of the Port Authorities or of the Government and is amply sufficient to provide for all possible needs for many years to come.

Landing and Shipping Fees Committee.

30. In order that the local views could be obtained on the various questions affecting the Port, it was arranged that Colonel DuCane should be afforded an opportunity of attending a meeting of the Landing and Shipping Fees Committee. This meeting took

place on May 20th, 1919, and several matters were discussed in detail, the chief of which are as follows:—

(i) Rates chargeable.

It was pointed out that the figure of R.1 per ton taken in the preliminary report on Tuticorin Harbour contained in G.O. 1087 of 20/7/16 as the nett revenue (after payment of working expenses) available for interest, maintenance and sinking fund, would give a low total charge when compared with the figures ruling at Madras, Bombay, or Colombo. After considerable discussion the members of the Committee finally agreed that Rs.1-8-0 might be taken instead of R.1. In estimating the probable nett revenue we have accordingly adopted this figure of Rs.1-8-0.

(ii) Size of Ship.

It was stated that the largest ship at present using the Port is about 10,000 tons, with a maximum draft of about 28 feet. It was, therefore, decided that the depth of any new channel recommended should not be less than 30 feet at low water.

(iii) Length of Wharfage.

The length of deep water quay which would be required in the first instance provoked considerable discussion. It was pointed out that at the present time up to nine ships have been anchored in the roadstead at one time and that ships often stayed at Tuticorin for ten days or a fortnight. If, however, a quay is provided alongside which ships could lie for the purpose of loading or discharging it was agreed that with these new facilities cargo would be handled more quickly and, allowing for increase of trade, a length of not less than 3,000 feet should be constructed in the first instance, provision being made for future extensions as they become necessary owing to the increasing trade of the Port.

(iv) Cranes.

The question as to whether the scheme for development should include the provision of electric or hydraulic cranes was mentioned by one member of the Committee and it was suggested that hydraulic equipment would be the most suitable as it is more easily and more safely handled by native labour, especially in a port where no troubles arising from frost have to be feared.

(v) Labour.

The opinion was expressed that there should be no difficulty in obtaining an ample supply of unskilled labour, but that skilled labour would have to be imported from other parts.

(vi) Water Supply.

The conditions of water supply are at present very indifferent, as drinking water has to be brought over from Colombo by steamer. Colonel DuCane was informed that the Public Works Department have in hand a new water supply scheme and that there will be no difficulty in extending this scheme so as to include the site which may be selected for the new harbour.

(vii) Scheme 3.

The three schemes outlined in G.O. 1087 were considered as Colonel DuCane was anxious to obtain the local opinion as to whether, if Scheme 3 or a similar scheme were recommended, the distance of the new quay from the present business part of the town would be a serious difficulty. The general opinion was expressed that a new quay on the site proposed in Scheme 3 would not militate against the success of the development of the port, because, while no doubt the main centre of business would move to the new area, there would still be a certain amount of lighterage to the old piers and go-downs for local traffic.

Schemes
outlined in
G.O. 1087.

31. We have most carefully considered the three schemes proposed in G.O. 1087 and in view of the difficulties of maintaining the long channels proposed in Schemes Nos. 1 and 2, we strongly recommend that a policy of development along the lines of Scheme No. 3 should be adopted, namely with a short entrance channel South of Hare Island and with wharfage accommodation between the Islands and the mainland.

Devil's Pass.

32. The advisability of again opening out the Devil's Pass has been the subject of much controversy, but after careful examination of the various surveys and the present local conditions we most strongly recommend that it should be left closed. It is evident that there was a considerable tidal scouring action through the Pass before it became closed and we think that this action might form a favourable factor in keeping clear the entrance channel to the harbour if it is so arranged that the tide can gain ingress and egress to the bay as well as to the inner basin through the proposed channel between the islands. In this way also a boat channel can be formed to give access from the new to the old harbour without going outside the islands.

Scheme recom-
mended.

33. We submit herewith Plan No. 2 shewing the scheme of development which we recommend. This provides for a dock with deep water quays approximately on the site suggested for Scheme No. 3 by the Sub-Committee of the Port Conservancy Board in April, 1916 (*vide* G.O. 1087 dated July 20th, 1916), access to the dock being gained by an entrance channel dredged through the south end of Hare Island. We consider that this scheme offers far greater advantages than either of the other two schemes suggested by the Sub-Committee, and will cost less in maintenance. There is ample scope for expansion and the opportunities for land reclamation are likely in the future to be a valuable asset to the port. A detailed description of the proposed works together with an estimate of cost is given in the following paragraphs. The scheme submitted is capable of progressive development to meet the anticipated growth in the trade of the port.

Entrance
Channel.

34. We have provided for a dredged Entrance Channel 30 feet deep at L.W.O.S.T. extending from the dock to the five fathom line. This depth will enable vessels of the deepest draught now using the port to enter at all states of the tide. We recommend that the width of the channel should be 600 feet at the five fathom line narrowing to 400 feet as indicated on the Plan. From the borings which are available it appears that a surface layer of soft material underlain by coral will be met in dredging this channel, but that no rock is likely to be encountered.

Entrance
Groynes.

35. We have shewn groynes, to be constructed of rubble stone, running out from the islands to the coral reef in such a way as to protect the inner portion of the channel from heavy seas and for the purpose of reducing such wave action as enters between the heads of the groynes.

Dock.

36. The Dock is so laid out that it can be built in successive stages. The first stage provides for the construction of an Arm 2,000 feet long leading from a Turning Basin about 1,000 feet by 1,000 feet, in which vessels can manoeuvre in entering and leaving the Dock. The second stage provides for lengthening the Arm by an additional 2,000 feet, while further extensions can be carried out by stages in a similar manner. A depth of 30 feet at L.W.O.S.T. is provided both in the Turning Basin and in the Arm.

Quays.

37. We are informed by Colonel DuCane, as a result of consultation with the leading merchants, that it would be desirable to provide not less than 3,000 lineal feet of quay as a first instalment and after careful consideration of the past expansion and future prospects of trade at Tuticorin we recommend the provision in the first instance of a length of 3,500 feet of quay on the South and East sides of the Dock. An additional 2,000 feet would be provided on the construction of the second stage, while the completed scheme with two Arms as shown on Plan No. 2 would give a total of 16,900 feet of quay. This total length

will probably meet all requirements for a long time to come, but there will be no difficulty in providing even further accommodation should the necessity arise in the far future. This could be done by enlarging the boat channel referred to below and constructing a third Arm northward of the other two.

38. We have indicated on the Plan a convenient site leading out of the Turning Basin where a Dry Dock could be eventually constructed if required. Site for Dry Dock.

39. In order to ensure smooth water in the Dock and to prevent silting up due to any sand or mud which might be brought in by the tidal currents, we have shewn on the plan an inner protecting groyne some 10,000 feet long extending from the mainland to Hare Island. The area enclosed between this groyne and the line of high water is approximately 1,200 acres including the area to be devoted to the Dock. Inner Groyne.

40. In order to give access to the town for lighters and native cargo boats, we have shewn a Boat Channel 6 feet deep at low water and 300 feet wide leading from the Dock along the inner side of Hare Island and joining up with a natural existing channel running North and South alongside the island. When this channel has been formed it is probable that the tidal currents will be sufficient to maintain it. Boat Channel.

41. We have included in the estimates given later a provision for the cost of Reclamation, depositing the dredged materials in land reclamation behind the quay walls and in the formation of banks for road and railway access, etc. We estimate that the materials available in the first instalment will be sufficient to reclaim about 400 acres, as shewn by the hatched area on the plan. Eventually the whole of the area enclosed by the Inner Groyne can be reclaimed as the dredged materials become available.

42. Our estimates provide for the construction in the first instance of some 80,000 square feet of single storey sheds on the Quay for the accommodation of such goods as require storage under cover. Sheds.

