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P.W.D DEPARTMENT

G.O. No. / B.P. No.	1594-W	Press. / Mis.
Dated	25-6-1881	A97.

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GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

25th June 1881, No. 1,594 W.

General.
Establishment.

Read again—

No. 89. Letter from the Government of India, Public Works Department, dated 3rd June 1881, No. 221 I.

With a view to insure early compliance with the orders of the Government of India to prepare and submit for sanction within the current year the complete revised estimate for the works of the Godávari Delta, the Honorable the Governor in Council directs that the following special arrangements be made immediately on the return of Colonel Mullins to duty.

2. Lieutenant-Colonel J. O. Hasted, R.E., to assume charge of a special department in the office of the Chief Engineer for Irrigation, which will be constituted with the above object, and which will work under the general instructions of the Chief Engineer for Irrigation. Arrangements will also be made, as soon as may be found convenient, for placing the services of Mr. C. Vincent at Colonel Hasted's disposal, and for appointing such draughtsmen, clerks, &c., as may be needed.

3. For dealing with the information required to show the expected increase of revenue, &c., to be anticipated by the completion of the works in question the requisite arrangements will be made in the Revenue Department.

(True Extract.)

Captain, R.E.,
Ag. Under Secy. to Govt., P.W.D.

To the Revenue Department.
" the Financial Department.
" the Chief Engineer for Irrigation.
" Lieutenant-Colonel J. O. Hasted, R.E.
" the Examiner of Public Works Accounts.

Exd. A. F. Goodall.
Spare Copies

GENERAL.
ESTABLISHMENT.

Govt. of {1881} Madras.

PUBLIC WORKS.

To

THE REVENUE DEPARTMENT,
&c., &c., &c.

Dated June, 25th.

Issued

Recd. Encl.

G. O., 25th June 1881, No. 1,594 W.

JUNE.
No. 89.

Godávari Delta Works.—Special arrangements made for preparing and submitting for sanction of the Government of India the complete revised estimates for the —

No 1594 W of 25th June/81

H. E. Read again.
Letter from the G of I PWD
No 221 I dated 3/6/81

1. With a view to insure early compliance with the orders of the G of I to prepare & submit for sanction within the current year, the complete revised estimates for the works of the Godavary delta the Hon'ble the G in C directs that the following special arrangements be made immediately on the return of Colonel Mullins to duty

2. Dt Col / O. Hasted Re to assume charge of a special department in the office of the CE for I which will

be constituted into the above object, and which will work under the general instructions of the Ch. Engr. for Irrigation. Arrangements will also be made as soon as may be found convenient for placing the services of Mr. C Vincent at Col Hartedi's disposal and for appointing such draughtsmen, clerks &c. as may be needed

3. For dealing with the information required to show the expected increase of revenue &c. to be anticipated by the completion of the works in question the requisite arrangements will be made in

the Revenue Dept.

Ctt

22.6.81

The Revenue Dept. (Copy forwarded to the Chief Secy
Fmt. Dept. (To Govt. "By order" 25-6-81)
C. E. for Irrigation
Lt. Col. J. V. Hartedi R.E.
Ex. P. W. D. 21 Dec 80-6-81

PUBLIC WORKS DEPT. PROCEEDINGS, SEPTEMBER, 1865.

CIVIL WORKS.

Communications.

Godavery Navigation Works.

Pros.	(General)	2nd May 1862,	Nos.	7—8.
"	(General / Estabt.)	23rd "	"	"	37—8.
"	(Commns.)	11th July	"	"	22—9.
"	(")	Dec.	"	"	55—7.
G. G.'s "	(General)	June 1863,	"	63—9.
" "	(Commns.)	July	"	"	4—6 and 30—7.
" "	(General)	Aug.	"	No. 5.
"	(Civil Works / Commns.)	July 1864,	Nos.	16—19.
"	(Estabt.)	"	"	No. 145, Part B.
"	(")	Aug.	"	Nos. 31—2.
"	(Civil Works / Commns.)	Sept.	"	"	1—4.
"	(Estabt.)	Dec.	"	"	152—3, Part B.
"	(")	Feb. 1865,	"	141—2,	"
"	(Account)	March	"	"	129—31, "

No. 1066, dated 15th October, 1863.

[No. 49.] *From*—LIEUT.-COL. A. IMAGY, R. E., *Secy. to Chief Commr., Central Provinces in the P. W. Dept.,*

To—Secretary to Government of India, P. W. Dept., with G. G.

I am directed by the Officiating Chief Commissioner to submit herewith, for the [illegible]deration and orders of His Excellency the Viceroy, estimates aggregating Rs. 35,05,20[illegible] system of works contemplated to afford a navi[illegible] [illegible]ge for boats and steamers roun[illegible] first barrier or rapids in the River Goda[illegible]

2. Before proceeding to detail the works that constitute the scheme, and to [illegible]eate the various links in the project that tend to the accomplishment [illegible] object in [illegible] I am to state that the amount of 35 lakhs, set forth as the cost o[illegible] [illegible] mistake a sum of Company's Rs. 4,80,000 on account of Establishment, excl[illegible] this amount, Rs. 30,20,203 would become the total of the estimate as it should have b[illegible]ared according to Departmental Rules.

3. The numerous works that quite enter into the project may be grouped under the following classes or heads :—

1st.—Masonry anicut or dam across the river.

2nd.—Dam with scouring sluices across the channel or arm of the river, which cuts off the Lunka or Island from the main land.

3rd.—Canal, 23 miles in length, with all the necessary locks and drainage works.

4th.—Flood embankments for protecting the canal against the high river freshes.

4. With the exception of certain modifications in the construction details of the locks, the frontier of the head or entrance locks, and the addition of a powerful scouring sluice at the mouth of the large natural channel (two before noted) or branch of the river which forms the head of the canal, the present project is identical in scope and design with that originally proposed in the year 1856.

5. The nature and functions of the anicut or dam, canal and flood embankments, with their subsidiary works and adjuncts are detailed in the specification which accompanies the estimates proposed by Mr. Schmidt, but these I am briefly here to recapitulate with the view to render, by immediate comparison, and reference more clear and appreciable certain modifications suggested by Captain Haig in submitting the estimates to the Chief Commissioner.

6. *Anicut.*—The anicut or weir stretches nearly a mile in length across the Godavery near the upper extremity of a rocky reach 30 miles in length, forming a capacious pool at its back at the head of the rapids which is connected with the open water below the river by a canal nearly 23 miles in length.

7. In the anicut sluices are provided by means of which the back-water may be lowered at pleasure to meet the repairs necessary to the masonry works, and to act as scouring sluices in floods. The eastern extremity adjoining the wing-wall is to be built three feet lower than the remaining portion, to enable boats and steamers to pass over this barrier during freshes.

Ks. 28/6

8. The shore of the Island from the point where the left end of the anicut abuts against it, and thence upwards, will be protected with stone pitching partly laid in mortar.

9. *Dam with scouring Sluices.*—Near the mouth of the large natural channel already referred to, and which is formed by the left bank of this river and the Island, it is proposed to place a retaining wall, pierced by 16 large scouring sluices, and causing an embankment to be raised four feet above the highest flood line.

10. *Canal Locks and Drainage Works.*—The canal, as already indicated, connects the head-water above the anicut by a detour of 23 miles with the open water down the stream. The entrance to this canal is effected through the large natural channel by means of a double lock placed about midway between the scouring sluice and the Anicut Island, at the lower end of the canal, the *accumulated* difference of fall between the river at that point, and the head of canal, amounts to 69 feet, and this it is proposed to overcome by a series of locks grouped in pairs (excepting the highest which will be a single lock), and dividing the drop equally between them.

The canal in its course crosses several water-courses or local drainage channels, and it is proposed to receive into it the discharge from most of these during floods. Culverts are provided for three of the larger streams, and the most important one, the "Turabaka," has an aequeduct of three 30 feet arches provided for it.

11. *Flood embankments.*—As the general level of the river bank is lower than that of the highest floods, it becomes necessary to provide for a continuous system of flood embankments commencing at the head of the Anicut Island above Doomagoodium crossing the channel formed by the Island and the river bank by means of the dam above scouring sluices already described, and following the course of the canal (between it and the river) to its lowest terminus at the Tail Locks at or near Sodarum.

12. In now introducing the modifications of the foregoing designs suggested by Captain Haig, Superintending Engineer, Upper Godavery, I am to explain how it has happened that these newly made proposals or modifications were not primarily introduced into this project before the submission of the plans and estimates.

13. Towards the beginning of last year, the considerations and the individual or particular addition (noticed in para. 4) to the works, as in the very first instance contemplated to be projected, were decided upon to be introduced.

14. The project in this modified form with the detailed plans of the anicut and locks placed in Mr. Schmidt's hands, and almost immediately afterwards Captain Haig quitted the Division on leave. There were unfortunately a few questions of engineering regarding the line for the canal, at some points of its course, which during the two busy years which had elapsed since the commencement of the works could not well be decided upon.

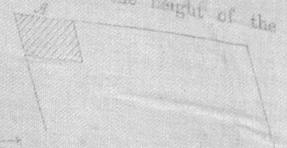
15. Such portions, however, of the canal line as were required for immediate operation were marked out alone when there was a choice of alternative lines, until those parts of the works circumstances imperatively required a decision respecting them. with the progress

16. Mr. Schmidt, who had now the maturing of the project, took as the basis of his estimate for the canal, a section taken along one of these lines, already marked out, and the result has been that the canal passes over ground, involving not only conditions most objectionable in an engineering point of view, but an amount of earth-work wholly unnecessary.

17. On Captain Haig rejoining the Division, the estimates had too far advanced to allow of remodelling them, and Mr. Schmidt was permitted to complete them, with the reservation on the part of Captain Haig of pointing out his views in the submission of the designs and estimates. They are as follows :—

No. I.—Anicut.

To reduce the height of the anicut by three feet, and as this will tend to the reduction of the velocity of the floods in passing over this wall or weir to suppress the greater part of the cut-stone covering, leaving only one row of heavy cut-stone blocks, *vide* margin A.



18. A great reduction of cost must inevitably result from this modification, and a safer work is substituted.

19. The collateral advantages that would ensue from the above, obviating as it does the necessity for diminishing the height of one end of the anicut to enable the steamers to pass over these works in flood, and for constructing the necessary block wall proposed to be carried up-stream to confine the stream flowing down to the opening to form a "shoot" along which steamers could pass on, a great diminution of the scour along the shore of the Island, for the protection of which simple groin work, instead of the very extensive and expensive stone work proposed by Mr. Schmidt would perfectly answer, and the facility offered to steamers of passing over the work at certain floods more easily than in the former case.

No. II.—Scouring Sluices.

20. To substitute a wall of solid masonry pierced with sluices for the heavy embankment provided for, a larger area of vents, and consequently a greater scouring would thus be obtained at a considerable less cost.

No. III.—Head Lock.

21. The head lock of the canal to be single instead of double for reasons below indicated. The dimensions of the lock chambers to be reduced from 200 feet × 25 feet to 175 × 25.

No. IV.—Canal.

22. To alter the line of canal near the village of Duntimun, where it is taken through the rocky base of a hill, projecting into the river, by causing it to follow the valley of a stream which flows into the Godavery near the village of Turabaka, at the 9th mile.

23. It is proposed to bank the stream across its mouth, and place a lock in the canal immediately below it. The lock gates are to be raised sufficiently high to exclude extreme floods which will be admitted into the basin above through an opening cut for the purpose through the low seeddee which divides the stream, near its mouth, from the Godavery.

24. The high floods of the Godavery entering by this opening will stand back up the canal to the head lock at Doomagoodium, where the difference of levels at such times between the inner and outer water will be 15 instead of 26 feet, thus rendering a *single* lock quite efficient, *vide* anterior para. No.

No. V.—Calingulah or Waste-Water Weir.

25. This work is an additional one to those provided by Mr. Schmidt, and is rendered necessary under the following circumstances of the canal.

26. Except during floods the difference of level between the water in the canal and that of the River Godavery would, at the extremity, if the canal near the village of Sodarum be 70 feet, and some means has to be provided for dropping the surplus water not expended in lockage or irrigation through that height.

27. At Budrachullum, where rock rises from the river bed to the surface of the ground, this is effected by cutting an escape through the narrow strip of rock between the canal and the river, allowing the water to run into the latter down the face of the rock.

28. The canal below this point is on a dead level, and when the floods rise at Budrachullum higher than the level of the canal water, thereby preventing any discharge at that point, the surplus water at Sodarum must be drawn off by means of a calingulah or waste-water weir.

No. VI.—Drainage Culverts.

29. The culverts forming as they do vents for the passage of the streams, the line of canal crosses, also admit into the canal the floods of the river causing much harm, only to be remedied by costly masonry works and heavy flood bank.

30. To obviate this, it is suggested to dispense with such drainage altogether, and open tanks at an inconsiderable cost, compared with the other arrangements for the reception of the water to be utilised for irrigation purposes.

31. In most cases old tanks already exist, and evidence both of the feasibility and of the advantage of such measure.

32. It is, therefore, proposed to suppress the three drainage culverts provided for in Mr. Schmidt's estimates.

33. The project in its present amended form is in essential particulars the same as that originally proposed, and first estimated for in the beginning of the year 1861, the alterations proposed is introduced, being chiefly suggested by the more perfect consideration and maturing of the subordinate details of the scheme.

34. By the removal of the canal line from the objectionable ground referred to in the commencement of this letter to a more favourable and economical site, by the omission of the greater part of the unnecessary block masonry, in the faces of the walls, &c., as well as the sodding and dressing of banks, and the drainage works previously noticed. Mr. Schmidt's estimate with the additional calingulah calculated to cost Rs. 12,360, a provision of Co.'s Rs. 10,000 for clearing the river approaches to the canal, and Rs. 25,000 for covering with iron bars the present wooden rails of tramway which are fast wearing away along a portion of its length where it is used for the conveyance of materials, may be reduced to Rs. 16,34,287.

35. Mr. Schmidt's item of Rs. 4,80,000 for Establishment as already noticed has been unnecessarily introduced into his estimate, and his calculations of Rs. 1,00,000 for accommodation of establishment is too much by half, and it is, therefore, reduced to Rs. 50,000.

36. It will have been seen that the probable cost of the project as revised by Captain Haig, amounts to Rs. 16,34,287; this provides for the work done since 1st May last, in addition to what is required to complete the first barrier works.

37. The aggregate expenditure prior to the above date, excluding the lakh paid on account of establishment equals 3½ lakhs, so that, if the project be completed on the principles advocated by Captain Haig, it would be represented by an outlay of 20 lakhs in round numbers for a canal with a minimum width of 25 feet at bottom, and locks of 175 feet by 25 feet in the chambers.

38. Bills for the adjusted portion of the expenditure up to 30th April last have been prepared, and in great part submitted to the Central Office of Accounts, Madras, but there remains large amount of unadjusted expenditure on the books of the Upper Godavery District, under the general head of "Advances," which includes the cost of a large quantity of "Stock" made or purchased, such as machinery, tools, boats, &c., &c., which has still to be brought to

account, under the proper heads, and debited to the various works, including the "tram-roads" and improvement of "river bed," as well as to the first barrier works to which it is so chargeable.

39. Under the system of the Madras Department of Public Works, it was the practice to include under the head of "Advances" expenditure in stock and building materials which as the articles were expended was written off to the various works on which they were used.

40. It will, therefore, be understood that but a small portion of the amount on the Upper Godavery books under this head is actual "Advances re-payable" properly as so called.

41. On the subject of the modifications as proposed by Captain Haig of the scheme as now matured by Mr. Schmidt, I am directed to express the concurrence generally of the Officiating Chief Commissioner, with that Officer's suggestions especially as regards the alteration of certain portions of the canal line and the suppression of drainage culverts.

42. The reduction of the height of the anicut by three feet has as already indicated, the advantages of economy by doing away with the necessity for constructing costly masonry works to form a "shoot" for the passage of steamers at the lower end of the anicut, and to protect the head and river face of the Island from the action of scour, which would be absolutely indispensable, were the anicut raised to its maximum height.

43. It is also probably a step in the direction of safety, as preventing floodings of country above anicut, for as the floods which now reach the river arise chiefly from the drainage of uncleared country which sheds into the drainage channels probably only ·25 of the rainfall, it follows that on extension of cultivation, the greater quantity of water that will be drained off, and the more rapid collection of this drainage with the bed of the stream will lead to much heavier and more rapid floods than have hitherto been encountered, and consequently counted upon, hence the lower the anicut, less the danger to the country above it.

44. But the lower the anicut has also the disadvantage of impairing to a certain extent the navigability of the river immediately above the anicut, by reducing the volume of back-water that would be afforded by the higher structure, and by reducing the storage, in the dry season of water. The fact of the river bed having a fall of 25 feet per mile causes this river to be affected by lowering the anicut 3 feet in a modified degree to a length of nearly 15 miles up-stream.

45. As the structure can, however, at any future date be raised to any height that may be deemed necessary, it is considered that the reduced height may be permitted.