43. We have referred in paragraph 30 (iv.) to the opinion expressed at the meeting of the Landing and Shipping Fees Committee that hydraulic equipment would be preferable to electric, so we have provided in our estimates for the installation of hydraulic power and cranes in preference to electricity. The great bulk of the work could be conveniently handled by 30 cwt. cranes, and we recommend the adoption of this size with the addition of two 10 ton cranes to handle special lifts. Cranes.

44. We have allowed for the construction of 5 miles of road 40 feet wide to connect with Tuticorin Town and to provide access to the dock quays, etc. Roads.

45. We have considered various methods of constructing the quay walls, of which the ordinary method in open trench presents certain difficulties owing to the nature of the underlying strata. The coral appears to be very porous, at least in parts, and the cost of keeping down the water in the trenches during construction might be excessive. For this reason we have estimated on the basis of a wall of concrete block construction, the blocks being about 20 tons in weight. The excavation on the site of the walls would be carried out by dredging. The coral bottom would then be levelled off with Portland Cement concrete by divers to form a foundation for the blocks. This type of work is more expensive than a wall built in trench under normal conditions, so we would recommend that trial pits be sunk at suitable points along the proposed line of the wall in order to find out by practical test whether trench work would be feasible or not at a reasonable cost for pumping. Quay Walls.

Concrete for Quay Walls.

46. Owing to the excessive cost of Portland Cement at the present time, we have based our estimate on the use of hydraulic lime concrete blocks with a Portland Cement facing about a foot thick on the Dock side the wall being finished off with a coping of granite or other hard stone. Considerable care must be taken in obtaining a good quality of hydraulic lime so as to obviate the danger of the lime being dissolved by the sea water and the consequent disintegration of the concrete. A mixture commonly used for sea work is one part of lime to two parts of puzzuolana, which together form an hydraulic cement; but, if puzzuolana is not easily obtainable, hard burnt clay might prove suitable provided it is finely ground and thoroughly mixed with the lime. This will be a matter for careful experiment, as it will be necessary to determine the proportions of the mixture by means of preliminary trials based on tensile and other tests.

Supply of Stone.

47. There does not appear to be any suitable stone for use in concrete work in the immediate vicinity of the proposed Dock, and it would be necessary to make a thorough survey of the neighbourhood in order to select the most suitable quarry site. The rates for stone adopted in our estimates are based on those prevalent in other cases of large quarrying work in Southern India. Sufficient allowance has been made to cover railway freight up to about 20 miles, within which distance it is anticipated a suitable quarry site will be found.

Construction of Groynes.

48. The long Inner Groyne from the mainland to Hare Island would be constructed of dredged coral with a quarry rubble facing about 1 ft. 6 ins. thick on the sea side. The two Outer Groynes protecting the Entrance Channel would be constructed throughout of quarry rubble.

Dredging Plant.

49. The questions of type of dredger and cost of dredging are of the greatest importance, considering that the dredging and reclamation including the dredging plant will cost about two-thirds of the total amount of the first instalment. If all the dredging were to be done in sand or other soft material, it would be a very favourable case for a suction dredger which could deposit direct into the reclamation where the distance is not too great. It appears, however, from the borings that only some 2,000,000 cubic yards or about 40 per cent. will prove to be soft and that the balance of 3,100,000 cubic yards or about 60 per cent. will be coral. While it is possible that a suction dredger with a suitable cutter might deal with the coral, there is no certainty that the whole of it could be satisfactorily broken up in this manner or that when broken it would pass easily through the pipe line. Should a cutter suction dredger not prove to be satisfactory, the Port Authority would be faced with serious consequences, since they would not only have on their hands a most expensive plant, but they would be faced with a long delay in obtaining more suitable appliances. Under these circumstances we would not advise the adoption of the cutter suction type of dredger. On the other hand we have no hesitation in saying that the coral can be adequately dealt with by a bucket ladder dredger of suitable design. In order to confirm our own opinion on these matters we have discussed the problem with one of the leading manufacturers of dredging plant in this country.

Bucket Dredger recommended.

50. We would recommend the purchase for Tuticorin of a bucket dredger provided with a set of small buckets for working in the coral and another set of large buckets for the sand. The dredger should be capable of dredging to a depth of 40 feet and should have a capacity of 500 cubic yards per hour measured in the excavations. The cost of such a dredger at present market prices would be about £180,000 (Rs. 18 lakhs) and the barges to work with the dredger would cost about £50,000 (Rs. 5 lakhs). The barges will be more suitable to the conditions under which the dredger will be working than a hopper dredger.

Execution of Dredging.

51. In order to ensure that the dredger should have smooth water to work in and so be as free as possible from interruptions due to the weather, we suggest that the dredging

should be done from the Dock towards the sea, a portion of the Boat Channel being cut to a sufficient depth to give the dredger access to the site. Preliminary work of this nature could be carried out by the dredger "Manar" which could afterwards be continuously employed in removing the soft material overlying the coral on the dock site.

52. We presume that the Port Authority would construct and operate its own railway and sidings connecting with the existing metro-gauge line of the South Indian Railway to the south of the town of Tuticorin, and for this purpose we have estimated for some 10 miles of metro-gauge railway and sidings. The cost of this item is somewhat high owing to the present market price for steel rails being about £22 to £23 per ton delivered in India. The weight of rail on which we have based our price is 60 lbs. per lineal yard. It is possible that it might be considered preferable for the Railway Company to build the connection and interchange sidings, so we have only included 4 miles in our main estimate for quayside lines and connection to the interchange sidings, and the balance of 6 miles is shown as a subsidiary item at the end of the estimate.

53. While the only railway connection at present is to the metro-gauge line, it is possible that in the future the Port may also be served by a 5 ft. 6 in. gauge line, and we would recommend that in designing the quayside sidings sufficient space should be allowed to permit of a third rail being added for the broad gauge.

54. With regard to the method of carrying out the work, the amount of dredging (approximately 5,000,000 cubic yards) is the key to the whole position. It will take at least a year, and probably longer, to construct the new dredger, so we suggest that the work might be started and the way prepared for her by the use of the "Manar," which is at present at Tuticorin. This dredger might start work on the Boat Channel and dredge to a sufficient depth to allow for the entrance of the new dredger when it arrives. The latter would then get to work on the Boat Channel, the Turning Basin and the site of the quay wall. When a sufficient length has been dredged to allow the construction of the wall to be started, the dredger would be available for work on the Turning Basin and the Entrance Channel, completing a further length of the site of the quay wall as it becomes necessary. If this method is followed the dredger will be working in smooth water practically all the time and will be able to work throughout the year. While the dredging is proceeding work could be simultaneously carried out on the Inner Groyne and the two Entrance Groynes.

55. We estimate that the dredging, upon which the whole work depends, could be completed in about 3½ years from the time that the new dredger arrives at the Port or, allowing a year-and-a-half for the delivery of the dredger, a total of five years would be required for the completion of the first instalment. If the scheme which we have proposed is adopted, while the work of construction is going on there will be no interference with the present working arrangements of the Port and we think that a portion of the new quay might be brought into operation a year or so before the full width and depth of the dredging has been attained.

56. The following schedule gives our approximate estimate, based on present day prices, for the first instalment of the scheme described above and shown on Plan No. 2. This estimate includes the Channel and Dock dredged to 30 feet below L.W.O.S.T., 3,500 lineal feet of quay wall, equipment and a provision for contingencies, engineering fees and expenses. In calculating labour costs we have allowed for approximately a 50 per cent. increase above the ordinary rates given in the Public Works Dept. Schedule, to cover rise in rates, bonus, etc., due to the increased cost of living. In all cases where it has been necessary to convert sterling into rupees, the rate of exchange has been assumed as Rs. 10 to the £1 sterling.

Estimate of cost of first instalment of works, including Channel and Dock dredged to 30 ft. below L.W.O.S.T. and 3,500 lineal feet of Quay wall :—

	Rs.
Dredging Entrance Channel Soft	5,74,500
" " " Coral	17,90,000
" " " Soft	3,49,000
" " " Coral	12,67,000
" " " for Boat Channel Soft	54,500
" " " Quay Walls Soft	31,000
" " " Coral	49,000
Disposal of dredged material in land reclamation, say	10,00,000
Inner groyne from Hare Island to mainland, with rubble facing 1' 6" thick and coral hearting	1,47,000
N. & S. groynes outside islands	1,34,550
Quay wall, including concrete in foundations, concrete blocks, mass concrete, granite coping and bollards	11,06,000
Transit Sheds	4,00,000
Roads, &c.	1,76,000
Cranes and hydraulic equipment	6,00,000
Water service, fencing, offices and workshops	1,88,000
Electric lighting installation	1,00,000
Dredger	18,00,000
Barges	5,00,000
Block making and setting plant	3,00,000
Quay Sidings (see paragraph 52)	2,00,000
	107,66,550
Engineering and contingencies, say 15 per cent.	16,14,982
	123,81,532
Interchange sidings and connection to S. Indian Ry. if carried out by Port Authority (see paragraph 52)	3,00,000
TOTAL	126,81,532

Say Rs. 127 Lakhs.

Estimate of Cost of Second Instalment.

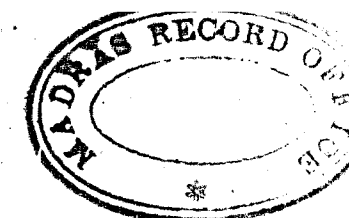
57. We have also prepared the following schedule giving the estimated cost of the second instalment of the work which will provide 2,000 additional lineal feet of Quay :—

	Rs.
Dredging Soft	1,54,545
" " Coral	4,38,331
Depositing dredged material	1,75,000
Quay Wall	6,32,000
Additional road, water, fencing, &c.	50,000
Transit Sheds	2,00,000
Cranes	3,00,000
Sidings (4 miles)	2,00,000
	21,49,876
Engineering and Contingencies, say 15 per cent.	3,22,482
TOTAL	24,72,358

Say Rs. 25 Lakhs.

Estimates are liberal.

58. In the foregoing estimates we have made very liberal allowances for the dredging and sufficient to cover the cost if executed under the worst conditions that are likely to be



met with ; so it is quite possible that a substantial saving on the dredging items—which amount to a large proportion of the estimate for the first instalment—may be effected when the works are carried out. The prices which we have assumed are, on the whole, a good deal higher than those adopted in our estimates for the Port of Cochin as reported in January, 1918—the increase being necessary on account of the rise in the cost of labour and materials which has taken place since that date. Another point which should be borne in mind when considering the cost of the works is the fact that the whole of the capital outlay on the dredging and block-making plants is included in the present estimates, although the plants will be available for further extensions and for maintenance, so that, from a strictly financial point of view, it would be fair to debit some proportion of the cost of the plants to maintenance and to future capital outlay.

59. In carrying out the first instalment of the works the capital expenditure to be incurred each year may be taken approximately at one-fifth of the total cost. Annual Expenditure on Construction.

60. In addition to the capital cost of the works it will be necessary to provide for the interest payable on the various instalments of capital during the period of construction which reckoned at 5½ per cent. would amount to about Rs. 17 Lakhs for the first instalment, assuming the expenditure to be spread equally over the five years in which we estimate that the work could be completed. This sum added to the estimated cost of the works given in the first schedule would increase the expenditure on the first instalment of the works to Rs. 144 Lakhs. Interest during Construction.

61. It is difficult to estimate at all exactly what maintenance charges on new works will amount to, but there is no doubt that a certain quantity of silt will be deposited in the Entrance Channel and in the Dock and will have to be periodically removed, for which purpose it will be necessary to keep the dredging plant at the Port for use when required. This plant would also be available for proceeding with the future extensions of the scheme as and when they may become necessary. The groynes, quay walls, buildings, roads, equipment, etc., will also require a certain amount of repair and renewal. We have gone into these figures as closely as circumstances will permit and our estimate for maintenance and interest charges in respect of the first instalment of the work are given below :— Maintenance and Interest Charges.

	Rs.
Dredging and repairs to Works and plant	2,88,000
Interest on capital outlay of Rs.144 Lakhs at 6 per cent., including sinking fund	8,64,000
TOTAL	11,52,000

The above sum does not include the cost of management, establishment charges and other working expenses which are deducted from the gross revenue of the Port before arriving at the nett revenue referred to in paragraph 30 (i).

62. As soon as the first instalment of the scheme has been completed there will be available for use a length of 3,500 feet of quay. Based on performances at other ports we estimate that if this quayage is employed to its full capacity and assuming the nett revenue given in paragraph 30 (i) of Rs.1-8-0 per ton of goods handled, the total earning capacity of the first instalment can be taken at Rs.21,00,000. This is nearly twice the amount required to pay the maintenance and interest charges given in paragraph 61, so it is clear that, provided the trade is forthcoming, the scheme should prove not only financially sound but highly remunerative. Earning capacity of Dock.

63. The following particulars of the trade of Tuticorin were supplied to Colonel DuCane by the Port Officer and have been checked from the official publications giving the trade particulars of the various Ports in the Presidency :— Trade of Tuticorin.

(i) *Exports*.—The chief exports consist of cotton, coffee, sonna, oil-cakes, chillies, onions, fibre, menazite, tea, rubber, cattle and other livestock.

(ii) *Imports*.—These consist of piece goods, betel-nuts, oil, hides, hardware spirits, grain, coal, heavy machinery and railway material.

(iii) Vessels entered, Port dues, etc.

Year.	Vessels entered.				Port dues.	Landing and Shipping dues.
	No. of steamers.	Tonnage.	No. of sailing vessels.	Tonnage.		
1909/10	707	1,292,540	1,544	53,934	Rs. 64,843	Rs. 79,067
1910/11	704	1,263,128	1,498	55,044	65,729	90,060
1911/12	643	1,198,866	1,546	60,319	65,784	85,019
1912/13	578	1,273,165	1,411	57,555	79,904	95,235
1913/14	545	1,443,384	1,350	54,296	67,274	104,314

Tonnage dealt with in the Port.

64. In the foregoing table we have not given the figures published for the years of the War as they afford no indication of the trade prospects to be anticipated under normal conditions. From a careful study of the above table and other available documents we find that a fair average for the goods actually handled in the port prior to the year 1913-14 can be reckoned at about 480,000 tons. This figure is obtained by taking the average receipts from the Landing and Shipping dues at Rs.90,000 and converting into tons on the basis of 3 annas per ton as given on page 10 of G.O. 1087 W.

Revenue Prospects.

65. Applying the rate of Rs.1-8-0 per ton referred to in paragraph 30 (i), we get an estimated nett revenue from the above tonnage of Rs.7,20,000. The revenue from berthage charges, if estimated at Madras rates and taking the average number of ships entering the port for the three years to 1913-14 at 588 and allowing three days per ship at the quay, would amount to Rs.70,560. In addition to the above sums we think that a further revenue from rents on reclaimed and existing Government lands can be taken for 300 acres at Rs.100 per acre, or a total of Rs.30,000. Summarising these receipts we obtain the following nett revenue without allowing for any increase in trade due to expansion and to the additional facilities offered:—

	Rs.
Landing and Shipping Fees	7,20,000
Berthage charges	70,560
Rents	30,000
TOTAL	8,20,560

In order, therefore, for the port to become self-supporting a further increase of trade of about 40 per cent. will be required to bring the revenue up to the sum of Rs.11,52,000 required to meet the annual maintenance and interest charges as estimated in paragraph 61. The Table given under paragraph 6 shows that the trade of the port increased by 134 per cent. in the ten years up to 1913-14 without any additional facilities being afforded; so we think that there is reason to assume that the trade will have increased by at least 40 per cent. by the time the first instalment of the work is completed, and, with the new facilities which we have described, a considerable further increase may be confidently expected.

Works should be carried out.

66. Under these circumstances, we consider that the construction of a deep-water port at Tuticorin would be fully justified from a financial point of view, and, as the port would certainly benefit the general interests of the district, we are strongly of opinion that the works which we have recommended should be carried out as soon as circumstances will permit.