46. It will also have been noticed that a minimum width of 24 feet has been proposed for the canal, as this also can hereafter be increased as expediency renders advisable or necessary, the Officiating Chief Commissioner recommends that it may be so adopted.

47. It is considered, however, by the Officiating Chief Commissioner, unadvisable to reduce to a minimum the dimensions of the locks to suit only the smaller kinds of boats and steamers that are now plying, and no superior kind of vessels that may hereafter be introduced when the character of this river as a navigable one becomes fully established. The Officiating Chief Commissioner considers that it would be injudicious to build such works as locks on the reduced scale now proposed. Captain Haig strongly recommends that such works as these which could not be satisfactorily enlarged to suit increased traffic should be built with reference to future demands upon them. It has been well established that powerful steamers will be required to contend against the streams of the Godavery during the rainy season, and to carry the weight of the horse-power engine that will be necessary. Boats of considerable size to meet this, and the carriage of merchandize will be required, and the Officiating Chief Commissioner cannot recommend the reduced size of lock for construction.

48. The drawings, which accompany Mr. Schmidt's estimates, the Officiating Chief Commissioner observes, will unmistakably disappoint the Government of India, and will be found painfully deficient in not unimportant details; too numerous to be pointed in this already lengthy letter, for a project calculated cost 20 lakhs of Rupees.

49. A great want of good draftsmen in their parts may possibly account for the absence of neatly executed drawings, but this is at best the mechanical part of the work, and cannot be held as a sufficient reason for withholding enlarged details of construction to establish to efficiency, in an engineering point of view, of the constructive arrangements of a series of work of such vast importance as those under review must be held to be.

50. Considerable indifference as to the general appearance in such of the drawings as have been furnished is manifest, in the incorrect headings, the want of dimensions, the irregular printing, and the non-assimilation in some cases of the plan with section and elevation, and *vice versâ*, which render examination and testing troublesome.

51. The printing in particular is executed in some instances in defiance of the conventional practices and usages.

52. As, however, considerable delay has already taken place in presenting the scheme even in its present state for the orders of the Government of India, and as a much greater one would ensue in having the plans revised and re-executed, and further as the suggestions herein offered require the decision of His Excellency the Viceroy to allow of the works being projected on permanently established views and conditions, I am desired to submit these

papers, and I am directed to solicit that orders may be telegraphed in due course with the view of saving as much time as possible in maturing the project in accordance with the views of the Supreme Government.

53. It will be seen that the 16 lakhs now shewn exceeds by 25 per cent. the sum of 12 lakhs recommended in paras. 8 and 123 of the Officiating Chief Commissioner's Report on the Godavery. That recommendation was based on the Report of Captain Haig, on the probable result of the revised estimate then under preparation. The Officiating Chief Commissioner has not yet received from Captain Haig any complete explanation of the difference, but it doubtless arises in part from the rise of prices and rates of labour which is constantly increasing.

Dated 1st August, 1863.

(No. 50.) *From*—R. SCHMIDT, Esq., C. E., *Executive Engineer,*
To—Superintending Engineer, Upper Godavery Circle.

I have the honour of forwarding herewith, for the information of the Secretary of State for India in the Public Works Department, and the Government of the Central Provinces, the detailed estimates prepared in accordance with your designs of new works in the Division lately placed under my charge.

The works, for the execution of which the present estimates have been prepared, are intended to establish uninterrupted water communication between two sections of the Godavery River, now separated for purposes of navigation by the lowest of the three rocky barriers obstructing its course.

The works consist—

1stly.—Of a masonry anicut or dam across the River Godavery.

2ndly.—Of a dam with scouring sluices across an arm of the Godavery formed by its left bank, and an Island about 500 feet from shore.

3rdly.—Of a canal 23 miles long with all necessary locks and drainage works.

4thly.—Of a system of flood embankments intended to protect the canal against the high river freshes.

Anicut across the River Godavery.—The site chosen for the anicut is a bed of solid rock of most irregular section, which stretches across the whole width of the river, is strewn with loose boulders, and has numerous hollows filled with decomposed rock and silt.

The total length of the anicut between wing-walls is 5,195 feet, with a width varying according to depth from 12 feet to 20 feet. It will be founded throughout on solid rock, care being taken to clear the site of the foundations from silt and all decomposed matter. The material used in its construction is rubble stone quarried and collected on the spot laid in hydraulic mortar and built up with vertical faces. To the upper surface an ascending slope is given of 1 in 6, and this will be covered with sand-stone blocks 2 feet thick, accurately dressed and closely fitted together.

These blocks are being prepared in a quarry opened for the purpose, at a place not far from the river, 12 miles above the anicut, and can be transported by water during the freshes. Limestone of excellent quality is found in abundance on the Tol River, about 20 miles from the works, to which it also can be brought by water.

In the anicut sluices are provided, by means of which the back-water may occasionally be lowered for purposes of repair, also the eastern end adjoining the wing-wall is kept 3 feet lower than the rest, enabling boats and steamers to pass over the barrier during freshes, and will be closed by wooden shutters only after the flood waters have subsided.

The shore of the Island from the anicut upwards will be protected with stone pitching, partly laid in mortar.

Dam and scouring sluices across entrance channel at Doomagoodium.—Near to the south of the channel, which is formed by the left bank of the Godavery and the Island, it is proposed to construct a retaining wall pierced by 16 large scouring sluices, over which will be carried on embankment raised to a height of 4 feet above the level of highest flood.

Commencing at high ground at the back of Doomagoodium Station, this embankment will be carried to the locks at the entrance to the canal, and thence over the scouring sluices to the head of the Island, converting the channel into portion of the canal, and protecting the canal against the floods of the river.

The retaining walls and scouring sluices it is proposed to build of rubble stone found near at hand, laid in hydraulic mortar; dressed stone being used for arches and copings only.

Head Locks at Doomagoodium.—The entrance to the canal is effected through the scouring already described by means of a double lock, placed about midway between the scouring sluices and the head of the Island.

The clear width given to this lock is 25 feet between verticals, and the length of each chamber 200 feet. It will be built of rubble masonry faced with quarry dressed blocks; dressed stone being used for copings, and brick for culverts and inverts.

Connected with this lock, and forming part of its structure, are three culverts, through which the canal will be supplied with water and a fourth culvert serving the purpose of feeding and emptying the locks.

Canal between Doomagoodium and Sodarum.—Of the canal, the following are the dimensions upon which the present estimates are founded:—

Width at bottom	24 feet.
Slope of sides	2 to 1
Fall per mile	4 inches.
Total length between wing-walls of head and tail locks	22 miles 4,451 feet.

The soil through which the canal is being dug varies considerably in places. A great portion of it, however, consists of decomposed rock and hard strata, which must be worked with pick and crowbar, being exceedingly compact while in their original site.

Blasting and cutting through rock, although it has been avoided whenever possible, yet occurs in several places, and forms an item in the estimates.

Much additional excavation is caused by the filling up of a number of water-courses which are crossed by the canal in a direction rectangular to its course.

The discharge during floods from the greater portion of these water-courses or vagus, it is proposed to receive into the canal, while culverts are provided for three of the larger streams, and the most important one, the Turabaka Vagoo, is crossed by an aqueduct of three 30 feet arches.

Tail Locks near Sodarum at lower end of canal.—At the lower end of the canal, the accumulated difference of fall between the river and canal amounts to 69 feet, which fall it is proposed to overcome by a series of seven locks, dividing the drop equally between them.

These locks have been grouped in pairs with exception of the highest, which is a single lock, and advantage has been taken of the formation of the ground and of the beds of some natural water-courses falling into the Godavery here, to lessen the quantity of excavation which would otherwise be exceedingly heavy, and to form a basin between the two upper pairs of locks for storage of water and for the convenience of boats.

The materials used in the construction of the locks will be similar to those employed in the head locks, it being supposed that stone of good quality may be procured at convenient distance, and carried by water to the site of the works.

For the last eight miles of its course the surface of the canal water will be above the general level of the country, and thus become available for irrigation of a large tract of ground.

Flood embankments.—As the general level of the river bank is lower than the surface of the Godavery during its highest floods, it has become necessary to provide, in the present estimates, for the construction of a system of continuous flood embankments, commencing at the head of the Island above Doomagoodium, crossing the channel formed by that Island and the shore by means of the scouring sluices above described, and following the course of the canal between it and the river to its lower terminus at the tail locks near Sodarum.

In addition to this continuous outer flood embankment, inner flood banks have been provided from the scouring sluices to the head locks, and thence to high ground at the back of Doomagoodium Station, also at each of the four places where water-courses are carried under the bed of the canal into the river.

This arrangement gives free access of the flood water in the river to such portions of the water-courses as are enclosed by the inner flood banks, and makes it possible to dispense with the use of self-acting sluices.

The height of the flood embankments is in places considerable, and adds greatly to the quantity of excavation for the canal, proportionately increasing its width whenever a deficiency of materials for the flood bank occurs.

The dimensions of flood banks upon which their contents have been calculated are—

For embankments on Island and at head of canal—width on top 15 feet, slopes $1\frac{1}{2}$ to 1.

For outer and inner flood banks on the course of the canal—width on top 12 feet, slopes 2 to 1.

Bills of quantities.—The quantities of earth-work in excavation for the canal and flood embankments have been calculated from carefully executed working sections, taken for the purpose of these estimates, along the line originally fixed upon, and the contents were

obtained for lengths of ground, varying from 200 feet in length to 100 feet and less, with the help of Huntington's earth-work tables.

In the bills of quantities herewith submitted, the calculations have, for the sake of easier reference, been considerably condensed.

For the purpose of estimating the cubical contents of masonry in the anicut, cross sections of the most uneven ground, were taken with great care at distances of 10 to 20 feet apart over its entire length, and allowance made for decayed rock, which it would probably be necessary to remove.

In the case of all masonry structures on the line of canal, their sites have been carefully examined, and the quantities calculated from rough working sketches prepared for each.

Though these sketches when fairly worked out, and more leisurely considered, may have to undergo some modifications, such modifications will but little affect the total quantities, and rather tend to a saving than to an increase on the present estimates.

Scope of the estimates.—As will be observed by a reference to the bills of quantities, the estimates now prepared are, for *such works and portions of works only which remained unexecuted on the 1st May last, and are not intended to cover any part of the expenditure incurred before that date.*

They also do *not* include any provision for the improvement of the river bed, and of the approaches to the canal, nor any works connected with the completion, maintenance, repair, and partial re-construction of the line of tramroad.

Nor has any allowance been made for the cost and maintenance of the Transport Fleet for establishments, plant, cattle and rolling-stock employed on working the tramway, or for any other expenditure incurred by, or on account of, the Transport and Supply Department, excepting the loss on sale of rice to workmen.

Further the estimates do not provide for any future improvements of Doomagoodium Station, for public buildings not occupied by members of the Divisional staff, nor for any expenditure on account of Departments of the Superintending Engineer and Controller of Accounts.

Finally, they make no allowance for prospective rises in the price of labour, the contemplation of which involves elements too uncertain for calculation, and will chiefly depend upon the greater or less amount of completion which may arise, and upon the assistance which other departments of Government may be able to grant.

Schedule of Rates.—In no respect do the present estimates differ more widely from the former preliminary ones than in the schedule of rates upon which the probable cost of the proposed works has been calculated.

This difference is owing to an enormous increase in the cost of labour, which the experience of two working seasons has unfortunately proved, cannot be diverted from the more populous and attractive districts on the coast and within the Hyderabad Territory, without the strong inducement of greatly increased pay, and which even, when collected on the works at serious cost and outlay, has a tendency within a brief space to dwindle down to nothing unless kept up by constant recruiting at ever-increasing distance, and on the most comprehensive scale.

So great appears to be the dislike of all native workmen to the Upper Godavery Works, that even double pay with most substantial collateral advantages in the shape of house accommodation, half-pay when sick, short working hours during the hot months, and rice sold to them at a fixed rate considerably under cost price—has hitherto induced the most worthless portion only of the labouring population of neighbouring districts to present itself for employment to the Upper Godavery Recruiting Agents.

As a consequence, not only are abnormally high prices paid for each day's work, but from the inferiority of most of the workmen collected, such day's work is unequal to a fair day's work performed elsewhere.

Also as most of the men care little about remaining, and are only too ready after a short stay, of a pretext to break their engagements and to return to their houses, it becomes extremely difficult to keep a control over them, and to introduce that amount of organization which alone can ensure the successful and economical performance of great public works.

The wages now paid in cash are for a coolie per month ... ... Rs. 7
for a brick-layer per month 12
Carpenter per month 15

in addition to which each man receives batta on being engaged, house accommodation while on the works, free attendance and half-pay when sick in hospital, short hours and minor indulgences during the hot season, and a supply of rice upon which Government is a monthly loser of not less than Re. 1-4.

If to this be added the expense of keeping up recruiting parties in many places, and heavy travelling charges, also a percentage for inferior performance, the wages of a common coolie rise to the height of about Rs. 10 per month, and those of other workmen in proportion.

With such data to go upon, and apparently little tendency to future reduction, the rates for work in the new estimates could not be otherwise than high, even though due account has been taken of certain improvements in the mode of working, which may fairly be reckoned upon when works are spread over a considerable time, and both superintendence and labour have continued opportunity of becoming familiar with special works.

The following are details of rates for some of the principal works and for the bulk of labour :—

	Rs. per month.
Cost of Coolie labour.—Average wages of 531 daily coolies employed on anicut, per man	6·80
Sick pay and hospital charges, 5 per cent. on labour	·30
House accommodation	·36
Loss on sale of rice	1·25
Recruiting charges	·31
Loss of labour incurred by working short hours during three hot months	·33
Total cost per month of one coolie ...	9·35
Cost of Brick-layer's Labour.—Average wages of 92 brick-layers employed on anicut work	12·00
Sick pay and hospital charges, 5 per cent. on labour	·60
Loss on rice, house accommodation, and recruiting charges, the same as for coolies	1·92
Loss of labour incurred by working short hours during three hot months	·60
Total cost of brick-layer's labour ...	15·12
Cost of limestone per 100 cubic feet.—Quarrying limestone by contract per 100 cubic feet	3·75
Cost and maintenance of quarry, tramway, and superintendence over Contractor	·95
Mixed land and water carriage to works result of season 1862-63 ...	21·75
Breaking limestone ready for burning in kilns	1·85
Indirect charges on daily labour as shown in cost of coolie labour...	7·70
Total cost of 100 cubic feet of limestone broken ...	36·00
Cost of slacked lime per 100 cubic feet.—Burning lime, including loading, firing, and drawing kilns	3·79
Slacking and sifting	1·22
Indirect charges on labour as shown in cost of coolie labour ...	1·88
1·70 tons of fire-wood at Rs. 1-8 per ton	2·55
Add cost of limestone	36·00
100 cubic feet of limestone equal to 125 cubic feet of slacked lime.	
Total cost of 100 cubic feet of slacked lime $\frac{100 \times 45{\cdot}44}{125} =$	36·35
Cost of cement per 100 cubic feet.—Mixing with clay in equal portions, making, drying, and stacking cakes of raw cement ...	2·75
Burning in kiln	·90
Transporting to works	·96
Indirect charges on daily labour as shown in cost of coolie labour...	1·73
Fire-wood at Rs. 1-8 per ton	·60
Add cost of slacked lime	36·35
100 cubic feet of slacked lime = 200 cubic feet of cement.	
Total cost per 100 cubic feet of cement burnt and delivered $\frac{43{\cdot}29}{2} =$	21·65

	Rs. per month.
Cost of hydraulic mortar per 100 cubic feet set.—Mixing with sand in equal portions 200 cubic feet of mortar	2·00
Mortar mills and kilns	·35
Add cost of cement	21·65
200 cubic feet of materials for mortar = 150 cubic feet of mortar set.	
Total cost of 100 cubic feet of mortar set... $\frac{2 \times 24{\cdot}00}{3} =$	16·00
Cost of hydraulic mortar per 100 cubic feet of rubble masonry finished.—Proportion of mortar to rubble masonry when finished, 45 to 100.	
Total cost of hydraulic mortar per 100 cubic feet of rubble masonry ... ... $\frac{16{\cdot}00 \times 45}{100} =$	7·20
Cost of rubble masonry per 100 cubic feet.—Cost of hydraulic mortar per 100 cubic feet of work	7·20
Brick-layers' contract labour	2·77
Coolie labour engaged in quarrying stone, preparing foundations, assisting brick-layers, and making temporary dams and railways	11·27
Work Establishment, 6·4 per cent. on labour	·91
Indirect charges on labour as shewn in cost of coolie labour ...	5·44
Workshop expenses and stores not included in indirect labour charges	·41
Total cost of rubble masonry per 100 cubic feet ...	28·00
Cost of earth-work in canal per 1,000 cubic feet.—Cost of excavation at ruling rates for contract labour per 1,000	6·00
Daily labour of workmen engaged in loading material, making tramways, workshop operations and sundries, 3 per cent. on contract labour	·18
Work Establishment, 5 per cent. on all labour	·32
Indirect charges on labour as shewn in cost of coolie labour ...	2·50
Tools, plant, and extra charges for removing stones	1·00
Total cost of earth-work per 1,000 cubic feet ...	10·00

Establishments.—For the purpose of the present estimates, it has been assumed that funds will be available to complete the whole of the works within four years commencing within the 1st May last, and the total sum requisite to maintain an efficient establishment has been calculated accordingly.