THE PORT OF NEGAPATAM.

67. Colonel DuCane visited this port in company with Captain Henley after leaving Tuticorin, and there met the Port Officer, Captain Boas, and some of the principal merchants. He also attended a meeting of the Landing and Shipping Fees Committee.

Col. DuCane's Visit.

68. Negapatam is the principal seaport of the Tanjore district. Vessels visiting the port lie at anchor in an open roadstead some three miles off shore, cargo being handled between ship and shore in native boats drawing about 3½ feet. The coast is open and exposed, but records shew that there are very few days when cargo cannot be handled in the roadstead. The harbour is formed by the Kaduvayar River which runs parallel to the coast in a northerly direction and is protected from the sea by a narrow sandspit. The entrance to the harbour is much impeded by the bar at the mouth of the river which is constantly shifting its position over wide limits according to the wind, weather and season of the year. Inside the river, between the mouth and the landing quays, silt and sand is constantly being deposited owing to the insufficiency of river or tidal scour. The result is that conditions are unfavourable for continuous work at the Port, the constant shifting of the entrance channel and the silt deposited in the entrance often causing much delay to boats entering or leaving the harbour.

General Description.

69. The tidal range at Negapatam is small, being only about 3 feet on spring tides. Colonel DuCane was informed by Mr. L. B. Clarke, a former Port Officer, that the littoral currents do not exceed 1½ to 2 knots per hour. Observations made by Mr. Clarke shew that these currents run in a northerly direction during the S.W. Monsoon and in a southerly direction during the N.E. Monsoon. This information is confirmed by the Meteorological books published by the Indian Government.

Tides and Currents.

70. The wind blows from N.N.E. to E.N.E. during the five months from November to March, from S.S.E. during April and from S.W. to W. during the remaining months of the year. The highest average strength occurs in June, being an off-shore wind with an average strength of 4.5 on the Beaufort scale. No local observations with regard to the size of waves appear to have been made, but conditions at Negapatam both with regard to wind and waves may safely be taken as similar to those at Madras. Both ports have the same sea exposure and both are within the cyclonic area.

Wind and Waves.

71. Colonel DuCane was unable to obtain any definite information with regard to sand drift at Negapatam and, as there are no groynes on the sea side of the sandspit, no conclusions could be drawn by observation. He, therefore, visited Tranquebar about 20 miles north of Negapatam where some groynes have been built straight out into the sea. These groynes had undoubtedly trapped sand on the south side indicating, as at Madras and Tuticorin, a preponderance of sand drift from south to north. The amount of the drift, however, appears to be quite unknown.

Sand Drift.

72. As previously stated the harbour is on the Kaduvayar River and there is another small stream joining the Kaduvayar just above the harbour. Both these rivers pass through a heavily irrigated country and a great quantity of water is utilised for irrigation purposes, the rivers being controlled by a series of anicuts and regulators. Various proposals have been made to increase the flow at Negapatam by the diversion of surplus water from other streams into the Kaduvayar. We do not think, however, that these proposals would give useful results, as the extra water which might be obtained would for the most part occur in the rainy season when the Kaduvayar is already in flood and when the bar is at its best. Colonel DuCane was informed by Mr. Schroff, Officiating Executive Engineer of the Division, that at other periods the increase of water would only amount on the average to about 135 cubic feet per second for about 34 days in the year and this additional quantity would be insufficient to have any material effect on the bar. The river is tidal for a distance of about 9 miles from the sea.

Rivers.

the Bar.

73. The state of the bar varies very considerably according to the season of the year. Observations in 1916 and 1917 show the following results which should be taken as approximations only, since slight variations may occur almost from day to day according to the state of the weather.

DEPTH OF WATER ON BAR AT L.W. IN FEET.

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1916 ...	1	2	1½	1½	1	2½	1½	2	2	2	3½	1½
1917 ...	1½	1	2	2	2	1½	1½	2½	2½	2½	3½	—

From this Table it appears that the bar is at its best about October and November, when the N.E. monsoon rains are falling, and at its worst during the period before the S.W. monsoon commences. We have had an opportunity of studying surveys prepared by the Port Officer showing the variations in the entrance from month to month which show that, in addition to the variations of depth, the bar is continually shifting its position according to the season.

Landing and Shipping Fees Committee.

74. Colonel DuCane attended a meeting of the Landing and Shipping Fees Committee and discussed with them a number of points connected with the improvement of the port. The only European firm at present trading at Negapatam is the Madura Company. It was stated that the trading months are from May to August, and that, although boats could ply on most days in the year, there was not much trade during the North-east monsoon. The question of the construction of a pier outside the harbour and at right angles to the shore was discussed from the trade point of view, but there was no unanimity amongst the members of the Committee with regard to its desirability. Mr. Scott, the representative of the Madura Company, stated that his Company would not use a pier for coal traffic owing to the inconvenience in getting the coal to the yard. Considerable doubt was also expressed as to whether a pier would be used for the coolie emigration traffic (amounting to 80,000 coolies a year) owing to its distance from the emigration yards. It was also pointed out that at the present moment the port is on the black list with the Insurance Companies owing to the amount of cargo damaged or lost in crossing the bar.

Trade Statistics.

75. The trade returns show that there was an increase of 84 per cent. at Negapatam in the ten years ending in 1913-14—the value in that year amounting to about Rs.216 lakhs, representing about 3 per cent. of the whole trade of the Presidency. The opinion was expressed at the meeting of the Committee (and is confirmed by letters written by two of the leading merchants to the Port Officer in April, 1919) that if the state of the bar and the channel leading to the piers could be stabilized and improved the increase in trade would in all probability be very large.

Extensive Development of Port is not justified.

76. After careful consideration of all the circumstances, we are strongly of opinion that no extensive development is required or justified at this port at the present time, and that the difficulties of the situation would be met by its improvement as an open roadstead. Negapatam has no natural advantage as a deep-water port. There is insufficient tidal volume to provide scour for a deep entrance channel, and the only feasible scheme, if deep-water development is required, would be to form an artificial harbour with extensive breakwaters to protect the deepened entrance channel.

Proposal for a Pier in Open Water.

77. In view of the fact that the Port Officer and certain members of the Committee are in favour of the construction of a pier in open water at right angles to the coast and similar to that at Pondicherry, we have considered this proposal, but we do not think that it would be so beneficial to the port as the improvement of existing facilities. The cost of such a pier would be considerable, and the ranging of boats alongside a structure in the open sea renders the working of cargo difficult. It is, we believe, a fact that a

large proportion of the trade at the port of Pondicherry is still carried on from the beach in preference to using the pier, owing to the working difficulties at the pier and the desire to avoid pier dues.

78. In view of what we have said our recommendations will be confined to the mitigation of the present difficulties experienced in working cargoes between ship and shore by means of native cargo boats. We think that this will be effected best by stabilizing as far as possible the entrance and bar by means of two breakwaters running out to about the 2-fathom line as shown on Plan No. 3. A channel 200 feet wide at the entrance would then be dredged through the bar and sandspit with a depth of 6 feet at low water. The width of this channel would be diminished to 150 feet at the sandspit and to 100 feet alongside the existing wharf wall. With the channel protected by breakwaters the shifting of the entrance due to wave action which now takes place each season would be avoided and such tidal scour as is available would be concentrated to the best advantage. The scour due to tide and river is, however, so small that a considerable amount of maintenance dredging would probably have to be done.

Improvements recommended.

79. The breakwaters would be in shallow water and need not be of very heavy construction. They should be taken to a height of 8 feet above high water between the one and 2-fathom line reducing gradually to a height of 5 feet at the beach. The cheapest method of constructing them would be by means of rubble mounds with heavy wave-breaker blocks of from 7 to 10 tons weight on the outer face.

Breakwaters.

80. The nett run of sand appears to be from south to north and it is, therefore, likely that there will be accretion to the south of the south breakwater which will tend to strengthen the sandspit. There will also probably be some shoaling near the ends of the breakwaters which will have to be dealt with by periodic dredging.

Accretion of Sand.

81. We estimate the cost of the above works at approximately Rs. 6 lakhs, made up as follows:—

Estimate of Cost.

	Rs.
North and South Breakwaters	3,60,000
Dredging	40,000
Cranes and plant for handling 7 to 10 ton blocks in breakwaters...	75,000
	4,75,000
Engineering and contingencies, say 15 per cent.	71,000
	5,46,000
Add for hire of dredger	50,000
TOTAL	5,96,000

Say, Rs.6 lakhs.

82. We have included in the above Estimate a sum of Rs.50,000 for the hire of a dredger, because the suction dredger "Pentland," now at Negapatam, is unsuitable for the work of dredging through the bar, and the quantity to be dredged is too small to warrant the purchase of a suitable dredger, even if the finances of the port would permit. The best solution, therefore, would be to hire a dredger from another port, possibly the "Manar" from Tuticorin or the dredger from Cocanada if one of them could be spared for the purpose.

Hire of Dredger.

83. We estimate the annual expenditure if the proposed works are carried out, as follows:—

Interest and Maintenance Charges.

	Rs.
Dredging and maintenance of breakwaters	13,600
Administration of the Port	2,500
Interest on capital outlay of Rs. 6 lakhs at 6 per cent. including Sinking fund	36,000
TOTAL	52,100

NEGAPATAM. Receipts.

84. Taking the figures for the two years 1912-13 and 1913-14 from the Marine Budget Estimates 1916-17, we find that the average receipts at Negapatam amounted to about Rs. 21,500 per annum. Comparing this amount with the annual expenditure given in the previous paragraph, it is evident that there would have to be an increase in revenue of about 140 per cent. to make the port self-supporting under the improved conditions. Although this increase may at first sight appear to be more than could be reasonably expected, we may point out that the trade of the port increased at a rapid rate during the previous years and that, in the opinion of the local authorities, it would increase at a still higher rate if the difficulties experienced at the bar and in the channel could be overcome. This increase is estimated by the Port Officer in his letter No. 14.L & S/585 of 1st May, 1919, at 200 per cent., and by the Hon. A. K. G. Ahmedthanby Maricair in his letter to the Port Officer dated 19th April, 1919, at from 300 to 400 per cent. While we have no means of checking these estimates, which require further investigation, we certainly think that the increased facilities would warrant an increase in Landing and Shipping charges and that the merchants would not be adverse to paying rather higher dues if they were safe-guarded against loss and delay in handling their cargoes. We, therefore, recommend that a careful survey of the trade prospects be made and that, if this proves favourable, the scheme outlined above should be carried out.

MANGALORE.

Col. DuCane's Visit.

85. Colonel DuCane visited the various points of interest at Mangalore accompanied by Capt. Henley and the Port Officer and discussed the situation with the Collector of South Canara, the P.W.D. Engineer and a number of the leading merchants.

General Description.

86. Mangalore is an open roadstead and the port is closed during the S.W. monsoon from May to September when no vessels visit the port. Throughout the remainder of the year vessels lie at anchor in the roadstead about 3 miles from the harbour, the cargoes being handled in lighters between the vessels and wharves situated on the mainland inside the inner harbour. This is formed by the course of the Gurpur River which joins the Netravati River near its mouth. The Gurpur River is separated from the sea only by a narrow sandspit for a distance of $3\frac{1}{2}$ miles from the mouth. The coastal region consists generally of a laterite plateau intersected by numerous river valleys and with granitic outcrops shewing in places through the laterite. The valleys are very fertile and are utilised for paddy fields and coconut gardens.

Charts and Surveys.

87. The oldest available survey is dated 1852, but there are a number of surveys in the eighties and nineties which shew that the changes in the sandspit are extensive and remarkable. No borings have been made and there is no means of saying at what depth below the surface rock is likely to be met. It is, however, noticeable that rocks are charted inside the entrance near the mouth of the Netravati River.

Tides.

88. The tidal ranges are as follows :—

Spring tides ...	...	...	...	5 to 6 feet.
Neap tides ...	...	...	...	3 to 4 feet.

Littoral Currents.

89. There is very little information available with regard to littoral currents, but, from the data which Col. DuCane was able to obtain, there is no doubt that the currents are weak and are chiefly influenced by the prevailing direction of the wind.

Directions of Wind.

90. From a study of the Meteorological Atlas of the Eastern Seas published in 1908, we find that, on the average, the highest percentage of winds in January is N., in February N.N.W., in March N.N.W., in April N.W., in May N.W., in June W.S.W., in July W., in August W.S.W. and W. nearly equally, in September N.W., in October N.W., in November N., in December N. and N.N.E. nearly equally. Thus neither the N.E. nor S.W. monsoon blows true in the coastal area. The S.W. monsoon breaks in June when only 14 per cent. of winds are from S.W., 47 per cent. being from W.S.W. and W. In July the preponderance is strongly westerly, being about 49 per cent. due West, while W. and W.S.W. together

account for 79 per cent. In August the tendency is to work round in a Northerly direction, the percentages being W.S.W. 26.5, W. 24.5, W.N.W. 13.7, and N.W. 22.7. Through September, October and November the tendency is continuously towards the N. and N.N.E. until in December and January about 50 per cent. of all winds are from N. to N.E. In February they begin to work back to the Westward, 40 per cent. being N. and N.N.W. and this Westward tendency is continuous until June, when the S.W. monsoon is again in full swing.

91. The maximum average intensities of the winds occur in July and August, reaching a strength of 5.4 (Beaufort Scale) from W.S.W. and W. in July and August, and a strength of 6.0 from S.W. in July. The winds of the N.E. monsoon are less severe, and in most months have an average strength of 3.0 (Beaufort Scale) or under. There are, unfortunately, no records available of maximum wind forces for the regular monsoon winds. Mangalore must be considered as within the cyclone area since there are several recorded cyclones and cyclonic storms in this neighbourhood. No records of intensities are available for this district, but in Bombay wind velocities of from 40 to 50 miles per hour and wind pressures up to 14 lbs. per square foot are recorded in exceptional storms.

92. No information at all is available as to littoral drift of sand, and there are no groynes or other structures in the neighbourhood from which conclusions can be drawn. It may, however, be said that there are no indications of any extensive littoral drift either at Malpe or Bhatkal. Marmagoa also is not troubled with sand, the silt in the harbour there being brought down by the river. It may, therefore, be concluded that there is no extensive drift on the West coast such as exists on the East.

93. Two rivers affect the harbour at Mangalore :—

(i) *The Gurpur River* turns South at Sultan's Battery and runs South and parallel to the coast for about $3\frac{1}{2}$ miles when it is met by the current of the Netravati, and both find their way through the sandspit in a westerly direction to the sea. The catchment area is 260 square miles and the length of the river 27 miles. The maximum flood discharge is about 60,000 cub. ft. per second.

(ii) *The Netravati River* rises in the Western Ghats and has a length of 48 miles with a catchment area of about 1,232 sq. miles. The maximum flood discharge may be taken as about 120,000 cub. ft. per second.

From January to May there is little or no flow in either of the rivers, but from May to September they are continually flowing and the heaviest floods take place during this period. From September to January there are slight floods only. The rivers are both tidal for about 10 to 12 miles.

94. A study of the plans and surveys shew that there have been great changes in the situation and condition of the harbour entrance. At various times there have been one, two or three entrances to the backwater; but since 1887, when the Gurpur River entrance became closed, the entrance opposite the Netravati River has been the only one open. About May—i.e., before the S.W. monsoon breaks—the entrance is at its narrowest and the bar at its worst. In most years there are 5 to 6 feet of water on the bar at low tide, but in 1919 the conditions were exceptionally bad and the depth was then only about 4 feet. This was probably due to the partial failure of the monsoon in 1918. After the S.W. monsoon there is generally an average depth of about 8 feet on the bar.

95. The width and form of the sandspit varies after each monsoon. Since the closing up of the Gurpur River entrance in 1887, the sandspit has on the whole increased in width and is now about 200 feet wide at its narrowest point.