As regards the native portion of the establishment, which includes men employed in offices and stores only, and no mistrees, time-keepers, and others, directly chargeable to works, a slight margin is given for prospective increase of pay of deserving individuals.

On the other hand, the salaries of Europeans have been calculated at existing rates with no allowance whatever for future increase.

Were the prospect of completing the works less distant than can be inferred from the present difficulty of procuring labour and from the large increase of the new estimates, the ordinary advantages of the public service would probably be sufficient to secure all requisite superintendence.

The case, however, becomes much altered when the works are spread over a series of years, and Europeans attached to them have the prospect of spending a long period in a notoriously unhealthy locality, exposed to more than ordinary risk of sickness, deprived of every comfort, and engaged on duties more onerous and less likely to be noticed than those of other Officers more fortunately circumstanced.

In such a case, it would be requisite either to make frequent changes in the staff to the evident detriment of the works, or else to offer extra rewards in the shape of rapid promotion or increased allowances to such men as would be found willing to undergo the risk, and the discomfort of a prolonged stay in the jungles of the Upper Godavery.

Accommodation for Establishment.—Another circumstance which it became necessary to take into consideration in the new estimates is the necessity to provide house accommodation for every member of the establishment, both European and Native.

The district being almost completely destitute of population, there are no villages in which natives could find quarters, nor can Europeans be expected to build houses at their

own expense in a place notoriously unhealthy, which, after a short occupation, they may be forced any day to leave with no other chance of disposing of their property than the terms which a possible successor may be inclined to offer.

It will thus be requisite not only to build houses at the expense of Government, but also to build them in a sufficiently substantial manner to give fair protection against the obnoxious influences of the climate which more than from any other cause appear to be aggravated by defective accommodation.

What has been hitherto effected in the way of housing Europeans will count for little, as the huts which they now occupy are of the most temporary kind, are mostly built of mud, with floors of the same unwholesome material (clay being rarely available,) and ill provided with doors and windows.

The annual cost in repairing buildings of this class is out of proportion to the value, and apart from their insecurity and sanitary defects, makes it highly desirable to see them replaced by structures of a somewhat more substantial kind.

Estimated additional cost for a canal and locks, 45 feet wide.—The original estimates for works at the lower barrier appear to have been for a canal 60 feet broad at bottom with locks, having a clear width of 45 feet, while the present estimates provide for a canal 24 broad only at bottom with locks of 25 feet.

This reduction in the main dimensions of the canal will have the necessary consequence of preventing all paddle-wheel steamers, such as are now employed in the navigation of Indian rivers, from making use of the new canal, while the saving in money effected by the reduction is trifling compared with the total amount of the estimates, and would appear to be a small compensation for the exclusion of the most generally preferred class of steamers.

Roughly stated, the difference of cost between locks 25 feet wide and locks 45 feet wide amounts to 1¼ lakhs, which would be little more than 4 per cent. in excess of the present estimates.

The culverts crossing the line of canal have already been estimated for a width of 45 feet, and to the canal itself much additional width is given by the excess of excavation required in places for the construction of the flood embankments.

To construct both canal and locks therefore of sufficient width to make them passable for paddle-wheel steamers enabling them to communicate with stations higher up the river, without either break or risk, would occasion no great expenditure than say 4 lakhs, raising the total cost of works from 35 lakhs, at which they are now estimated, to 39 lakhs when made of increased width.

Permanent workshops and graving dock for repair of steamers and boats.—Under the impression that Doomagoodium on account of its central position with regard to any future navigation of the Godavery would probably require permanent facilities for repairing steamers and boats, designs had been prepared for a small basin in connection with head locks at Doomagoodium, also for a graving dock to which access would be gained from that basin. A range of workshops covered with corrugated sheet iron was placed alongside the dock, fitted with all machinery necessary for emergent repairs.

Though this portion of the general design has, for the present, been abandoned, it may not be out of place here to mention that the execution of this very desirable adjunct to the Upper Godavery Works would cause but a very trifling addition to the estimates, since all machinery which could possibly be required has already been purchased, but cannot be erected for want of proper shops.

The additional outlay caused by the erection of permanent shops, a basin and graving dock as above described, would not exceed Rs. 50,000.

Drawings and papers accompanying estimates.—The following copies from plans and rough sketches of some of the principal works are forwarded with the estimates, and though avoidably imperfect and incomplete, may render some assistance in further illustrating the general features of the design:—

1. Plan shewing Island and site of Anicut.
2. „ „ 1st Sub-division of Canal.
3. „ „ 2nd „ „
4. „ „ 3rd „ „
5. Cross Sections of Anicut.
6. Wing-walls of „
7. Works for protection of head of Island.
8. Dam and Scouring Sluices at mouth of entrance Channel.
9. Head Locks at Doomagoodium.
10. Drainage Culvert two miles from Head Locks.
11. „ „ three „ „

The estimates comprise the following papers:—

1stly.—Bills of quantities, 36 sheets.

2ndly.—Abstract of quantities and cost of works, 9 sheets.

3rdly.—General Abstract of quantities and cost of works, 1 sheet.

No. 333, dated 1st September, 1863.

[No. 51.] *From*—Captain F. T. Haig, R. E., *Supdy. Engr., Upper Godavery Circle,*

To—*Secy. to Chief Commr., Central Provinces, in the P. W. Dept.*

I have the honour to forward the estimates,

Enclosures. (a)

1.—Bill of quantities.
2.—Abstract of quantities and cost.
3.—General abstract of quantities and cost.
4.—Remarks by the Executive Engineer.

(a) All these enclosures went with Secretary to Chief Commissioner's No. 1906 of 15th October 1863, forwarded on 30th June 1864.

* No. 5 enclosed.

2. The drawings from which Mr. Schmidt's quantities have been calculated, together with a Memorandum by him, which is, in fact, a specification explanatory of the nature and objects of the works proposed, accompany the estimates. These drawings are not in as much detail as could be desired, but they are sufficiently so to exhibit the designs of the various works, and it was not possible for Mr. Schmidt, with the means at his disposal, to prepare more elaborate plans. Nor, indeed, as events have turned out, was it at all necessary to do so, for the designs of most of the works embraced in his estimate must, if my present recommendations are adopted, be altered. It is sufficient for our present purpose that the quantities shown in his detailed estimates have been taken out with great care, and that their accuracy may be relied on.

3. In explanation of the circumstances which have led to the submission of the estimates in this two-fold form, it is necessary for me to draw your attention briefly to the past history of the project.

4. Mr. Schmidt joined my Head-Quarters as Executive Engineer of the 1st Division on the 11th April last, and as the Government of India was particularly desirous that revised estimates for the works should be framed as soon as possible, I made this the chief part of Mr. Schmidt's duties, and before my departure from the Division on leave, which took place on the 20th April, furnished him with such materials in the way of sections, plans, sketches, &c., as were available for the prosecution of the work assigned to him. The project, the probable cost of which he had to compute, was in all essential points, in fact, in almost every point, identical in scope and design with that originally proposed by me in my Report of May 1856, and subsequently estimated for in detail in January 1861.

It consisted, in brief, of an anicut or weir one mile in length across the Godavery near the upper extremity of a rocky reach 30 miles in length, with a canal connecting the pool thus formed at the head of the rapids with the open water below them. Locks sufficient to overcome a total rise of 70 feet, together with a few drainage culverts, were the only adjuncts to the canal which the original scheme embraced.

5. In the two and a half years, however, which had elapsed since the commencement of the works in January 1861, when the project in this form was laid before the Madras Government, two important modifications of the original design had been suggested, partly by my own increasing acquaintance with the peculiarities of the river, and more leisurely considerations of the conditions which the works proposed should fulfil; and partly by the Chief Engineer and Sir W. Denison, in the course of a discussion of the whole subject of the Godavery navigation in the beginning of last year. These modifications consisted of—1st, the reduction of the dimensions of the lock chambers from a length of 200 feet, and a width of 45 feet, to a length of 180 feet, and a width of 30 feet; 2ndly, the alteration of the site originally proposed for the head or entrance lock, and the addition of a powerful scouring sluice at the mouth of the large natural channel or branch of the river which, dividing the Island on which the anicut abuts from the main land, forms the head of the canal.

6. The project, in this modified form, with the detailed plans of the anicut and locks which accompanied the first estimate, was placed in Mr. Schmidt's hands, and almost immediately after I left the Division. There were unfortunately a few questions regarding the best line for the canal at some points of its course, which, during the two busy years which had elapsed since the commencement of the works, I had not had leisure to decide. Without any experienced Officer to take charge of the works at this barrier, with no Assistant above the

rank or experience of a 2nd Assistant Engineer of a year's standing, and works in hand at all three barriers, extending over a length of 300 miles, to superintend, I was obliged to content myself with marking out such portions of the line of the canal as were required for immediate execution, and with leaving the parts where there was a choice of alternative lines until, with the progress of the works, circumstances imperatively required a decision respecting them.

7. During by absence from the Division, Mr. Schmidt took, as the basis of his estimate for the canal, a section taken along one of those lines which, in many places, passed over ground involving, not only conditions most objectionable in an engineering point of view, but an amount of earth-work which was wholy unnecessary.

Had I been at hand, I could have pointed out the objections to this line, and prevented its adoption in M. Schmidt's estimate. On my return, however, from leave, the estimates were so far advanced that, though I was in time to suppress some objectionable alterations of the original design for the tail locks, I found the attempt to re-cast the estimates, with the modifications which I considered necessary, would involve such delay, that I directed Mr. Schmidt to complete them in their original form, and reserved to myself the duty of pointing out, when submitting them to the Chief Commissioner, the alterations which it might appear advisable to make. Mr. Schmidt, who had bestowed much care and pains upon the work, placed the complete estimates in my hands on the 1st ultimo, and the accompanying drawings a few days afterwards.

8. On receipt of these estimates, finding that they aggregated an amount so far beyond my anticipations, I determined to investigate the whole project *de novo*, with a view to the possibility of some such alteration of its original features as might either afford the means of reducing its cost without diminishing its value as a link in the navigation, or, if that should be found impossible, of substituting a less valuable, less perfect means of communication, the expense of which would approach more nearly the amount which I had originally led the Government to suppose would be sufficient.

This investigation has, with the preparation of the revised estimate, in which it resulted, occupied nearly a month, a delay which I regret, but which, under the circumstances, were unavoidable.

9. The result is a partial modification of the original design which, together with a slight reduction of some Mr. Schmidt's rates, reduces the estimate from Rs. 35,00,000 to Rs. 16,34,287, or more correctly speaking, from Rs. 30,20,000 to Rs. 16,34,287, for Mr. Schmidt included by mistake in his estimate the cost of the Engineer and Subordinate Establishments, amounting to Rs. 4,80,000, which, under thes ystem in force under the Government of India, is separately provided for in the Annual Budgets.

10. Before entering into a detailed description of the project in its new form, I must guard against a possible misconception of its merits in an engineering point of view, as compared with the original scheme. Where the motives for a reduction of cost have been so strong, not a unnatural suspicion may arise that this object may have been attained at a sacrifice, either of efficiency or of safety in the works proposed.

It may possibly be feared that, in the constructive details of the works, dimensions may have been pared down till a minimum only of strength has been obtained, or that safety may have been jeopardized by the suppression of some important adjuncts. I would, therefore, call attention to the fact that in two most important particulars, the modified scheme possesses a marked superiority over that which it supplants. The anicut will be 3 feet lower in height, and consequently exposed to a less trial, and the pressure of water on the large gates of the entrance lock, 32 feet in height, will be reduced from 26 to 15 feet.

Add to this that by an alteration of the line of canal, it is removed for a length of five and half miles from the river bank, and placed beyond the possibility of injury from floods, and that along another six miles of its course below Budruchullum, a similar change substitutes a line almost beyond the reach of floods for one peculiarly and most dangerously exposed to them. (I should remark that this last and most objectionable piece of line, though adopted in Mr. Schmidt's estimate, formed in no way an essential part of the original project).

The project, therefore, which I now recommend for adoption is, in my opinion, much superior in an engineering point of view to the original one, an opinion, which I trust, the Government will accept unless controverted by direct criticism of the professional merits of the works proposed.

11. The alterations which I proposed are as follows:—

1st.—To reduce the height of the anicut 3 feet, and as this will be attended with a corresponding reduction of over-fall and of velocity of the current over the work in floods, to suppress the greater part of the cut-stone covering, leaving only one row of heavy coping stones 5 feet long and 2 feet thick along the down-stream crest of the work, and substituting rubble masonry for the remainder. Of the advantage of diminishing the height of the anicut, supposing this not to involve any increased outlay upon the other works, there

can, of course, be but one opinion; it will give a cheaper as well as safer a work. As to the substitution of rubble masonry for the cut-stone copping, I may remark that such is the excellence of the hydraulic cement with which the masonry is put together, that it was very questionable whether this alteration might not have been made even if the anicut had remained at its original height. The material used for the rubble work is an exceedingly hard stone quarried alongside the anicut out of the rock on which the work rests, and are artificially prepared hydraulic cement which sets rapidly and firmly under-water, about 2,000 feet in length of the anicut which was built this year, is now being exposed to the action of the floods; and observation of the parts uncovered from time to time by the subsidence of the river, confirms me in the opinion that to cover it with cut-stone, a material which here is rather inferior in quality and very dear, would be an unnecessary expense.

12. 2nd.—The heavy stone pitching entered in Mr. Schmidt's estimate for the protection of the head and river face of the island, on which the left end of the anicut rests, will be suppressed, being no longer necessary. It was originally intended to have an opening 350 yards in width at this end of the anicut, to enable steamers to pass over the work in floods, and a wall was to have been carried up-stream for a length of 500 yards parallel to the face of the island, to confine the stream flowing down to the opening, so as to form a "shoot" along which steamers could pass. The strong current which would thus be caused along the shore of the island rendered necessary its protection by means of stone work on rather an extensive scale. This will, however, now be dispensed with, as steamers will be able to pass over the work at certain heights of flood more easily than in the former case, and the velocity of approach will not be such as to require anything more than a little simple groin work at the head of the island.

13. 3rd.—A wall of solid masonry pierced with sluices will be substituted for the embankment, with sluices underneath, estimated for by Mr. Schmidt. A larger area of vents, and consequently a greater scouring power may thus be obtained at a considerable reduction of cost.

14. 4th.—*The lock at the head of the canal* will be single instead of double. The reason for this will presently appear.

15. 5th.—*The canal.*—The original plan was to give the canal an uniform slope of 4 inches a mile from the head down to the tail locks. The line was to have run parallel to, and within 200 or 300 yards of the river all along. The drainages crossing it were to be led underneath it by means of culverts, and an embankment high enough to exclude the floods was to run between it and the river along its whole length. Near the village of Duntimun, the canal was either to have been taken through, or round the rocky base of a hill which there projects into the river. The first alteration I propose to make is in this part of the line. A much better course has been found following the valley of a stream which falls into the river near the village of Turabaka at the 9th mile. This river will be banked across at its month, and a lock placed in the canal immediately below it. The gates of this lock will be raised to a height sufficient to exclude the extreme floods which will be admitted into the basin above through an opening cut for the purpose in a low saddle which divides the river near its mouth from the Godavery.

The waters of this river, which I will distinguish as the Turabaka River, will generally be discharged by the canal through the lock, but will have a vent also, if ever an extreme flood should rise so high, by the opening above referred to, into the Godavery. The high floods of the Godavery, which will enter by this opening, will stand back up the canal to the head lock at Doomagoodium, where the difference of level at such times between the river and outer water will be 15 feet. Had the original arrangement been retained, and no lock placed at Turabaka, this difference would have been 26 feet. It is for this reason that the double lock at head of canal contemplated in the original scheme is now to be replaced by a single one.

15. The slope of the floor of the canal will be 9 inches per mile from the head of the Turabaka lock, and the sills of the latter will be laid at such a level that the supply of water from the head may at any time be cut off without affecting the navigation of the canal below which will, at such times, be still water. Below the Turabaka rock the same slope of 2 inches per mile will be continued as far as Budrachullum, the 13th mile, but from this point on to the tail locks at Sodarum the head will be on a dead level.