96. For a number of years up to about 1909 there was a considerable erosion of the foreshore on the sea side to the north of the sandspit, but since that date erosion has stopped and accretion has taken place approximately to the old foreshore line.

Waves.

97. No observations have been made as to the heights or lengths of the waves, but we think that a maximum height of 15 feet would be a safe assumption. The direction of the waves is stated by the Port Officer to be from about S.W. at the beginning of the monsoon, working gradually round to W. and N. of W.

Railway connection.

98. The Port is served by the South Indian Railway, 5 ft. 6 ins. gauge, which crosses the Western Ghats at the Palghat Gap and then turns northward generally parallel to the coast for a distance of about 190 miles to the terminus at Mangalore.

Trade.

99. The value of imports and exports at Mangalore in 1913-14 amounted to about Rs. 209 lakhs, representing about 3 per cent. of the total trade of the Presidency. The increase in the 10 years up to that date was 18 per cent., being much less than the increase at Tuticorin and Negapatam during the same period. A study of the detailed exports and imports shows that coffee forms about 80 per cent. in value of the foreign export trade and 40 per cent. of the total imports and exports. This is not strictly speaking local trade, as it is brought down by road for long distances from the plantations on the Mysore plateau. The proportion in value of trade due to the coffee plantations is actually higher than the above figures indicate, since the wagons bringing coffee down to the coast return to the plantations laden with fertilisers and general merchandise. It should, however, be noted that, although the value of the coffee is high, the actual freight only amounts to about 6,000 tons per annum.

Future prospects of trade.

100. After careful consideration of the information obtained by Colonel DuCane from some of the leading merchants we are of opinion that the future prospects of trade are not likely to justify the development of the port on a large scale. The opening up of new sources of trade depends mainly on railway communication being provided to the Mysore territory, and this again depends largely on the decision of the Mysore Government with reference to Bhatkal. We understand that a railway line has been surveyed from Arsikere and Hassan down the Ghats to Mangalore, but should the railway to Bhatkal be built from Shimoga it is not likely that the Arsikere-Mangalore Line would be constructed.

Extent of development required.

101. There are three possible schemes to be considered in connection with the development at Mangalore, viz.:—

(a) An extensive scheme with deep water entrance channel and deep water wharves for ocean going vessels.

(b) A less extensive scheme with an entrance channel 20ft. deep and corresponding wharves for coasting vessels.

(c) The improvement of the existing harbour as an open roadstead and for lighterage facilities only.

The choice between these three schemes must be governed by the following factors:—

(i) Whether the physical conditions of the port are such that it can be developed at a reasonable cost for construction and maintenance.

(ii) Whether the local trade is likely to grow to such an extent as to justify the expenditure of schemes (a) or (b).

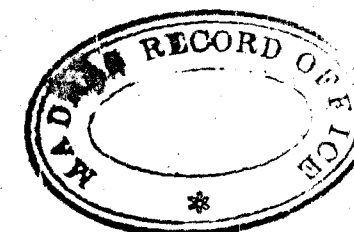
(iii) Whether railway communications are likely to be so improved as to open up new sources of trade.

(iv) Whether any other port in the neighbourhood is likely to be developed.

After a careful study of the problem and keeping in view the above factors we have come to the following conclusions:—

Deep water Scheme (a).

102. Provided that rock is not encountered in large quantities the dredging of a deep entrance channel into the inner harbour presents no insuperable difficulties, although the cost would be high owing to the great amount of material to be removed. On the other hand the area of tidal water is small and the flow of the river water intermittent, and we are not satisfied that there would be sufficient scour to effectively assist the maintenance



of the channel when dredged. We therefore anticipate that the annual charges for maintenance dredging would be a serious matter and are doubtful whether a good channel could be maintained at any cost which could be reasonably borne by the probable revenue of the port. We think that in embarking on a scheme of deep water development at Mangalore unjustifiable commercial risks would be taken and we therefore recommend that this idea be abandoned.

103. The depth of water suggested for a coasting port is 20 feet at low water and the function of the harbour would then be to act as a distributing link with the deep water ports, where cargo to or from foreign countries could be trans-shipped. The advantages gained would be that the coasting vessels could load alongside a wharf and under shelter, instead of from lighters in the roadstead as at present, and that the port would be accessible to such vessels throughout the year. No great amount of trade, however, would be developed merely by coasting vessels, and it must be borne in mind that the attractions of the port as an objective for a railway from the interior would be seriously diminished if there was little or no prospect of its being eventually improved to provide facilities for ocean going steamers. The physical objections to Scheme (a) already outlined would also apply, though in a lesser degree, to the scheme for a coasting harbour. The cost of the latter, although much less than for a deep-water port would still be considerable, amounting approximately to Rs. 65 lakhs, and we do not think that the revenue resulting from the improved facilities would be sufficient to cover the interest on this amount of capital and the maintenance charges. In view of these considerations we cannot recommend the adoption of Scheme (b) and we consider that any expenditure which may be contemplated at Mangalore should be limited to the improvement of the conditions of the port as an open roadstead.

Scheme (b) for Coasting Vessels.

104. We do not recommend that any work should be carried out on the bar, as records shew that except on few occasions there is sufficient water to allow native boats to enter or leave the harbour at all states of the tide. The only works which we think necessary are the provision of a new wharf in the inner harbour and the formation of a new channel 200 feet wide by 6 feet in depth at low water as shown on Plan No. 4. To ensure the stabilization of the channel without banking up the water of the Gurpur River and so increasing the tendency of the river to break through the sandspit opposite Sultan's Battery, we propose that the channel should be trained on each side by rubble banks extending only up to the height of low water.

Scheme (c) recommended.

105. We have estimated for a Wharf 600 ft. long in the first instance, but this could be afterwards lengthened to any extent which may be found necessary. The cost of the works would be approximately Rs. 6 lakhs, made up as follows:—

	Rs.
Dredging new channel	2,68,500
Rubble slopes and banks to channel	96,800
Masonry wall for Wharf	60,000
	4,25,300
Engineering and contingencies, say 15 per cent.	63,800
	4,89,100
Add for hire of Dredger	1,00,000
	5,89,100
Say Rs. 6 lakhs.	

Estimate of Cost.

106. We estimate the annual expenditure if the proposed works are constructed, as follows:—

	Rs.
Dredging and maintenance of wall and rubble banks	39,400
Administration of the Port	2,400
Interest on capital outlay of Rs. 6 lakhs at 6 per cent., including sinking fund	36,000
	77,800

Interest and Maintenance Charges.

Receipts.

107. The average net receipts for the two years 1912-13 and 1913-14, as obtained from the Marine Budget Estimates 1916-17, amounted to about Rs. 19,200 per annum, which is Rs. 58,600 less than the estimated annual expenditure given in the last paragraph, so that the receipts for those years would have to be fully quadrupled before they would balance the contemplated outgoings. There was an increase of only 18 per cent. in the trade at Mangalore during the ten years prior to 1913-14, so that the future outlook of the port is not nearly so promising as at Negapatam, where the increase during the same period was 84 per cent., although the actual value of the trade of the two ports in 1913-14 was about the same.

Suggested Government Grant.

108. The scheme we have proposed appears to us to represent the minimum to be undertaken if an appreciable benefit is to result; but it is evident from the above figures that the scheme is beyond the present financial resources of the port. We feel, however, that the improvement of the harbour as indicated would considerably benefit the conditions and trade at present existing and it therefore appears to us to be a case for careful consideration as to whether a free grant in aid could be made from Government funds.

MALPE.

THE PORT OF MALPE.

Col. DuCane's Visit.

109. Colonel DuCane visited Malpe from Mangalore in company with Capt. Henley and the Port Officer of Mangalore, who is also the officer in charge of Malpe.

General Description.