16. Excepting during floods, there will be a difference of level of 70 feet between the water in the canal at Sodarum and the river, and some means has to be provided for dropping the surplus water not expended in lockage or irrigation through that height. Were this escape made at Sodarum, a very expensive and rather formidable series of masonry falls would be required, but at Budrachullum rock rises from the river bed to the surface of the ground, and an escape can be made at this point at no greater cost than simply cutting through the narrow strip of rock between the canal and the river, and allowing the water to fall down the face of the rock into the river below. The canal below this point being on a dead level, the waste-weir can thus be made at the point where the ground offers special facilities for the purpose. A calingiah or waste-weir, with a drop of 11 feet, will, however, be provided near Sodarum, also for use at such times occurring only once in several years, as the floods rise at Budrachullum

to a height greater than that of the canal water, and must prevent any discharge at that point.

17. With regard to the drainages crossing the line of canal, the difficulty of dealing with them is increased greatly by the fact of the canal crossing them to close to their mouths that the floods of the Godavery stand back of them to a greater height than the surface of the canal water. The same culverts therefore which give vent to these streams must let in the floods of the river which, unless banked out inside as well as outside, would enter the canal and do much harm.

The culverts originally planned were of this character, and were necessarily expensive works, for the banks of the Godavery over which the canal runs being 60 feet higher than the summer level of the stream; every trifling little water-course that falls into the river discharges itself into an immense gully of that depth. Thus a great height of flood banks and great length of culverts became necessary.

18. The possibility of shutting up the drainages altogether, and storing in tanks for irrigation, the water which could only be discharged into the river by means of the expensive works above described, have long engaged my attention. It had obvious advantages. By the one method we should have to pay heavily for assisting the drainage water to run to waste into the Godavery; by the other we might retain it for use. It was not, however, until a month or two ago that I obtained reliable data as to the actual discharges of the different nullahs. I find that in most cases old tanks already exist upon them, and that in the one or two cases where new tanks must be made, the expense of these works will be but a fraction of that of the culverts which they would replace.

I propose, therefore, to suppress the three culverts included in Mr. Schmidt's estimate, and instead of them to tank the streams on which they were to have been placed. In every case the water thus stored can be used for irrigation, and the people are ready to avail themselves of it. The country, in fact, abounds with old tanks of small size, the jungle is full of them, showing that at some former period, cultivation must have been much more extended, and probably the population much more dense than now.

19. *Lastly, the tail locks at Sodarum.*—The plan of these remains unaltered, except in the reduced dimensions given to them. With their intermediate basins they will extend over a length of about a mile, descending through very broken ground which has been taken advantage of for the purpose 70 feet from the canal surface to the summer level of the river. The locks are arranged as follows:—1st, a single lock on the highest level with a drop of 5 feet; 2nd, a basin half a mile long and 70 yards broad, separates this from a double lock with a drop of 20 feet; 3rd, a basin of smaller dimensions leading to another double lock with the same drop; 4th, a third basin with a double lock at foot with a drop of 25 feet.

20. The dimensions allowed of the locks in the chambers are 175 feet in length by 25 feet in width.

21. The width allowed for the canal in the estimate is eight yards at bottom, or 15 yards at the water line.

22. The flood banks are everywhere to be raised to a height of 4 feet above the highest flood, and to have a width of two yards at top, which corresponds to a thickness of 22 feet at the highest flood line, the slopes being 2 to 1.

23. I have now described the project in the amended form, in which I would recommend it for adoption. It is, in all essential particulars, the same as that originally proposed, the alterations which have been introduced being partly suggested by a desire to avoid all sources of unnecessary expense, and partly by the more perfect maturing of some of the subordinate details of the scheme since the first estimate (of 1861) was framed.

24. With regard to the probable cost, Mr. Schmidt's estimate, which is in full detail, amounts to Rs. 35,00,000.

My own estimate for the revised project amounts to Rs. 16,34,287, the reduction being chiefly in the quantities of work to be done, and only slightly in rates.

The principal differences in *quantities* are :—

	Mr. Schmidt's Estimate, Cubic feet.	Revised Estimate, Cubic feet.
Earth-work, including filling in	108,079,832	74,869,475
Rubble masonry	3,798,104	2,565,916
Dressed stone	219,686	93,710
Block masonry in face work	366,350	Replaced by coursed rubble.
Sodding and dressing banks	5,279,026	1,300,000

These differences result with the exception of the two last from the changes introduced in the designs or mode of construction of the different works as before described.

The greater part of the block masonry in the faces of walls, &c., I consider wholly unnecessary, as well as the sodding and dressing of banks; neither were introduced in the arranging of the numerous hydraulic works in the Delta.

25. The quantities above given for the revised estimate are taken from the "general abstract of revised quantities and cost," which accompanies Mr. Schmidt's estimates. The details I have not thought it necessary to give, as it would have added greatly to the delay in the preparation and submission of the revised estimates. The quantities have, however, been carefully calculated by Lieutenant Montgomerie in communication with Mr. Schmidt when that was necessary, and the revised estimate prepared by making the necessary deductions from, and additions to, Mr. Schmidt's estimate.

In one instance only, that of the earth-work for a part of the canal below Badrachullum, is the estimate not based on actual detailed measurements. The section of this (altered) part of the line was not ready in time, but I have since received it, and believe, the quantities assumed, will be found sufficient. In any case the amount in doubt is but a small fraction of the total quantity of earth-work.

My impression is that the Government would be better pleased to have a really reliable estimate of the cost of the works within five per cent. of the accurate amount, than to wait longer for a more detailed and exact calculation of the actual amount of the expenditure that will be required, and to this degree of accuracy, the quantities in the revised general abstract may be relied on.

26. The rates assumed in the estimates are as follows :—

	Mr. Schmidt's Estimate. Per 100 cubic feet.	Revised Estimate. Per 100 cubic feet.
	Rs.	Rs.
Rubble masonry	28	22 Mean of 2,321½ and 20.
Dressed stone	75	75
Brick-work	30	30
	Per 1,000 cubic feet.	Per 1,000 cubic feet.
	Rs.	Rs.
Earth-work	10	8¾

These are the rates for the most important descriptions of works. In regard to all others, the two estimates agree.

27. The difference in the rates is owing to two causes, *first*, to Mr. Schmidt's having assumed that there would be a loss in the rice supplied to the coolies, amounting to Re. 1-4 per head per month; *secondly*, to his having allowed a much higher rate for the cost of carriage of limestone than there is, in my opinion, any necessity for; *thirdly*, to his having charged the same rate for rubble masonry in all the other works as in the anicut, though, in the latter case, it includes the expense of dams, baling and excavating foundations, while these items are all separately allowed for in the estimate for the former.

28. With regard to the first, even if the price of rice had not been raised, the loss would not have amounted to the figure assumed by Mr. Schmidt.

On the whole of the transactions of the past year, it came to only Re. 0-12-8 per head per month. But lately the price has been raised from 20 to 15 seers per rupee, a rate which as yet we have no reason to believe will entail any increase of wages, and at which we can certainly supply the rice without loss. I have, however, allowed half a rupee in the item of indirect charges on labour on this account, which raises this item to 20 per cent. of the wages in the case of common coolies, instead of 37 per cent. according to Mr. Schmidt.

29. In the second case, I allow four annas per mile for the cost of carriage of limestone instead of six annas, a rate which ought to be abundantly sufficient, seeing that the greater part of the transport will be effected by water. In the third case, the amended rate I have introduced seems to me to be a correction, the necessity for which is palpable. In building the anicut the cost of damming up the river, of baling, and of excavating foundations in the solid rock, is a heavy addition to the cost of the rubble masonry, of which the work is composed, and it is obviously a mistake to charge the same rate for this description of work in the locks and sluice where each of these contingent charges is, as in Mr. Schmidt's estimate, separately allowed for. It is true that, in the case of the tail locks, the limestone, if that from the same quarries, which supply the anicut, is used, will be more expensive in consequence of the increased distance it will have to be carried, but this item of expense can be calculated separately, and I have made allowance for it in the rates I have taken for the works referred to.

30. The above corrections in Mr. Schmidt's rates seem to me to be quite necessary, but it will be observed that the mere reductions which they involve accounts for but a very small part of the difference between his estimate and the revised one, which is mainly owing to the reduction in quantities.

31. The item of Rs. 1,00,000 allowed by Mr. Schmidt for accommodation for establishment and temporary buildings, I have cut down to Rs. 50,000, which I consider more than sufficient.

The details for this must, of course, be given hereafter. Mr. Schmidt in his Memorandum remarks, that "what has hitherto been done in the way of housing Europeans will count for

little," and, therefore, allows largely for the expense of more suitable accommodation; but he conveys an altogether erroneous impression of the kind of accommodation already provided when he speaks of the houses now occupied by the Europeans as huts of the most temporary kind, mostly built of mud with floors of the same unhealthy material, and ill-provided with doors and windows, excepting the houses built by some of the officers at their own expense; more than half those occupied by Europeans have substantial stone-walls, and are furnished with doors and windows quite sufficient for all purposes. They are capable of improvement, but I am not disposed to recommend such an extensive style of buildings as Mr. Schmidt appears to contemplate.

32. The revised estimate includes items which are omitted in Mr. Schmidt's, *viz.*, Rs. 12,360 for a calingula or waste weir at the lower end of the canal, Rs. 10,000 for clearing the river approaches to the canal at both ends of rocks and bushes, and Rs. 25,000 for covering the present wooden rails of the tramroad with thin iron bar, along a portion of its length, where it will be used for the conveyance of materials.

It has been found that the wooden rail soon wears to an extent which immensely increases the cost of traction, and that the iron bar, which it was originally proposed, to lay down after the first year, or as soon as ever there were funds available for the purpose, is absolutely necessary if the tramroad is to be of any real service.

33. The item of Rs. 4,80,000, allowed by Mr. Schmidt for establishments, is unnecessary; these being separately provided for in the Budget as already remarked. The cost of the work establishments is included in the rates.

34. On the whole, the Government may, I think, receive, with confidence, the estimates which I now submit.

The only question in regard to them can be respecting the rates, and as these have been deduced with care from the work already performed, and there is no very great difference between Mr. Schmidt's calculation and my own, there is good reason to believe that they are sufficient. That they are high, is no more than was to be expected from the nature of the localities when work has to be carried on, the deficiency of the local population, and the necessity of importing the whole of the labour required from distant, and more healthy district when it is already in abundant demand.

35. At the commencement of the works in January 1861, when my first estimate was made, the pay of common labourers was Rs. 4½ and Rs. 5. It has gradually risen to Rs. 6 and Rs. 6½, or allowing for the loss on sale of rice supplied by Government, Rs. 6½ and Rs. 7. The wages of brick-layers, carpenters, smiths, and all descriptions of artificers, has risen in nearly the same proportion.

The price of timber and every description of building materials has increased at least 100 per cent., partly by the immensely enhanced demand, and partly by the taxes imposed on all descriptions of forest produce since the transfer to the English Government of the Talooks along the north bank of the Godavery. The salaries of Native Clerks, Maistrees, &c., have also risen, but not to the same extent as in the former cases.

36. The actual cost, however, of all labour, has increased much more than the mere difference in wages would indicate since the beginning of 1861. The extent to which the unhealthiness of the climate was likely to operate upon prices was then little suspected, and the incidental charges due to the cost of housing the people, sick pay, travelling batta, and other similar inducements held out to attract labour, which now amount to 20 per cent. upon wages, were, in the absence of any experience of nature of the climate during the feverish months, estimated at a much lower figure.

37. The rates adopted in the original estimate were for—

Earth work, Rs. 2-12 to Rs. 5-8 per 1,000 cubic feet, chiefly the former figure.

Rubble masonry, Rs. 10-3 to Rs. 11-2 per 100 cubic feet.

Dressed stone, Rs. 41 per 100 cubic feet.

The corresponding rates in the present estimates are Rs. 8-12, Rs. 22, and Rs. 70, an increase which is somewhat larger in proportion to the increased cost of labour and materials as above explained. I am, however, of opinion that, in framing the first estimate, the probable increase of wages from the increased competition for labour throughout the country was not sufficiently taken into consideration, and that the rates on which it was based were lower than the circumstances of the case required. I took, perhaps, too sanguine a view of our prospects in regard to the supply of labour, and the time that would be required for the completion of the works. Yet, while admitting this much, when I look back to that time, and compare our present knowledge, derived from the improvement of the two past years, of the conditions under which the works projected for the improvement of this river have to be carried on, with the very imperfect acquaintance with the climate, the localities and the state of the labour market with which we started, I cease to wonder at the great difference between the two estimates.

Certainly had I then produced an estimate, amounting to 21 lakhs, or about one-third of what the whole of the magnificent works in the Delta for the irrigation of a million acres

have cost, including an anicut with a clear water-way of 2½ miles, an aqueduct half a mile long, and immense main ducts delivering a volume of 800,000 cubic yards an hour, besides a multitude of smaller masonry works, and hundreds of miles of canals, I do not believe that any one of the Officers acquainted with the history and extent of those works would have hesitated to denounce my estimate as simply preposterous.

38. Rupees 2-12-0 to Rs. 5-8-0 per hundred cubic feet for earth-work may seem a low rate, yet it was 30 per cent. more than was actually being paid in the Kistna District, where rates were higher than in the Godavery Delta at the time these works were commenced.

This I ascertained by a reference to the District Engineer, Kistna Division, at the time having obtained from him a table of the ruling rates for earth-work in his Division.

39. The fact seems to be that, where unhealthiness of climate becomes an element of cost, it is the ruling element, and a mistake in calculating its effect affects the whole estimate of the cost of any particular works in much the same ratio as it does this particular item If one District is twice as unhealthy as another, the relative cost of work, where the labour available is not indigenous, will be in much the same proportion.

40. In enumerating the causes which have operated to raise prices, I ought not to omit to notice the desultory manner in which funds have hitherto been supplied for the works. This, while it has added heavily to the expense of the work already done, has, in my opinion, had a permanent, though not so marked, an effect upon prices generally. It has, more than anything else, helped to give the works a bad name. Again and again, from failure of funds, and the consequent impossibility of laying in a proper supply of food, have the people been driven from the works by the threatened starvation. We have had three distinct, well-marked, local famines due to this cause alone.

Hundreds, and even thousands, of labourers have disappeared on each occasion in the course of a few weeks. At times there was no food, at others no money, once or twice there was neither one nor the other. A scarcity of this kind, which occurred last February, unquestionably caused the loss of half of the work that might have been done during that season.

For days the works were in great part suspended, while the work-people of all classes were dispersed over the country in search of a few handfuls of any description of food that could be obtained. Even the Company of Sappers that was stationed here, and which had always the preference wherever there was any rice to distribute, was, by order of the Commander-in-Chief, on the representation of the Commandant of the Corps, removed because the men were actually in want of necessary food, and the sickness which was prevalent among them at the time was aggravated in consequence. I have no wish to re-open this subject, and to reiterate complaints about a state of things which belongs to the past, and is not likely to return, but, unquestionably, the effect of all this has been greatly to shake confidence throughout the Districts whence most of our labour is derived. In the Coast Districts, the Upper Godavery country always had a bad name; it was designated by a peculiar term expressive of all its peculiar disadvantages, and of many more which popular superstition and ignorance attribute to it.

If a better acquaintance with it of late has shown that some of these do not exist, it has, on the other hand, taught the people that, employment upon the works now in progress is liable to other evils of a more formidable character.

Intending immigrants, if they are to judge by past experience, must lay their account, not only with the certainty of catching fever, but with the risk of a double famine, both of food and wages.

41. In regard to quantities, the present and the former* estimate do not differ much, allowance being made for the reduced section which it is now proposed to give to the canal, and other changes already described.

* *Viz.*, of January 1861.

The quantities of the most important classes of work in the two estimates compare as follows:—

	Original Estimate. Cubic feet.	Present Estimate. Cubic feet.
Earth-work	106,923,213	74,869,475
Rubble masonry	2,650,698	2,565,916
Dressed stone	250,641	93,710
Rubble stone laid dry, and pitching	1,315,791	86,210

To the second column should be added the quantities of the work performed up to 1st May last, as the new estimate includes all work yet to be done subsequent to that date, but these being comparatively small, would not much affect the comparison. The rubble masonry, in the new estimate, is in excess of that in the old one, chiefly in consequence of the extra lock now proposed to be built midway along the canal, and the heavy sluice wall now introduced at the mouth of the link channel.

42. In order, however, to arrive at a correct estimate of the total probable cost of the works for this barrier, some account must be given of the expenditure and work done up to 1st May last. The bills, for all the adjusted expenditure up to that date, which amounted to Rs. 4,29,000 have been prepared, and in great part submitted to the Central Office of Accounts in Madras, but there remains a large amount of unadjusted expenditure on the books of the Upper Godavery District under the general head of "Advances," which includes the cost of a large quantity of stock, made or purchased, such as machinery, tools, boats, rolling-stock, &c., which has still to be brought to account under the proper heads, and debited to the various works, including the "tram roads," and "improvement of river bed," as well as to the 1st barrier works to which it is chargeable. Under the system of the Madras Department Public Works, it was the practice to include under the head of "Advances" expenditure on "Stock," and building materials which, as the articles were expended, was written off to the various works on which they were used. It will, therefore, be understood that but a small portion of the amount on the Upper Godavery books under this head is actually advances "re-payable," properly so called.

As this amount is so large, compared with that of the expenditure accounted for in bills, it must be first adjusted before any correct detailed statement can be given of the actual expenditure chargeable to the anicut and canal. A small temporary addition, amounting to Rs. 150 per month for four months, to my present Office Establishment, has been recently applied for, for the purpose of bringing up these arrears. I shall not, therefore, now attempt any analysis of the expenditure incurred before 1st May last, but simply state that, that due to the anicut and canal works amounts to about 4½ lakhs, for which about 270,000 cubic feet of earth-work in canal and embankments masonry had been built, of 8,000,000 cubic feet of rubble executed, a number of houses for the European establishment built, about 15,000 Natives housed during 2½ years, workshops, hospital stores, and other public buildings erected, lime-stone and cut-stone quarries opened, and a large amount of preparatory work, such as laying tram-roads, building kilns, &c., performed.

It includes also Rs. 1,00,000 for the pay, Civil and Military, of establishments of all grades from the District Engineer downwards.

43. Taking, then, the expenditure already incurred at 4½ lakhs, and the amount of the present estimate at Rs. 16,35,000, the total cost of the works will probably amount to 21 lakhs. This is for a canal with a minimum width of 8 yards at bottom, and locks of 175 feet by 25 feet in the chambers.

No. 1736, dated 4th August, 1864.

Endorsed by Secy. to Chief Commr., Central Provinces, in the P. W. Dept.

Forwarded, with reference to Telegram, dated 30th July 1864, from Colonel Strachey.

P. S.—Captain Haig's Report, of which this is a copy, was sent with this Office No. 959, dated 30th June 1864, and its receipt at Simla has been acknowledged in the Post Office registry receipts.

No. 909, dated 24th June, 1864.

[No. 52.] *From*—Lieut.-Col. C. H. Dickens, R. A., *Secy. to Chief Commr., Central Provinces, in the P. W. Dept.,*

To—Secretary to Government of India, P. W. Dept.

In continuation of No. 1239 of the 17th December 1863, a duplicate of which was forwarded on the 21st April last, I am directed by the Chief Commissioner to forward a copy of No. 1236 of the 26th April 1864, from Captain Haig, Superintending Engineer, Upper Godavery Circle, expressing his views further on the proposal for a modification of the 1st Barrier Project, and to solicit that the same may receive the early consideration and orders of His Excellency the Viceroy in Council.

No. 1236, dated 26th April, 1864.

[No. 53.] *From*—Captain F. T. Haig, R. E., *Supg. Engr., Upper Godavery Circle,*

To—Secretary to Chief Commr., Central Provinces, in the P. W. Dept.

A review of the operations of the year now drawing to a close, induces me again to request most earnestly that early orders may be passed upon my letter No. 616 of 16th November last, or at least upon that part of it, paras. 34 to 40, which contains a proposal for a modification of the 1st Barrier Project. Time has already been lost, and much labour expended upon works at

that barrier, which, if my proposal be carried into effect, will not be required for years to come, while those necessary for opening an immediate communication have been postponed.

The money thus expended is, of course, also wasted to some extent, inasmuch as it has been taken from works urgently required and devoted to others not likely to yield any return for years.

I do entreat, that, before another working season commences, some definite understanding may be come to as to the plan upon which we are to work and that the present state of uncertainty, so injurious in every way to the progress of the works, may be put an end to.

2. I have no doubt that I shall be charged with being myself the cause of the uncertainty referred to, in consequence of my having suggested certain alterations in the original plan of the works, instead of adhering to it in spite of the totally changed conditions of the labour market since the project was first drawn up. But I see no wisdom in obstinate adherence to plans based upon a state of things which existed in the infancy of the undertaking, and which is now totally altered. Had sufficient labour been procurable at moderate rates, I should never have desired any change in the original design of the works, and any modification of that design (trifling as they are) which have been proposed, have been suggested simply by the increased cost and growing scarcity of labour. If a rigid adherence to the plans of five or six years ago, in spite of the rapid changes which the present transition state of the whole country is causing in every department of industry, be a pleasure, it can be had by paying for it, both in time of execution or, in other words, in deferred returns, and in money; but we must distinctly understand, at the same time, that there is no real necessity for such increased expenditure, and that the project is perfectly capable of such modifications as will adapt it to the altered circumstances in which it has now to be carried on.

3. In my letter above referred to, I stated at length the reasons which led me to propose that, instead of making a canal 24 miles in length, we should, for the present, make one of only three miles, improving the intervening rocky part of the river-bed to an extent required for a limited period of navigation.

These reasons were, in brief, that labour has become so scarce, that the completion of the works on the original design is likely to occupy several years, while the increased, and increasing, rates of wages would raise the cost to a sum which, if expended solely upon the 1st barrier, would altogether prevent, or indefinitely postpone, the improvement of other parts of the river.

The experience of the working months which have since elapsed, has only tended to confirm these opinions. The progress made has been slow, wretchedly slow, and the prospect of completing the canal and opening the communications is even more distant than I anticipated.

4. On the 1st May 1863, there remained about 74,000,000 cubic feet of earth-work, and 2,835,000 cubic feet of masonry to be done, in addition to sundry other works which all require additional labour, but which it is not necessary here to specify.

By the Returns furnished by the Executive Engineer, it appears that, by the end of the present month, there will probably have been 10,000,000 cubic feet of earth-work and 3,50,000 cubic feet of masonry completed. That is to say that, this year, we shall have done one-seventh part of what remained to be done at its commencement, and that, if we continue to work at the same rate, the works will take another six years to finish.

5. Now, I cannot say that I think sufficient efforts to procure more labour were made this year, or that, by greater exertions, more might not have been obtained, but even allowing for increased exertions in future, will any one, in the present state of the labour market in Southern India, venture to say that we may calculate on doubling our rates of progress henceforth? On the one hand, the Madras Irrigation Company, our principal competitor in the Southern Districts, has just raised all its rates of wages, in order to double, if possible, the number, 18,000 men, now employed on their works. On the other hand, the Orissa works are just about to be commenced with such vigour as a private Company, well supplied with funds, and anxious for early dividends, alone knows how to put forth in such undertakings.

The Chief Engineer, with a strong staff of Executives and Assistants, is now on his way from England, and I know enough of him to be very sure that it will not be his fault if he does not sweep the Coast Districts of all their available surplus labour.

If other competitors were wanted, there is the Madras and Bombay Railway, which is likely soon to be pushed forward through the Hyderabad country. Thus the Districts whence the whole of our labour for the 1st barrier works has hitherto been derived, are likely to be drained in future of their surplus labour by Companies which can offer better terms than we can. Can we ignore this state of things, or is it wise to disregard it, and to go on month after month with no change of plans, still sticking to the original design several years old, although every year's experience warns us more and more of the necessity for some modification of those plans more suited to present circumstances?

6. Moreover, as I have pointed out before, while expending large sums in slowly prosecuting the works at one point, we are depriving ourselves of the means of carrying out much

needed improvements on other parts of the river, or even of opening roads in connexion with it. Every year, too, it becomes more uncertain what amount may be available for expenditure in the next.

I really cannot conceive any possible combination of circumstances which could more distinctly indicate the necessity for the reduction of expenditure, at any one point of the river, upon works not immediately necessary, and for the adoption of such a modification of the original project as I have suggested.

7. I explained this plan in my former letter on the subject, but I may repeat here that, I contemplate no change in the original design of the works, but simply the addition of one lock, placed two miles below the canal head, and the postponement, for the present, of all works below that point. We should, in fact, have two miles of canal with one small lock* to execute, instead of 24 miles with eight locks†. I cannot now give the actual difference in quantities which this plan would involve, but it will readily be understood that it must be very large. The lock might probably be completed in one year, and the communication opened by the commencement of the navigation season of 1865-66.

* For boats only.

† For steamers.

The cost of the lock would be small, not exceeding (I should think) Rs. 30,000. An estimate would, of course, be submitted for it were this plan decided upon. I did, in fact, request the Executive Engineer to prepare such an estimate some months ago, but other matters seem to have prevented his doing so.

8. With regard, however, to the other additional expense which this plan would involve, *viz.*, the blasting and removal of rocks in the river-bed between the proposed lock and Deverapitty (the original site for the tail locks), and which, in my letter above referred to, I roughly estimated at Rs. 10,000 or Rs. 15,000. I should mention that, as this was the only part of the plan, about the cost of which there was much uncertainty, I personally examined this part of the river in November last, and marked out a channel, and Lieutenant Montgomerie then made a careful measurement of all the rocks which would require removal in order to render it navigable. The total quantity amounted to only 6,000 cubic yards, which, I should think, could not cost more than the amount of my original estimate, as above stated, to remove. This part of the work could also be completed easily in one season.

9. In describing the project on a former occasion, I mentioned that, by its means, a four months' navigation would be obtained, which is true in regard to *steamers* (though even for them I think it understates the case,) which could run for that time uninterruptedly between Dowlaishwurum and the new lock, but I omitted to point out that for *boats* the rocky part of the river above Buddrachellum would be passable much longer, in fact, for six or eight months, and as steamers will be able to ascend to Buddrachellum during six months, and boats can be tracked up or down the remaining 12 miles, the communication would practically be open for that time even for steamers.

The correct statement of the case, therefore, is, that a canal of two miles, with a boat-lock at the end, and the river cleared of rock below, will open a communication past the 1st barrier for a large part of the year.

10. I would, then, most strongly urge the Government at once to decide upon this plan. I do not see that it is necessary that they should have before them a detailed estimate of the cost of the proposed lock to enable them to come to a decision. It is sufficient that this plan would give a good practicable communication past the 1st barrier, at a great saving, both in cost and time, as compared with the original plan. The saving in cost would be not less then eight lakhs.

The communication thus opened, the remaining works of the original project can be carried forward afterwards as the necessity for them arises, and funds are available.

11. Early orders will be of the utmost importance in enabling us to make the most of the next working and navigation season. A good deal of rice will have to be brought up by the river from the Coast, and if the plan now recommended should be decided upon, ought to be delivered several miles higher up river than if the original project is adhered to, otherwise a heavy expense for subsequent carriage by land will be incurred. In fact, immediate and important changes in the working arrangements will follow upon adoption of the new project, so that it is desirable that early intimation of the decision of Government should be given.

12. In conclusion, I beg to state that, so strongly do I feel the importance of the change of plan now advocated, that I would request that, if any doubts remain which may hinder an immediate decision respecting it, I may be summoned either to Nagpoor or Calcutta, as may be thought desirable, to afford in person any further explanations that may be required. The case, however, seems to me so plain, that I entertain a strong hope that the Government will have little difficulty in at once deciding upon it in accordance with my views.

P. S.—The accompanying outline sketch shows in *red* the piece of canal and the boat lock, which it is now proposed to execute in the first instance, *and in yellow*, the remaining 22 miles of canal required to complete the original project.

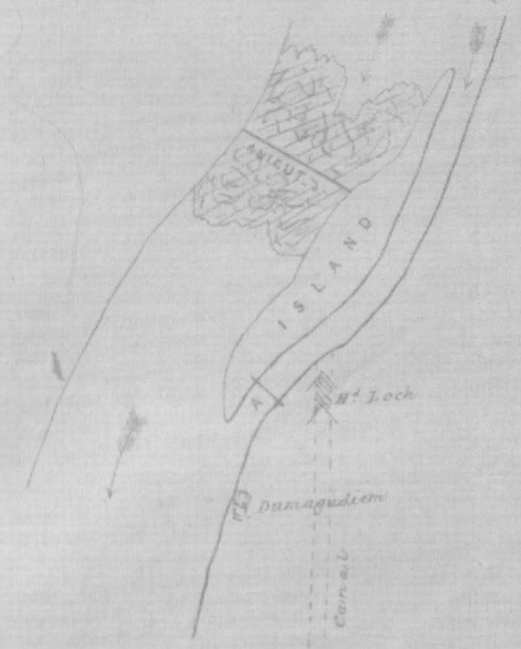
Dated 13th July, 1864.

[No. 54.] *From*—Captain F. T. Haig, *R. E., Superintending Engineer, Upper Godavery Circle,*

To—Secretary to Chief Commissioner, Central Provinces, in the P. W. Dept.

I have been prevented, until now, from writing in reply to your telegram, asking for information as to the discharge of the river, site of anicut, &c., 1st barrier. I now write demi-officially to save time.

The site on which the anicut is being built was chosen chiefly on account of the facilities which it afforded for the supply of building material. That is to say, the *exact* site. The position of the work was fixed, within limits of half a mile, either way, by that of the island on which it abuts. This island is separated from the main land by a channel about 80 yards wide, which forms an admirable entrance to the canal, and the means of keeping it quite clear from all deposits of silt by means of scouring.



This channel is to be closed at its mouth by a masonry wall (A) pierced with sluices. The canal is led off it a few hundred yards higher up, so that a powerful scour can be produced down the channel across the head of the canal to remove any silt. The channel also forms a fine basin of still-water in all states of the river. To secure this arrangement, it was necessary that the anicut should rest at one end in the island, and as the rocky part of the bed only extends down for about half a mile from the head of the island, the exact site was easily determinable. Wherever the work is actually placed, a large part of the bed is so high, that, for several months of the year, it is clear of the water, and thus affords the quarries whence the stone is obtained within a short distance. The stone is, in fact quarried all along the work, mostly within 100 yards of the place where it is used. The height of the anicut was chiefly determined by considerations as to the comparative cost of a high work, with less excavation in the canal, or a lower work with greater excavation.

The discharge of the Godavery at this point in floods is about 180 millions cubic yard per hour from the best data I can procure.

The velocity, *mean*, as far as I have been able to determine it, about six miles an hour. I reckon the over-fall at the anicut, in the highest flood, will be rather less than one foot.

The section of the bed on site of anicut, sent with the estimates prepared by Mr. Schmidt, was wrong. I pointed this out in forwarding the papers, and subsequent levels have confirmed it. The *right* end of the work will be 4 feet lower than he showed it, as the bed is that much higher than his section made it, and as we are building the masonry of all that part of it up to only 3 feet of the full height, with moveable shutters to raise the water this other 3 feet, the height of the work is about 7 feet less than what he represented it.

I sent you a section of the bed at this point lately, which will, better than anything else, enable you to understand its peculiar shape. The anicut is intended to be of three different heights, about half of it 160, one-fourth 161, and the other fourth 162,* the water being retained by means of shutters at 163 in summer.

* Above sea level.

There are reasons connected with the peculiar shape of the bed, and the material of which it is composed, which suggest this arrangement, but it would take long to detail them.

The lowest summer discharge of the river is about 150,000 to 200,000 cubic yards per hour.

No good stone, suitable for an anient of the sort proposed for the 2nd barrier, is to be had nearer than four or five miles. I therefore proposed a work of solid masonry, built with the stone quarried in the bed of the spot, and hydraulic mortar, and capped with dressed stone.

When the revised estimates are sent up, I hope all the above points will be rendered more plain.

I am very anxious to hear whether the Government of India intend to sanction the additional lock, two miles below the head of the canal, or not. Time is getting on.

No. 1514, dated 27th July, 1864.

Endorsed by Secy. to Chief Commr., Central Provinces, in the P. W. Dept.

For Secretary to Government of India, Public Works Department, in reply to his telegram dated 27th June 1864.

Dated 26th September, 1864.

[No. 55.] *Telegram from*—Lieut.-Col. C. H. Dickens, R. A., *Secy. to Chief Commr., Central Provinces, in the P. W. Dept.,*

To—Secretary to Government of India, P. W. Dept.

Captain Haig telegraphs from Madras as follows:—"Summer level at Gungaram foot of barrier, two hundred and thirty above sea. Ditto at Harvey's section, two hundred and thirty-one and half. Flood-level at Harvey's section, three hundred and two. Ditto at junction of Indrawutty, about three hundred and twelve. Slope of flood-surface, from Harvey's section down to foot of barrier, about one and half foot per mile. Summer level in open pool at village of Doomageodium, one hundred and forty-two. Flood-level there, one hundred and eighty-eight. Slope of flood-surface from top of barrier to Budrachellum, sixteen inches per mile.

No. 2169, dated 28th September, 1864.

Endorsed by Secy. to Chief Commr., Central Provinces.

Copy forwarded by post.

No. 1209, dated 5th December, 1863.

[No. 56.] *From*—Lieut.-Col. A. Impey, R. E., *Secy. to Chief Commr., Central Provinces, in the P. W. Dept.*

To—Secretary to Government of India, P. W. Dept.

Under instructions from the Officiating Chief Commissioner, I have the honour of forwarding, for your perusal, and for the orders of His Excellency the Viceroy, the accompanying documents which have been received from Captain Haig and Colonel Impey, in which the merits of the sizes of the locks, and nature of steamers adapted for the Godavery River, are fully discussed.