110. Malpe is at present a small place of little importance, and its only claim to consideration is as an alternative to Mangalore for a deep water port should it be considered necessary to provide one between Cochin and Marmagao. There does not seem to be any volume of trade to justify expenditure for the improvement of Malpe as an open roadstead, and we have not therefore considered it further from this point of view. Around Malpe there is flat low-lying land for several miles from the sea, the ground then rising to a laterite plateau with granite outcrops which appear to be typical of this stretch of the West Coast from Mangalore to Marmagao. About $1\frac{1}{4}$ to $1\frac{1}{2}$ miles off shore there is a string of granite islands known as St. Mary's Isles running roughly from S.S.E. to N.N.W. and generally parallel to the coast. A proposal has been made from time to time to make a harbour between the islands and the mainland, utilising the islands as protection from the S.W. monsoon seas.

Surveys and Borings.

111. The only surveys available are dated 1900 and 1913. The survey of 1900 shows the bottom between the islands and the mainland to be soft mud, but there is no indication as to the depth at which the underlying rock is likely to be found. No borings or probings appear to have been made, and in consequence, before accurate estimates can be prepared, more information as to the level of the rock must be obtained.

Tides, Currents, Winds and Waves.

112. The information given for Mangalore regarding the tides, currents, winds and waves are generally applicable to Malpe, which is situated only about 40 miles to the north of Mangalore.

Sand Drift.

113. No direct information as to sand drift is obtainable, but it should be noticed that the soundings of 1900 and 1913 when compared do not show any accumulation in this period.

River.

114. There is only one small river in the immediate neighbourhood which need be considered. This river runs for a short distance in a northerly direction, with the usual sandspit between it and the sea, but it is not of sufficient size to be a serious factor in any scheme of development.

Trade.

115. The amount of trade is too small to be given separately in the official trade publications, and would appear to be derived mainly from trade diverted from Mangalore.

Railways.

116. There is at present no railway access to the port, and Mangalore is the nearest point which the railway touches. If Malpe were to be developed it would necessitate the extension of this line from Mangalore, and this would be a fairly expensive project owing

to the number of rivers which would have to be crossed. To ensure the success of an important scheme provision would also have to be made to give the port direct railway connection to the interior.

117. Provided that a deep water port is considered necessary on this part of the coast and that an adequate railway connection is constructed, we consider that Malpe from its physical characteristics lends itself more readily to deep water development than Mangalore. We have accordingly prepared Plan No. 5, showing how a comprehensive scheme of development might be carried out, subject to any modifications which may be found desirable after a more detailed survey accompanied by borings and probings has been made. The main features of the scheme are as follows:—

Scheme for Deep Water Port.

(i) The dredging of an Entrance Channel 400 feet wide with a depth of 30 feet at low water of spring tides between North Island and Deria Bahadur Ghur and extending in a W.S.W. direction to the 5-fathom line.

(ii) The construction of two breakwaters extending from these islands in such a way as to protect the inner portion of the channel and to reduce the waves entering between the breakwater-heads before they reach the inner harbour.

(iii) A Turning Basin, about 1,000 ft. across, in which ships can manoeuvre when entering or leaving the harbour.

(iv) Two rubble Groynes extending from North Island and Deria Bahadur Ghur to the sandspit so as to form a sheltered enclosure of some 400 acres in which quay accommodation can be provided.

(v) A series of Arms or Shipping Berths and Quays, the latter having a total length of 10,000 feet, which could be constructed in instalments as required.

(vi) Land reclamation between the quays and the sandspit, for which the dredged material would be available.

Owing to the lack of detailed surveys and borings we do not propose to attempt a minute description of these works at the present time, as the best type of construction to be adopted would depend on the results so obtained.

118. For the purpose of investigating the general possibilities of development we have assumed that the physical conditions would prove favourable and have made approximate estimates as to the probable cost of the work. Our estimate for the construction of the outer works together with a first instalment of 2,500 feet of quays is given in the following schedule:—

	Rs.
Dredging Entrance Channel, including Turning Basin	7,25,900
Dredging single Arm for shipping berths	1,87,500
Extra allowance for probable rock in channel	4,40,000
Filling for land reclamation (included in dredging)	—
Breakwaters	23,81,500
Rubble Groynes	14,85,950
Quay walls, 2,500 lineal feet	9,36,000
Roads, drains, water supply, offices, workshops, &c.	2,15,000
Sheds	2,00,000
Cranes and hydraulic equipment	5,00,000
Rock drilling plant	1,00,000
Dredger and barges	15,00,000
Tug	2,00,000
Block making plant	3,00,000
Preliminary expenses	50,000
	92,81,850
Engineering and contingencies, say 15 per cent	13,83,277
TOTAL	1,06,65,127

Say Rs. 106 L.

TOTAL

72140

D42,8

N20,1

Cost per lin. ft.
of Quay.

119. The cost of the breakwaters, entrance channel and enclosing groynes, which is a constant amount irrespective of the length of quay constructed, brings the cost of the 2,500 feet of quay to Rs.4,240 per lineal foot; but as the length of quay is increased the estimates shew a more and more favourable result. Thus the extra cost of constructing an additional length of 2,500 feet of quay would be only Rs.23 lakhs as against Rs.106 lakhs for the first instalment, while the remaining 5,000 feet required to complete the whole scheme as shewn on the Plan would cost about Rs.49 lakhs more. The following table shews the effect of these figures on the average cost per lineal foot of quay :—

Length of quay provided.	Estimated cost in Lakhs of rupees.	Estimated cost per Lin. ft. of quay.
2,500 Lin. ft.	106	Rs. 4,240
5,000 " "	129	2,580
10,000 " "	178	1,780

Time of Completion.

120. We estimate that the construction of the first instalment of the work, taking eight months as the working season, could be completed in about three years, and that the capital required for construction might be spread equally over this period.

Interest during Construction.

121. On this assumption we calculate that the interest required on capital during construction would amount to about Rs.9 lakhs. This sum should be added to the capital cost of the works, thus making a total of Rs.115 lakhs for the first instalment.

Maintenance and Interest Charges.

122. The cost of maintenance in an entirely new port is difficult to assess in the first instance, but we consider that Malpe is favourably situated with regard to maintenance dredging. We estimate to the best of our ability the cost of maintenance and interest charges on the first instalment of the work as follows :—

	Rs.
Dredging and repairs to works and plant	1,94,000
Interest on capital outlay of Rs.115 lakhs at 6 per cent., including sinking fund	6,90,000
TOTAL	8,84,000

Earning capacity of First Instalment of Work.

123. If used to its full capacity we estimate that the 2,500 feet of quay included in the first instalment of the work would be capable of handling about 1,000,000 tons of goods per annum, which would bring in a nett revenue, after deducting administration and other charges, of Rs.10 lakhs, even if the low nett rate of R.1 per ton is reckoned upon. It is, therefore, evident that, if the trade is forthcoming, there would be a sufficient revenue even on the first instalment to more than cover the annual charges.

Procedure recommended.

124. Under the circumstances, although we think that Malpe is more favourably situated for development than Mangalore, we would recommend that no extensive work be undertaken until the position becomes clearer as to the future possible development of Bhatkal and as to the policy proposed for future railway connections to this portion of the coast. It may, however, be worth while to expend a small sum of money on a more extensive survey at Malpe than at present exists and on a few borings and probings on the site of the works shown on Plan No. 5. It will then be possible, should Bhatkal not be proceeded with, for the whole question of development of this port to be reconsidered with the assistance of more reliable data.

THE PORT OF COCANADA.

125. Col. DuCane visited Cocanada with Capt. Henley and there met Mr. Cook, the Port Officer, and Mr. Wainwright, the P.W.D. Engineer of the Godavari Northern Division. Col. DuCane's Visit.