2. In this Office letter No. 1066, forwarding Captain Haig's, or more properly, Mr. Schmidt's, Estimate for the 1st barrier, the Officiating Chief Commissioner's views, as far as the size of the locks for the Godavery navigation is concerned, I am to state, were laid before you; in these opinions the Chief Engineer of the Central Provinces, who, as Secretary to Officiating Chief Commissioner, has visited these works, most fully concurs, and the Superintending Engineer of the Godavery Works, the projector of the present scheme, in the 6th para. of his letter, now forwarded, discards most emphatically any intention of reducing to a minimum the dimensions of them, and he dismisses all intention of such reduction on the only grounds that the discussion might give rise to, *viz.*, an apparent reduction or saving in first cost, or of time required for execution.

3. The only point now to be investigated, to which a solution is wanting, is the most suitable dimensions to be determined on, and the Officiating Chief Commissoner considers that this question is solely dependent on the nature and dimensions of the steamer which, at the present time, would be deemed, in size and power, the most efficient for the navigation and commerce of this river.

4. Captain Haig, in the 9th para. of his letter, states that the dimensions and power of the steamers for this river cannot be fixed with reference to the monsoon navigation. The Officiating Chief Commissioner, I am desired to state, apprehends that, by dimensions, Captain Haig alludes to draught of water, and the Officiating Chief Commissioner is of opinion that the power of the steamer should be sufficient to overcome the resistance of the floods in the monsoon; steamers perfectly serviceable for towage during eight months of the year would, or might, become comparatively ineffective during the rains. The size of the steamer is not so much contended for, nor is great speed recognized; but the necessary power to

overcome a given resistance, and that this should be overcome within a specified time are qualities required, qualities indispensible for a boat which is profitably and beneficially to navigate the Godavery. To carry the engines which should govern or give this power would, the Officiating Chief Commissioner apprehends, require a boat of considerable dimensions, and it is for boats of this necessary size that the Officiating Chief Commissioner would wish the locks to be constructed.

5. The Officiating Chief Commissioner would particularly draw your attention to the 21st, 22nd, and 23rd paras. of Captain Haig's letter; the experience gained by an Officer of Captain Haig's ability and faculty of appreciating improvements in engineering, and his capability of applying such to local circumstances, render his remarks on what he saw on American Rivers as peculiarly valuable, and the Officiating Chief Commissioner doubts not but that his suggestions will be as appreciated by you as they have been by himself.

6. Captain Haig, after entering into a free discussion of the merits of a steamer adapted for this river, has arrived at the conclusion that the locks should be 190 feet by 27 feet width in the clear, but to ensure fair latitude, to ensure that no obstruction should hereafter exist, I am desired to state that the Officiating Chief Commissioner solicits sanction to the locks being constructed 200 by 30 feet in the clear.

The consideration of this important subject, and the result of such consideration and deductions therefrom, will cause a change in the estimates sent up to you, and the Officiating Chief Commissioner solicits speedy orders being issued, so that no further delay may exist in revising these, and in preparing such for the 2nd barrier.

7. In reference to the remarks contained in Colonel Impey's Minute regarding the transport service, I am to observe that, this subject is disposed of for the present by the correspondence marginally noted.

No. 2137 of 1863, from Government.

8. Respecting Colonel Impey's remarks upon the tramway project for the 3rd barrier, that matter is also disposed of by the orders in Government letter No. 1388 of the 14th July 1863, referring to Mr. Temple's Godavery Report.

9. I am to note the calculation correctly made in Colonel Impey's 15th para. regarding the probable consumption of salt by cattle, over and above the minimum consumption of this article which has been noted on previous occasions.

10. Lastly, Mr. Temple solicits notice to the testimony afforded by Colonel Impey to the general importance of opening communication by the Godavery.

No. 463, dated 21st October, 1863.

[No. 57.] *From*—Captain F. T. Haig, R. E., *Supdg. Engr., Upper Godavery Circle,*

To—Secretary to Chief Commissioner, Central Provinces, in the P. W. Dept.

In a postscript to my letter* which accompanied the estimates for the 1st barrier works, I stated that there was one question connected with that project which I was not then in a position to enter upon, *viz.*, the dimensions to be given to the locks. It could not be decided on a consideration of the circumstances of one barrier only, but only ona careful review of the requirements of the whole line of navigation, at least of that portion of it which it is proposed to open in the first instance, *viz.*, from the sea to the foot of the 3rd barrier.

* No. 333, dated 1st September 1863.

I have since then re-examined the project for the 2nd barrier, and can now afford definite proposals regarding the dimensions to be adopted for the river locks generally.

2. The question presenting itself in the first instance was this,—shall the locks be made of a size to admit cargo boats only, or shall they be made large enough for the passage of steamers; in other words, shall the river be rendered capable of uninterrupted navigation by steamers from end to end, or shall the passage of the barriers be made practicable for boats only without break of bulk, steamers continuing, as now, to ply in the reaches between?

3. This question had been discussed on a former occasion. In my letter of 3rd February 1862, to the Government of Madras, I noticed it, and gave the reasons which then induced me to decide in favour of a continuous and uninterrupted steam communication. Those reasons seemed to me sufficient at the time, but the difficulty subsequently experienced in procuring labour, and the greatly increased cost of all descriptions of work, as compared with what had been originally anticipated, induced me again to examine the alternative of a boat canal for the 1st barrier, with a view both to the dimensions of the first cost of the works, and to their speedier completion. The latter was the principal object I had in view, for it would require a very considerable difference in cost to justify a modification of the original scheme, which would so greatly detract from its completeness as that above-mentioned. There was, however, another consideration which weighed with me to some extent, *viz.*, that it was, perhaps, questionable whether we are yet in a position, for want of sufficient acquaintance with the peculiarities of the navigation, to determine what description of steamer would be best suited to it, and that it might be better to ascertain this by some years' actual experiment, providing for that

time for continuous boat navigation only, than to construct at once locks, which, in any case, must be expensive works, and which, in the end, might be found ill-adapted to the object in view.

4. This last consideration is the only one which need now occupy our attention. With regard to the other two above-mentioned, I may simply state,—first, that, after a careful investigation of the quantities of works which a boat canal at the 1st barrier would involve, as compared with a steamboat canal, the saving in earth-work would be inconsiderable, inasmuch as the excavations absolutely required for the formation of the flood embankment is such as to afford a canal of much larger dimensions than would be necessary for boats only. So that the extra quantity to be taken out to make it practicable for steamers is but small; and secondly, that, though there would be a saving of about 30 per cent. in the quantity of masonry, the gain in time of execution which would result would be in a much less ratio. There will be no difficulty in any case in completing the masonry works by the time the earth-work of the canal is finished. The direct saving in money, which would result from such a reduction in the dimensions of the canal and locks, might amount to three lakhs, rather less than 20 per cent. of what has yet to be spent upon the barrier. This would be no compensation for the disadvantages which such a curtailment of the original scheme would involve.

5. At the 2nd barrier, no earth-work will be required. Anicuts, with locks in the river bed, will be substituted for canals. I shall shortly have to give full explanation of the cause of this modification of the original project; for the present it is sufficient to state, that it is principally owing to the discovery of very important errors in the levels on which that project was based. In this case, the only room for saving would be in the quantity of masonry in the locks, but this would not be important in respect of the main point, the time required for the completion of the works.

6. I dismiss, therefore, the question of any reduction in the dimensions of the canals and locks at the 1st and 2nd barriers, on the ground of saving in first cost, or of time of execution.

7. It remains to consider whether we are yet in a position to determine the best dimensions for steamboat locks upon this river. I think that we are sufficiently so to enable us to plan locks of a class which shall fulfil all the main conditions required of such works so thoroughly, that to postpone their execution, in the hope of eventually planning something better, would be a needless sacrifice of some of the most important advantages which a river communication in these days should possess. We know now, from some years' actual trial, the nature of the flood-season navigation, the current to be overcome, and the speed and power required for that purpose. We know, also, something of the shoal-season navigation quite enough to understand what it will be when improved to the extent to which we may hope to improve it in the course of the next ten or fifteen years. We know, too, what is the most important point, the cost of carriage by the best steamers now on the river, and how far that approximates to what might be looked for from vessels of a larger size and greater power, within such limits as the very nature of the river must, for many years to come, improve on the vessels navigating it. We know, therefore, in regard to the main element in the whole question, the cost of carriage by the river, whether the communication, if established by means of locks of certain dimensions, will, all things considered, fulfil the essential conditions required of it. These points will best appear as I proceed.

8. The first point to be noticed is this—that there is necessarily a limit to the size of the steamers, which can, with advantage, be placed upon the Godavery. Independently of the dimensions that may be given to the canals and locks at the barriers, the nature of the shoal-season navigation must, for many years, be such as to render it inexpedient to use steamers of dimensions which would render them unwieldy and difficult to move when aground.

It is true we look forward to the improvement of this navigation, but this will be a work of time, and for many years to come it must occasionally happen that steamers will ground on sand banks, and be impeded from this cause in proportion to the difficulty of getting them afloat again.

9. In the next place, the dimensions and power of steamers for this river cannot be fixed with reference to the monsoon-navigation only. This is of too limited duration to render it advisable, in my opinion, to have one class of steamers specially adapted to it, and another adapted to the shoal-navigation which succeeds it. Taking the duration of the monsoon-navigation, in the natural state of the river, at four months, no greater draught of water would be possible for steamers in the fourth month than we have reason to expect to render practicable during the next two, chiefly by the application of stone-work in the river bed. Large steamers have a superiority in cheap carrying-power over small, but in an unimportant degree within any such general limits as to size as the nature of this navigation requires, and this gain would be much more than neutralized by the loss of interest on the capital invested in steamers which would run for only three months of the year, and would be laid up for the other nine. While, therefore, a steamer should possess power sufficient to enable her to move at an economical speed during the freshes, her dimensions should not exceed what would be found suitable for the very different navigation of the succeeding cold months.

10. Now, in regard to the last of these two conditions, we know pretty well what dimensions a steamer intended for the shoal-season navigation should not exceed. About 150 feet long by 22 feet beam is the limit. These dimensions are beyond what I would adopt in the

present state of the river, or for some years to come, but looking to a steady improvement of the navigation, I think they might be assumed for our present purpose. The draught of such a steamer ought not to exceed two feet at present, though, as the channels deepen and shoals are removed, this limit may, of course, be exceeded. The question then becomes—can sufficient power be placed in a steamer of such dimensions and draught to enable them to carry, economically at all times of the year, during the freshes and after their subsidence?

11. There is no model now upon the river which could guide to any reliable conclusion upon this point. Not one of the steamers, excepting one little one now running, was originally built for the navigation of the upper rivers. The "Prince," which is the most powerful, was originally intended for the Ganges. Two of the others were built for the still-water navigation of the Delta above the anicut, and the rest were sent out from England for use on the Eastern Coast Canal. The "Prince," however, approaches nearest to the dimensions I have mentioned; she is, in fact, about 140 feet long by 22 feet beam. I will give some account of her and her working.

12. The "Prince's" lines are ill adapted to a light draught boat, and the increased draught is not compensated for by any diminution of resistance or adaptation to speed. Her boilers are usually worked to a pressure of 45lbs., but would bear more than this, and are occasionally pressed to 60 lbs., but owing to a defeciency of cross and longitudinal bracing and stiffening, the vibration of the machinery and hull is so great, when steam is used at the higher pressure, that this cannot be kept up as a rule, but is only occasionally resorted to in heavy floods when strong currents are met with. The "Prince" has none of the modern appliances for economizing the use of steam by expansion with the steam jacket or super-heating. She has not even the, now almost universally adopted, feathering paddle by which so great an economy of power is effected. Her furnaces, moreover, which were originally constructed for burning coal, are exceedingly ill adapted for wood fuel, and there is sometimes difficulty in maintaining the proper pressure and amount of steam with this material.

13. This steamer is, therefore, in many respects, very far inferior to the description of vessels that might now be built, and placed on the river, of similar dimensions. Her speed, when alone in still-water, is 10 miles an hour with ordinary pressure of steam, but might be considerably more could that pressure be increased. Her usual tow is 75 tons nett carried either in native boats or barges not as well adapted for the purpose as the might be; occasionally the load towed is 100 tons nett. Her working expenses, *viz.*, for wages of crew, rations, stores and fuel, are Rs. 1,540 per month of 24 working days. She is employed only in towing goods *up*-stream, only half the above, supposing the length of each day's run down-stream the same as that up, but as this would be at least two and half times as much with an equal load, the average cost would be less than one third, or less than 1 pie* per ton per mile.

* ⅓ Anna.

16. This is the amount of the *working expenses only*. The fixed charges, interest on capital, depreciation, repairs and insurance, I do not here take into consideration, as they will be about the same per ton per mile whatever description of steamer is used, and will vary with the length of the navigation, the amount of traffic, &c.

17. This result, which is not imaginary, but based upon actual returns of the working of the steamer, will no doubt excite surprise, especially with those who have had, what they would perhaps call, the misfortune to make a trip up-river in the "Prince." But speed and cheapness of transport do not go together except within very low limits; they are absolutely incompatible, and however trying it may be to the patience to creep up-river at three miles per hour, the steamer which moves with its load of freight at this pace may really be exercising a much more beneficial effect upon the country than the locomotive with its train of wagons.

18. To avoid, however, any possibility of misconception, I would remark that the above calculations do not take into account such occasional delays as now occur from very imperfect arrangements for fueling and other defects of management incident to the present state of things, but which would certainly not happen were the traffic arrangements in a proper footing such as they would be, supposing a private Company were regularly working the river. I give in the Appendix the data of the actual working of the "Prince" in July last. The average load was then 75 tons, the daily run up-stream 27 miles and the cost of towing 8 pice per ton per mile, exclusive of the wages of the crew of the barges, which is, however, an insignificant amount.

Had there been an equal amount of traffic down-stream, the working expenses that month, with no greater load, would have been 2·7 pice per ton per mile.

I give this to prevent mistake, but of course no one would proceed upon such a calculation to estimate the probable cost of carriage by this river. The former one, is certainly that by which we should be guided, and with reference to it, it is important to remark that this is the cost of carriage by a steamer with all the imperfections above pointed out. It is quite capable of demonstration that, that same steamer, with some of those defects remedied, could tow 150 tons regularly instead of 100 as above assumed.

19. But it may still be supposed that, cheap as this cost of transport is, it may yet be much beyond what is obtained on other rivers, and what would be obtainable on the Godavery with larger steamers, I give therefore the following comparison of the actual cost (working expenses only) of a day's run of the "Prince" up the Godavery, and that of an American steamer of somewhat larger dimensions on the Ohio, a river incomparably superior as a navigation river to the Godavery, having much less current and a greater available depth.

1st—American Steamer—effective horse-power, 240.

Wages.—food and stores per day	61	Dollars
Coal	22	„
Total...	83	„
or Rs. ...	166	

Work done.—250 tons moved 60 miles up-stream = 15,000, tons moved one mile.

Cost.— $\frac{41679 \text{ pies}}{15000 \text{ tons}}$ = 2·1 pies per ton per mile.

2nd—"Prince"—effective horse-power as usually worked, 150.

Daily expenses as before	35	Rs.
Wood fuel (9 tons)	18	„
Total...	53	„

Work done.—105 tons moved 35 miles up-stream = 3675 tons moved one mile.

Cost.— $\frac{9878 \text{ pies}}{3675 \text{ tons}}$ = 2·5 pies per ton per mile.

20. I should observe that, the actual cost of carriage on the Ohio is only about half that here given, inasmuch as the steamers there run both day and night, instead of only during day-light, which is the standard to which, for the purpose of comparison with the Godavery as now navigated, I have reduced the calculation. At the same time, we may, of course, look forward to the use of the Godavery by night also as the navigation becomes better known. This calculation, however, shews how near the cost of carriage by such a steamer as the "Prince," with all her imperfections, approaches to that of one of the cheapest carrying rivers in the world, and I adduce it to show that, with steamers of dimensions limited to those which I think it not advisable to exceed upon this river, there is a certain prospect of exceedingly cheap transit. I know that calculations of this kind are objected to and mistrusted, but without some such investigation of the elements of the problem before us, I do not see how we are to arrive at any satisfactory calculation. My own conclusion is that, with steamers of the size of the "Prince", or rather with such steamers as could now be built to float within a lock large enough to hold the "Prince", the working expenses could be brought down to 1 pie per ton per mile, and to this rate the total expense of carriage would more and more approximate with the increase of traffic, in proportion to which the fixed charges diminish. I am also satisfied that there would be no corresponding gain in the adoption of much larger steamers, the peculiarities of the shoal-navigation being considered.

21. Now, disregarding, for the present, the question of length, the next thing to notice is that in shallow navigations, when the requisite amount of paddle surface for tug steamers must be obtained by lengthening the paddles more than is usual in ocean, or deep-river steamers, the use of the ordinary side paddle-wheel adds about $\frac{1}{3}$ to the width of the vessels, I mean that the total width, over all, at the paddle-boxes is about $1\frac{1}{3}$ that of the hull, and as the exposed position of the wheels renders them peculiarly liable to injury, such steamers require about double the width either of canal or lock to admit of their safe passage that Screw steamers of the same dimensions would do. For the same reason, the paddle-wheels of such steamers are peculiarly liable to injury in a rapid stream, in rounding to and approaching landing places, or in passing other steamers or boats in narrow channels. Hence the great majority of the accidents to our present steamers are of this nature. It would, therefore, manifestly be a gain with a navigation like the Godavery, which has a rapid stream in flood, and on which a steamer in a single trip from the Coast to Hinghunghat and back will have to pass through 66 locks and 110 miles of canal, if the side paddle-wheel could be replaced by some description of propeller astern. This is how the question stands as regards the navigation of the river, but as the expense of opening the navigation by works at the barriers is also a consideration of some importance, we are reminded that there would be an important gain if locks and canals of only half the width required for *side* paddle-steamers could be made to pass other vessels of equal size and power.

22. The advatages thus sought for may be obtained by the use of steamers propelled by a paddle-wheel placed astern, instead of by wheels at the side as in the common construction. Steamers of this class are not met with in England, first, because of the very limited extent of river navigation there, and secondly, because they are specially adapted for shallow rivers. But in America, on the Mississippi and its tributaries, they are to be seem by hundreds. They are there used both for carrying and for towing, and are built of all sizes up to 500 and 600 tons. They have a speed, generally, of from 10 to 12 miles, being used chiefly for goods traffic in which high speed is not required. In addition to the special advantages above mentioned, which would attach to them on a line of connected river and canal navigation like the Godavery, they possess that of carrying a large load on a light draught of water and of an undoubted economy of power in the diminution of slip which results from the wheel working in the back-water astern. It has been repeatedly ascertained in America that, of two steamers, the one with the ordinary side wheels, and the other with the stern wheel, of equal speed in still-water, the latter will, in the ascent of a strong current, always distance the former. Wherever I went on the Western rivers of America, I found the testimony upon this point uniform.

23. As to speed, when that is required for passenger traffic, equally fine lines can be given to these steamers, *when the draught of water is limited to 2 to 4 feet*, as it must be on the Godavery, as to those with side paddles. The fully horizontal lines of the stern, which the use of a single wheel placed there involves, in no wise prevent, rather they distinctly indicate the substitution of fine vertical lines. In fact, there is no principle more thoroughly established, in my opinion, than that in shallow draught steamers, the water should be displaced when the vessel is in motion almost entirely vertically. Much finer angles of entrance and run can be obtained in this way in vessels of this class, with less sacrifice of buoyancy, than with vessels with horizontal lines. The principle is now, I believe, universally admitted and acted upon. All the latest constructions for the Indus navigation have been of this kind.

24. If, then, equal adaptation for speed, and equal capacity for towing and carrying power can be obtained with stern-wheel as with side-wheel steamers, why should we hesitate to adopt the artificially constructed links in this navigation, to the use of vessels of the former class, which have advantages of their own, as above noticed, which, other things being equal, give them so decided a superiority and preference to vessels of the more common construction? Why build locks and canals of 45 feet in width if others of little more than half that width will admit steamers of equal speed and power?

25. It would be quite a mistake, in my opinion, to be guided in this question by the example of other rivers, unless we can find one analogous in its essential characteristics to the Godavery, *viz.*, a very shallow navigation, partly river, and partly canal, but this we cannot do; there is no example of such a navigation to be met with anywhere. Instead, therefore, of blindly building our locks and canals of certain dimensions upon this river, because they have been so made upon others of totally different character, the proper way is, after due investigation of the peculiarities of the navigation we have to deal with, to apply the principles deducible from experience upon other rivers to the determination of the method of improvement, and the class of works to be adopted upon this. Viewing the question in this light, taking into consideration all the special peculiarities of the Govadery above noticed, I would recommend that we build our locks for stern-wheel steamers only, that is, for a class of steamers not of novel design, but which has been abundantly tested, and thoroughly approved upon the American rivers; and which we have reason to believe to be specially suited to the Godavery. Such steamers will fulfil all the requirements of commerce and communication in the present day, and, if ever in the generation to come, the traffic shall become such as to render an enlargement or re-construction of the locks necessary, we may be very sure that the revenue of the river will be well able to afford it.

26. Now as to the actual dimensions to be given to the locks. In 1861, Colonel Horsley, then Chief Engineer, Madras, suggested that 45 feet in width of chamber was unnecessary, and recommended that it should be reduced to about 30 feet. His opinion was strongly supported by Sir W. Denison, and on the ground that stern-wheel steamers might be used. I adopted it, and recommended that these dimensions should be followed. It, however, subsequently occurred to me that, if the dimensions of the locks were to be reduced from those originally proposed, 45 feet by 200 feet, on the principle of the substitution of stern for side-wheeled steamers, 30 feet was not the proper width, but 25, as the latter would admit as large and powerful a stern-wheeler as the former (45 feet) would a side-wheeler. This change seemed obvious if this *principle* was to be followed in determining the size of the locks. I, at the same time, made some reduction in the length proposed, which I thought advisable, and the estimates for the 1st barrier locks have been made for locks of 175 feet by 25 feet in the chamber; such a lock would admit steamers of 145 feet long by 23 or 24 feet beam,

I think, however, that we might, perhaps, contemplate the use of a little larger vessel than this, and would, therefore, propose to make the chambers 190 feet by 27 feet. Beyond these dimensions, I certainly would not go.

27. If the Chief Commissioner approves of these dimensions, I will at once direct the necessary alteration, which will be trifling, to be made on the estimates of the 1st barrier works, and proceed with the estimates for the 2nd barrier in the same manner.

TRANSPORT ESTABLISHMENT.

In writing on this branch of expenditure, I have quoted largely from Captain Haig's Report on the transport operations of the past season. They may be summarised as follows :—

The steamers employed during the past year were as follows :—

1st Reach.—From Dowlaishwarum to 1st barrier at Doomagoodium.—

	H. P.	Draught.
"Prince"	80	3′ 1″ 8
"Hope"	25	1′ 6″ 7

2nd Reach.—From Doomagoodium to 2nd barrier at Durdula—

"Arthur Cotton"	20	2′ 0″ 7
"Shamrock"	12	2′ 0″ 6

3rd Reach.—From Boodagodium at end of Tramway, 20 miles distance to Mogulee—

"Queen"	26	2′ 0″ 8
"Rose"	12	2′ 0″ 6

4th Reach.—From Salagoum proposed terminus of Tramway to Balagur—

"May Flower"	12	2′ 0 6

In the 1st Reach.—The "Prince" commenced running about the end of June, but owing to rocky parts of the river becoming impracticable (below canal lock at or near) for a vessel of her draught of water and size, she ceased running after 26th November. The "Hope" continued at work for the season.

In the 2nd and 3rd Reaches.—The vessels continued running, in the former for 4½ months, commencing from 2nd July, and in the latter for 5 months, commencing from 20th June.

In the 4th Reach.—The steamer ran for only 3½ months, commencing 2nd July, and ended on the 15th October, and during those months occasional interruptions took place.

2. The season, as regards supply of water in the river and available depths for navigation, was an average one.

3. With the exception of some improvements by the removal of some rocks in the 1st Reach, the navigable parts of the river are still in their natural state wholly unimproved.

4. The expenditure during the year will be as follows :—

	During the working season.	During hot months.	Total.
	Rs.	Rs.	Rs.
Working expenses of steamers ...	39,830	3,686	43,516
Portages at barriers	5,309	3,890	10,199
Landing and shipping cargo ...	1,274	425	1,699
Sundries	789	327	1,116
Superintendence	7,756	4,120	14,876
Total ...	54,958	13,448	68,406

	Rs.
Working expenses	68,406
Hire of steamers	2,430
	65,976

The actual cost of the two classes of Traffic was—

Goods	...	0	3	0·4 per ton per mile.
Passengers	...	0	0	8·3 „ cent. „

Vide margin—Total ... Rs. 68,406

To this is to be added stock amounting to ... 23,446

Making the grand total amount to ... 91,852

The receipts were—

From goods	14,325
„ passengers ...	4,421
Hire of steamers and tandies supplied to Engineering Department	2,430
Total	21,176

Then deducting hire of steamers from working expenses, Rs. 65,976 are chargeable to the goods and passenger traffic.

5. The charges were for goods up-stream 1 anna 6 pie per ton, excepting for salt which was charged only 9 pie, and for all goods down-stream 1 anna. Passengers were divided into three classes, and were charged ¼, ½, and 1 anna, respectively. The lowest class formed the great bulk of those carried.

6. The goods traffic was equivalent to 193,534 tons carried one mile. The passenger traffic to 242,120 passengers one mile; *vide* margin. The up-stream tonnage being double that down; the mean charge per ton per mile was allowed for 182 tons of salt carried at 9 pie, about 1 anna 3 pie per mile. Hence the cost to the charge was as 12 to 5, or rather more than double.

The receipts from goods were to those from passengers as 7 to 2.

Debit expenses proposed thus—

Cost of goods traffic	Rs. 36,735
„ passengers	„ 10,495

7. Now, when looking at this as a mere statement of the operations of last year, it would, as compared with the result anticipated from the transit service, appear a great failure, and the failure seems most marked owing to the public having been led to believe, through an advertisement, that proper transit arrangements had been completed. The carrying out, in all its integrity, of the scheme laid before the Government of India by Captain Haig, R. E., would remove the impediments to the transit. Goods would then be placed on boats at points of departure, and would reach their destination without breaking bulk, and on this seemed to depend, to a great degree, the success in the present instance. Captain Haig, eager to show that the route could, and, as he hoped, would, be made the centre of transit, discarded from his mind the possibility and probability of failure, owing to known and well established and grounded aversion to merchants having their goods constantly knocked about, and to the fact that insurances on goods not being obtainable where breaking of bulk is the rule, and not the exception, and has shown that this aversion might be overcome.

8. Captain Haig states that had there been no transit service or operation, it would have been absolutely necessary to keep up communication between the barriers, Dowlaishwurum, and the Depôt at the coast. That, for these duties alone, some of these steamers with boats would have been required, *viz.*, in Rupees as follows :—

	Rs.
For Steamers	31,151
„ Boats	2,400
„ Bandies	5,000
„ Loading and unloading	900
„ Sundries	600
„ Superintendence	7,840
Total ...	47,891

The earnings from goods and passengers, not carried on account of Government, were Rs. 7,181. The working expenses, as before shewn, amounted to Rs. 65,976, it therefore leaves Rs. 58,795, consequently only Rs. 10,904 is the only expense or loss, according to these figures, that the Government has sustained by the Transit Department. I do not think that the Government of India can consider this as a loss, when by this expenditure has been gained the experience to guide their Officers in future. I must here quote a most apt remark made by Captain Haig—"How many now navigating other rivers with success were raised upon the wreck of others whose dear-bought experience they inherited gratis," and is it a dear-bought experience, bought at Rs. 11,000, under the peculiar circumstances of the case?

It is evident to me that, as the Government will have to take the initiative on this river with a Flotilla, as it has always done on the opening out of the great feeders of India, that they will have reason to rejoice at the experience gained at such trifling expense. Added to this, I doubt whether Captain Haig, without this experience, could have so well designed his project, that his plans would have been so perfect and so well considered.

He should have learned the power and nature of the boats to be best worked in this river, and, as he states, "every navigable river in the world has its own peculiarities, and the means of transport in use varies accordingly." These peculiarities, this knowledge, could not have been gained without the result of experiments; and for the great object in view, if the necessary, or even a portion of the necessary, experience has been gained, it is economically acquired.

9. It should be borne in mind how trifling the amount of traffic has been during the past year. It is, perhaps, fortunate that it was so, as the arrangements had not been matured; there was a very great disproportion between the work done and what could have been effected, and it is not exaggeration to say that the steamers could, imperfect as they are, have conveyed four times what they did. Now, Captain Haig states that an addition of 2,000 tons to the down-ward traffic and 1,000 to the up-river traffic up to the same points, would augment the traffic five-fold, and seems confident that with but a very moderate increase of boats, not in number of

steamers, and in the means of land transport, this traffic could well be carried on, and I doubt not but this channel of communication would be used for salt alone if available.

10. As an exaggerated idea of the loss sustained during the past year by this transit service has become current, I think it but due to Captain Haig, and others employed in this department, to state the facts as given by that Officer :—

"The trifling loss from injury to goods in transit this year (1862-63), notwithstanding the great imperfections of the means of transport at the barriers, and the want of sufficient cover to some of the boats, warrants the most favourable expectations as to the working of the line in future. A batch of cotton, consisting of 926 bales, was carried, partly from Chandah, partly from the 3rd barrier, to Coconada. The bales were but half screwed, and were most wretchedly packed. An accident happened to a boat containing 90 of them at the 2nd barrier, by which a large number were injured and several destroyed. Another boat-load was sent down from the 3rd barrier to the 2nd by the Agent of the owner, Mr. Stanborough, without any cover whatever, and exposed to heavy rain on the way. The carelessness of some newly engaged lascars in not bailing out a boat, and the ignorance of the Overseer who loaded it, in not putting in sufficient dunnage, led to the injury of some of the lower tiers of its cargo. The portage at the barrier was effected, during heavy rainy weather, by means of country carts imperfectly covered, working in tracks during which the mud was often axle deep. Notwithstanding all this, the *total loss*, as determined by a *Committee* of commercial men at Coconada, amounted to 32 bales or 3¼ per cent of the whole number. Now, if this was the sum total of the damage sustained, with such extremely imperfect arrangements as those of this year, we may certainly expect that, when the line is completed and furnished with all the requisites for the peculiar character of the transit, the transport of goods will be effected with safety and security".

11. I need hardly add that, if with such safety goods could be transported, the Government might insure and thus remove one of the great impediments to the present traffic, *viz.*, the risk loss from breaking bulk at the barriers.

12. From having myself visited the Godavery during this season, and the scene of operations, and from the knowledge I have gained, my own original adverse opinions to opening out at once this line of communication for transit has been entirely changed.

13. If it had not been intended to make *immediate* use of the Godavery as a means of transport, the tramway round the 2nd barrier need never have been carried out. The stores for Trichinopoly, or the 2nd barrier, might easily have been conveyed thither by a short road. The tramway round the 3rd barrier need not have been commenced. It was solely for opening out the Transport Department that these works were intended; as, under the former system, under the Madras Government, of supplying funds by driblets for the grand project, it was evident that a great number of years must elapse before the water communication round the barriers could be completed.

14. It has been shown that the loss by breaking bulk, with careful management, is not so great a risk as has been hitherto anticipated. This, therefore, need not be urged as an obstacle to opening out for transport these lines of communication. The sums expended on the 2nd and 3rd barriers tramway amount to Rs. 1,65,000. The 2nd barrier tramway could be completed for, say, Rs. 15,000, the 3rd, taking the 2nd barrier, cost as an average, or Rs. 5,000 per mile, would be opened for Rs. 1,00,000 more. Thus, communication, for the land-carriage of the transport service, adding 50,000 in round numbers for stores and boats, could be opened out for Rs. 1,65,000, and this I would suggest being at once carried out.

15. I would also myself strongly recommend the opening out of the two canals round the barriers, now that there is no difficulty in obtaiping funds for remunerative works. The reduction in cost of transit alone on salt would cause such a demand, such a consumption, that that article alone, by the increased sale by Government, would more than amply re-pay the interest due on the capital that would be expended. It must be borne in view that all the returns that have been made by different Officers, on the probable increased sale of that necessary article, have been based on the population alone of the Godavery Valley and of that of the Central Provinces; the great demand that would arise, if the cost of salt was reduced, for the supply of it to cattle, has never been considered; and if this certain consumption, or the above surmised reduction in price of salt be added to the former well-based probable returns, the increase in the revenue would be enormous.

16. The Government alone can reap this benefit caused by the opening of this transport service. No private Company could realize much by the carriage or transport up the Godavery; it is by the return to the Coast that a Carrying Company would realize its profits.

17. Is it not, then, if not the duty, still the interest of Government to take the initiative to carry out at once a project in all its integrity so profitable to itself, one that will be so beneficial to the interests of Central India? It should not then feel unsettled as to whether the least efficient is the tramway or road—or the most effective, the canals,—but the plan of

working determined on. A canal works for the future. Along their banks we shall possess a road in times of war for our troops, with the canal as a means of transport for the Commissariat &c., in times of peace, a fertilizing and drawing crowds to agriculture, and thereby again increase the revenue. Is there no higher object? There is no quarter of India where the means of reclaiming large tracts of country, where the good to be done, is more certain, or the means of its accomplishment more obvious, than in the Godavery Valley and the Central Provinces. It is impossible to estimate the influence which facility of transport must exercise upon those who, all their lives, lived buried in the recesses of these remote provinces. It is difficult to conceive the effect of these instantaneous interchanges of enlightened and barbarous ideas, and to follow the varied channels which are thus opened to the spread of civilization.

18. Before concluding this subject, I would draw your attention to the imperfect class of steamers existing on this river.