126. The port is situated in Cocanada Bay just north of the Godavari River, some 74 miles south of Vizagapatam and 370 miles north of Madras. Extensive floods occur on the Godavari every year and the great quantities of silt brought down by the flood water have had a marked effect upon the Bay by leading to the formation of a long spit of sand between the river and the open sea known as Godavari Point. Comparison of the latest chart with that of 1789 shows that this spit has advanced in a northerly direction across the mouth of Cocanada Bay for a distance of between 12 and 13 miles, or at the rate of nearly a mile every 10 years. During recent years the point has shown a distinct tendency to advance in a North-westerly direction. The whole area inside the spit has shoaled considerably. Soundings on the 1789 chart show 26 to 27 feet of water at low tide at a distance of about $\frac{1}{4}$ mile from the shore opposite Cocanada, whereas the latest surveys shew that there is a depth of only about 2 feet at the same point. Hope Island, which in 1789 was only a small sand bank about $2\frac{1}{4}$ miles long and less than $\frac{1}{4}$ mile wide, is now quite an extensive island covered with mangroves, while Coringa which is now some miles inland used to be a ship-building centre of some importance. General Description.

127. The wharves at Cocanada are situated on the outlet from the Rajamundry and Samalkot canals which are controlled by gates a short distance from the town. The ships at present visiting the port lie at anchor in the roadstead about 6 miles from the mouth of the harbour, goods being conveyed to and from the wharves by native boats. The harbour is approached by a channel about 200 feet wide running between two groynes built out into the bay approximately at right angles to the coast. Alterations and extensions to these groynes have been made from time to time as rendered necessary by the silting of the bay and they now extend about a mile from the shore, except for a gap in the northern groyne to allow the waters of the creek to flow into the entrance channel. Existing facilities.

128. In addition to the chart of 1789 referred to above, we have examined various other charts dated about 1850, together with more recent surveys, the latest of which is dated 1917. Surveys.

129. The range of spring tides is about $5\frac{1}{2}$ feet and that of neap tides about 3 feet. Tides.

130. There is no information as to the currents outside the bay, but in the entrance channel and across the mouth of the groynes the maximum velocity both on ebb and flood does not exceed about two knots an hour. Currents.

131. The trade of Cocanada has an increasing tendency, the statistics showing that for the ten years up to 1913-14 there was an increase of 56 per cent, while in 1913-14 the value of its trade amounted to Rs. 278 lakhs representing 4 per cent. of the total trade of the Presidency. Trade.

132. In view of the probable early development of Vizagapatam, we do not think that a large expenditure would be justified at Cocanada. Apart from this, the physical features of the Port are such as to render deep-water works almost impracticable from the maintenance point of view. The extension of Godavari Point and of the shoaling of the Bay appears to be still in active progress, and it therefore seems likely that Cocanada may ultimately suffer the same fate as Coringa and be left too far inland to make its maintenance as a port worth while. We therefore consider that, should it be thought advisable to incur further expenditure at this port, the outlay would best be directed towards the maintenance of a boat channel with about 6 feet of water at L.W.O.S.T. Although we think that the present channel beyond the groynes can be usefully maintained for several years, we feel certain that an extension of the groynes will Extent of Development recommended.

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Estimate.

Annual
Expenses and
Receipts.

Dredging.

134. In view of the fact that we do not consider it immediately necessary to carry out the above works, no useful purpose will be served at this date by a comparison of annual expenses and receipts, as these will undoubtedly have changed considerably before it is necessary to proceed with the extension of the channel.

135. It will be noted that in the estimates of the works proposed for Negapatam and Mangalore we have provided for the hire of a dredger, as the works are not of sufficient magnitude to warrant the purchase of dredging plant. In all the problems presented by the Madras Ports, whether major or minor, the dredging must always take a prominent position. We are not acquainted with the dredging resources of all the Ports; but we venture to suggest, if it has not already been done, that all dredging plant used at the minor ports should be placed under the control of one Central Authority. By doing this we think that the plant would be used with higher efficiency and would be available for those ports which are in the most urgent need of assistance.

We have the honour to be, Your Excellency,

Your obedient servants,

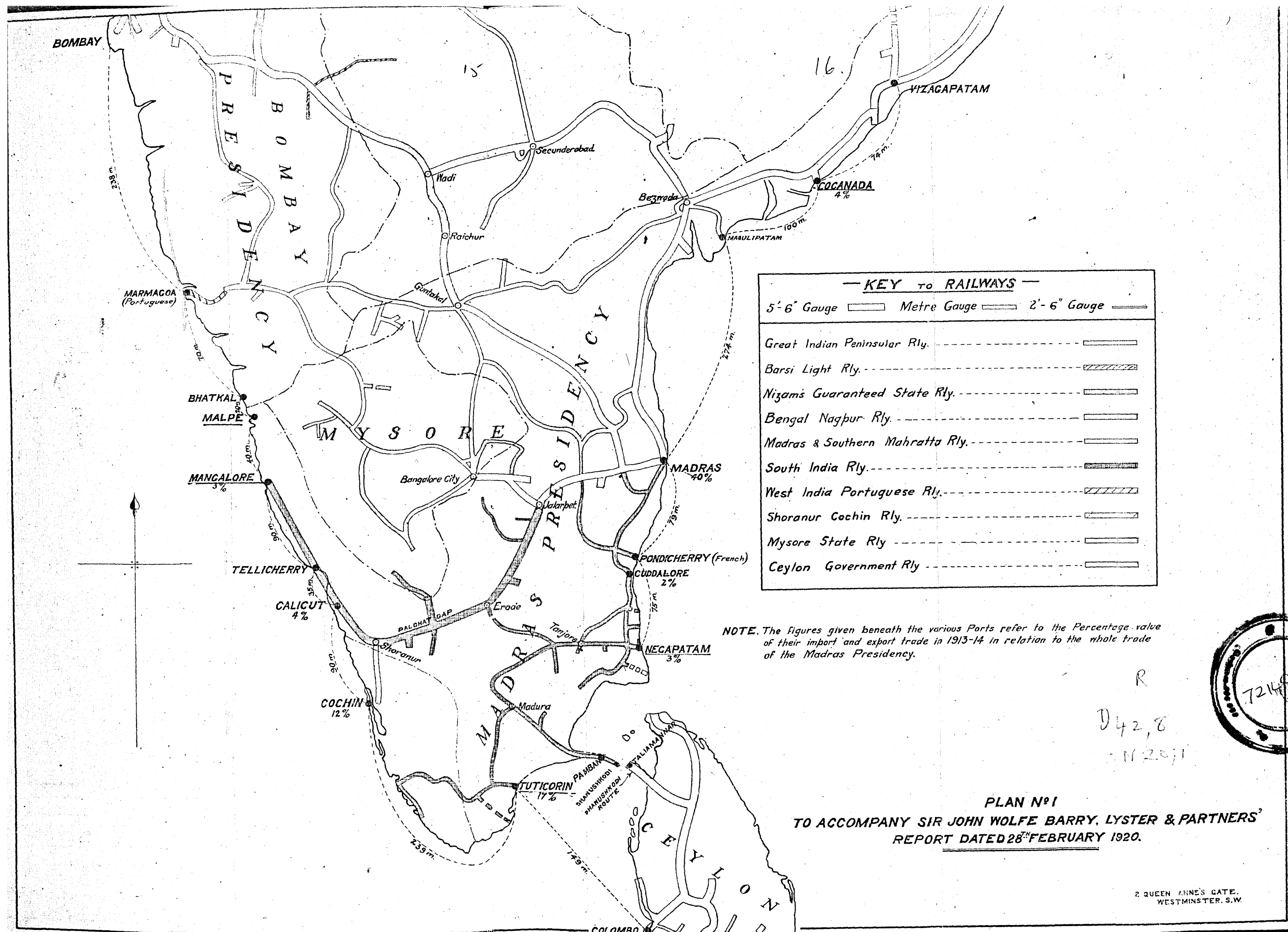
SIR JOHN WOLFE BARRY, LYSTER & PARTNERS.

ANTHONY G. Lyster.

E. CRUTTWELL.

K. A. WOLFE BARRY.

RUSTAT BLAKE.



செப்பனிருபவர் பெயர்
செப்பனிருவதற்காக எடுத்த
கொள்ள்ப்பட்ட நாள் Nov 95
செப்பனிட் குடித்த நாள் Nov 95
சரவாந்திரம் ஆராய்ச்சி
ம.ப.ப.எ. இலவியா
கையொப்பம் கையொப்பம்