19. The "*Prince*," working between the 1st barrier and Dowlaishwurum, has not sufficient horse-power, and is not sufficiently fine in her lines to be of the service, a steamer should be in this part of the river; her draught of water is also a foot too much, although, working between Doomagoodium and Dowlaishwurum for about 4¾ months only, she is unable to reach Doomagoodium excepting during freshes, having to lay at a place 26 miles lower down at the terminus of proper inlet of canal. On my way up from Dowlaishwurum during the month of August, she had to leave two dhonies she was towing up—and it was with the greatest difficulty she could tow up a barge containing 60 tons of goods.

20. I may here mention that these traffic boats are unsuited in the build, as they offer the greatest resistance to the stream. The "*Hope*" was not working on this line, but owing to her horse-power being only 25, she is manifestly unfit to contend against the weighty stream heaped up in the gorge, in fact, Captain Haig would not suggest one proceeding down the river in her. She, under any conditions in which she may be employed in the other reaches, requires a most careful over-hauling; strengthening in every way, and the bearings of the machinery and other portions of the same require renewal.

The "*Sir A. Cotton*" is a weak boat, her frame is said to be so, the bottom plates of hull are said to be only of one-eighth inch now, her engines are condensers, and said to be faulty. She also requires extensive work done to her.

The "*Shamrock*" is weak in horse-power, and so is the "*Rose*;" both these boats possess not the power necessary to work against the strong currents found in this river.

The "*Queen*" is a more powerful boat, but still has to be thoroughly overhauled. Her machinery is said not to be set in sufficiently strong framing, there is consequently a frequent jarring which injures it. The "*May Flower*," the smallest boat, and the "*Sir C. Trevelya*," the largest, above Doomagoodium, are more or less useless; the former being too small and crank; and the latter having no power at all, in fact, being unwieldy and unable with such a mould to work up against the stream.

21. Employing steamers unadapted to the river by build, and equally so from deficiency in horse-power, naturally renders all the operations in which they are engaged proportionately more expensive, and the cost of transport must, therefore, be enhanced. This is at present much felt in conveying provisions and stores up to Doomagoodium, and in the conveyance of lime and materials for the anicut and other works about Doomagoodium.

22. It seems to be an established fact that, for the operations on this river, powerful large steamers to cleave through the water (and not with bows like pier-head barges) drawing not more, when loaded, than 2 feet of water, with stern paddles and high-pressure engines, are necessary. Unless the condensing engine is very thoroughly known and watched, most of its power is lost, and from observations made to me, I learn that the Natives understand the high-pressure engines far better, and less power in working them is lost. All the awnings fore and aft of these steamers should be of light corrugated iron. The fuel burnt is wood, and the danger to goods, and inconvenience to passengers is very great owing to the ashes which are driven out of the funnel. I am unable to say what tonnage and what length and breadth should be given to the new steamers that I earnestly suggest should now be at once ordered, until a decision has been arrived at as to the length and width to be given to the locks to be constructed; but I recommend that foresight be the guide, and that the locks should be planned to be suitable for the size of steamers fit for this river, and not the size of steamers and power thereof be a guide to the dimensions of lock. There seems to be a great fear of laying too heavy an estimate before the Government, and to adopt the proportions of works to the probable sum it is thought that the Government might sanction, instead of, in the first instance, putting the bearings of the case fully and clearly before Government, so that a true and correct result may be arrived at, and to what extent the head of the Government is by sanction compromised.

23. Captain Haig intends to address the Chief Commissioner on this subject, and as the requirements and details will be, I apprehend, fully entered into, I need not add to the length of this paper by putting forth suggestions about such.

24. In conclusion, I have to remark that, owing to the almost impossibility of having anything like continuity in tow-paths, owing to the number of bays to the projecting rocks to the scarps, and to the windings of the stream amongst rocks away from the banks of the river, I do not believe that transport up-stream will be easily effected by boats. Steamers, as on the Ganges, with well-constructed cargo boats, I foresee to be the only sure and rapid means of transport. Dhonies do work up after January from Dowlaishwurum up to Budrachellum, but chiefly by poling; the progess being very slow, the distance being 105 miles, which they take about a month in overcoming. Boats, however, will, during four or five months in the year, (without a storeage of water), be able to descend the stream as soon as the canals are completed, and will thus, as on the Ganges, bring down to the sea that superior amount of produce which, as in the Ganges, the steamers and Railways are not able to accommodate.

Appendix to letter No. 463 of 21st October 1863, of Superintending Engineer, Upper Godavery Circle.

Expenses and work of steamer "Prince" running between Dowlaishwurum and Sodarum (terminus of 1st barrier canal) in the month of July 1863 :—

Expenses.	Rs.	A.	P.
Captain's pay	200	0	0
Engineers' ,, ...	300	0	0
Wages of Crew	318	0	0
Provisions	105	8	0
Small stores	130	0	0
Fuel, 240 tons wood ...	480	0	0
Sundries	6	8	0
Total	1,540	0	0

Works.

Total quantity of goods towed, 355 tons; distance towed, various, mostly 98 miles up-stream.

Work done.—Equivalent to 36554 tons moved 1 mile.

Cost.—For towing only 8 pies per ton per mile.

Greatest load taken at one ton, 97 tons.
Average ditto, 75 ,,

Total number of trips between terminus, 5, of which four were with Dhonies (small Native boats of worst possible build) only in two.

Total number of hours under weigh, 200.
Number of working days 25, including parts of days.
Pressure of Steam 40 to 45 lbs.
Number of revolutions 28 to 34 per minute.
No coal burnt.
93 Passengers carried free.
48 Tons of the whole tonnage were towed *down-stream*.

[No. 58.] No. 7598 / 2654, dated 10th March, 1865.

From—Lieut.-Col. W. Maxwell, R. A., *Secy. to Chief Commr., Central Provinces, in the P. W. Dept.,*

To—*Secretary to Government of India, P. W. Dept.*

In continuation of this Office No. 1209, dated 5th December 1863, concerning the size of locks on the 1st barrier canal, I am now to inform you, that as the Superintending Engineer, Upper Godavery Circle, reported the whole of the foundations excavated and ready for the commencement of the masonry, and requested permission to proceed with the work, the Chief Commissioner has sanctioned the prosecution of these locks, and trusts that His Excellency in Council will approve of the action taken by him in the matter.

2. Should there be any doubts as to the size or general design of these locks, or any modification be thought necessary, the Chief Commissioner would solicit early instructions on these points to enable him to ensure their immediate adoption.

No. 44, dated 20th March, 1865.

[No. 59.] *Telegram from*—Lieut.-Col. C. H. Dickens, R. A., *Secy. to Govt. of India, P. W. Dept.,*

To—Chief Commissioner of Central Provinces.

Size of locks on 1st barrier, Godavery, is to be 200 feet long by 30 feet wide.

No. 442, dated 20th May, 1865.

[No. 60.] *From*—Lieut.-Col. W. Maxwell, R. A., *Secy. to Cheif Commr., Central Provinces, in the P. W. Dept.,*

To—Secretary to Government of India, P. W. Dept.

I am directed to submit, for the orders of the Supreme Government, the following papers, having reference to the works at the 1st barrier in the Upper Godavery Circle :—

Letter No. 1008, dated 12th January 1865, from the Officiating Superintending Engineer, with Abstracts A and B, prepared by that Officer, amounting to Rs. 16,34,194.

Revised estimate No. 2 of 1864-65, by Mr. T. J. Isaac, with 12 Abstracts and 1 General Abstract, amounting to Rs. 17,08,963.

Ten drawings.

2. As the Superintending Engineer of the Upper Godavery Circle has the powers of a Chief Engineer, I am to state, that no remarks on engineering details have been made by the Chief Engineer, Central Provinces.

3. The Chief Commissioner observes, that the Superintending Engineer and the Executive Engineer do not quite agree on a few points connected with the execution of these extensive works :—

1st.—They differ regarding rates.

2nd.—Also as to the description of masonry to be used.

3rd.—The direction of the canal to the Turabaka Vagoo is not thought well of by Mr. Isaac.

4th.—They differ on the Turabaka Escape.

5th.—And Mr. Isaac objects to the inundating the country between Turabaka and the Tail Locks.

4. These are all general and important questions, which the Chief Commissioner would briefly remark upon—

1st.—As to rates.—It seems that the Officiating Superintending Engineer's views should be accepted, although from the 6th para. of Superintending Engineer's letter, up to date, the rates assumed are insufficient; the cause of this, however, is explained.

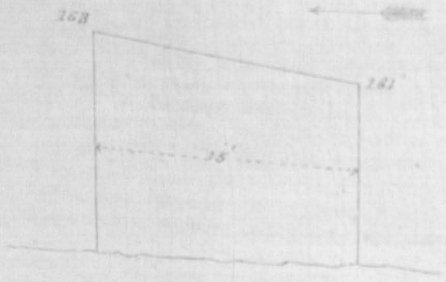
2nd.—As to the description of masonry.—The Officiating Superintending Engineer's views here also should be accepted, as he points out that the experience of the past has proved what parts must be of cut-stone, and what parts may be of rubble or brick masonry.

3rd.—The direction of canal.—This point has, no doubt, been carefully considered by both Captain Haig and Major Stoddard, and may, it is presumed, be considered definitely settled; and although the original project referred to by Mr. Isaac is, in his opinion, far more complete, still must be considered that it would cost 1½ lakhs of Rupees, or about it of the whole work at this barrier.

4th.—The Turabaka Escape.—This may be looked upon as an engineering question, which appears from para. 16 of Superintending Engineer's letter to have been well considered by both Captain Haig and Major Stoddard; whether this escape shall be increased in size (as suggested by Mr. Isaac), or altered in design as referred to by Major Stoddard, may be left to the decision of Chief Engineer on the spot.

5th.—The inundating of the country, Drawing No. 1, shows this, it seems certainly objectionable thus to swamp the lands indicated, more especially in a country that has not a healthy reputation; and it is recommended that this point should receive re-consideration at the hands of the Engineers.

The 163 feet level portion of the anicut, commencing at distance 1,400 (from the east wing-wall) and ending at distance 2,691, was completed last year to the full section intended by Captain Haig as below :—



The crest has a slope upwards (in the direction of the stream) opposing to the current an "inclined plane." The crest has no cut-stone placed on it, and as, at the time of its construction, Captain Haig, (not having then determined on lowering the anicut 3 feet) intended that a cut-stone coping of 2 feet thickness should be put on, little attention was paid to making the surface of the rubble masonry as smooth and secure as possible. A portion of this part of the anicut has been exposed to two years freshes, and it is as remarkable, as it is satisfactory, to see how very well the work has borne the trial, here and there a stone which had not been carefully set in the anicut has been torn off, but the cement, even at the *extreme* edge, where symptoms of wear and tear would certainly be expected to be found, is as sharp and hard as the hardest sand-stone. I am confident that our cut-stone would not have stood half as well.

It is my intention therefore to adopt a similar section in the 160 feet level portion of the anicut from the 2,691 distance, where the 163 feet part ends up to the 4,141 distance, and to have no cut-stone coping in this length, namely, 1,450 feet. Instead of iron-posts and crest boards in this portion, I propose to build piers of good rubble masonry, each 6 feet long, 3 feet high, and 3 feet thick, and 8 feet apart, in the clear, with grooves to receive crest boards. The over-fall in this portion will be no greater (in fact it will be rather less) than it is in the *highest* part of the 163 feet level, and there is a good *hard* rocky apron below, so that this portion will be sure to stand as well, if not better (if that were possible) than the 163 feet portion has done.

11. The remaining portion of the 160 feet level, a length of 1,250 feet, no part of which has as yet been touched, I would allow to remain as Captain Haig proposed, only I would reduce the quantity of cut-stone, by covering the crest with it to a width of only 5 feet, (or from the iron-posts to the edge of crest) instead of 8, and I would place the iron-posts 8 feet apart here, instead of 4½, as they are on the Dowlaishwurum Anicut, where the former distance is found not to be too great for shutters 2 inches thick. By the modifications just described, a great saving in the cost of the anicut will be effected.

12. One chief reason why Captain Haig proposes to make the western end of the anicut 3 feet lower than the centre is, that the rock in the bed of the river below the 163 feet part is of a *softer* description than it is below the 160 feet part, and is more likely to be injured by the fall of water at the commencement of the freshes when the river below the anicut is at its lowest level. By making the western end where the bed consists of *hard* rock, 3 feet lower, the crest boards being all removed when the river commences to rise, the bed below would be covered before the water commenced to pass over the 163 feet part, and the danger of the apron below it being undermined, greatly mitigated, if not quite removed. It would on this account alone, I consider, be necessary to keep the western end of the anicut at 160 feet level, and to raise the water above to 163 feet by crest boards, instead of building up the whole to 163 feet as recommended by Mr. Isaac.

As this part of the river bed is lowest, there will always be a pool of water below the anicut here, and the danger apprehended by Mr. Isaac from the concentration of the discharge during floods is more imaginary than real.

13. As Captain Haig, in his letter No. 333 of 31st August 1863, has fully described the whole project as finally revised by himself, it is unnecessary for me to add anything to his description. Mr. Isaac also has in his report given a general outline of the proposed works. A reference to Plan No. 1 will, it is also hoped, place in one view the arrangement of the whole projected works at the 1st barrier.

14. At para. 20 of his Report, Mr. Isaac states that the machinery for working the sluices in the Lunka Channel would be exposed to serious injury from drift wood, &c., in high floods; he would, therefore, build up the wall to flood level at once. Mr. Isaac would also recommend the adaptation of some hydraulic machinery for opening and shutting the sluices.

To these suggestions I would reply, that Captain Haig's proposal of using the common "nut and screw," to be worked by *moveable* levers, seems to me the very best, because *simplest* kind of machinery that could be used. As the levers will not be left in the capstan-headed screw during the freshes, all that will be exposed to drift wood would be the head of the screw only, and nothing could do any harm to that. As Mr. Isaac does not describe the sort of hydraulic machine he would adopt, it would be useless to discuss the point here. My own opinion, judging from the works of a similar kind in the lower district, is, that an iron screw, 2 inches or 2½ inches in diameter, working in a nut fastened on top of the wall, and furnished with a capstan-head for the reception of the levers, which is, I believe, Captain Haig's intention, is the most unobjectionable of all the expedients that have ever been tried for opening and closing sluices under great pressure.

15. In paras. 23 to 37 of his Report, Mr. Isaac discusses Captain Haig's proposal to intercept the drainage of the Vagoos (or hill torrents) and drop it into the canal providing for the escape of the surplus water a sluice of peculiar construction near Turabaka (*vide* Plan No. 6).

Mr. Isaac has been at considerable pains to calculate the discharge under different heads by the above escape, and the contents of the catchment basin, and he would seem to be of opinion that the area for discharge which Captain Haig has given is not sufficient. Mr. Isaac thinks that the areas of the catchment basins drained by the Vagoos intercepted by the canal between Doomagoodium and the guard lock at Seetumpett, ought not to be reckoned at less than 125 square miles. He takes 6 inches fall of rain in 24 hours as the maximum, half of which he supposes to be discharged in 12 hours.

16. Captain Haig estimates the areas of the catchment basins at only 85½ square miles, and as he has carefully considered this part of the project, I will, though at the risk of making this letter too long, quote largely from a memorandum which he drew up for my guidance before he left the district.

With reference to his proposal to intercept the drainages crossed by the canal, and drop their contents into it instead of passing them under, by means of culverts, as was originally determined, he observes—

"In one case only, that of the Penupilly Vagoo, No. 30, is any drainage crossing the line led out into the river, under the canal by a culvert. In every other instance the drainage is led *into* the canal and *out* again.

"The *inlets* will be many; the *outlets* three only, *viz.*, a sluice wall at Turabaka, a set of three sluices at Budrachullum; and a calingulah just above the tail locks.

"Only in the case of the most trifling drainages will these be allowed to flow into the canal *unchecked*. In all other cases the flow of the Vagoos will be regulated by tanks which will be formed on them a little above where the canal will cross them, which tanks will have a capacity sufficient to retain the water brought down during *heavy* rain-falls, and will be furnished with sluices which will discharge their contents into the canal at a rate which will be separately determined in each case, and which will be limited only to the quantity which the canal can conveniently discharge. In this way any sudden and violent influx of water into the canal will be prevented, and the silt and sand brought down by the Vagoos will be deposited in the tanks which will thus be both regulating, and, to a certain extent, filtering basins.

"The reasons for this arrangement in supersession of the culverts under the canal originally proposed, need not be here mentioned, but they are cogent and conclusive."

17. Between Doomagoodium and the guard lock at Seetumpett, five well defined lines of drainage are crossed by the canal, the total area drained by which Captain Haig reckons at 85½ square miles. The most important of these drainages are the northern and southern branches of the Tora Vagoo.

These branches unite and flow into the Godavery quite a small river, called the "Turabaka River."

18. The canal is connected with the northern branch of the Tora Vagoo near the 4th mile from its head, and it follows the Vagoo till it drops into the Turabaka River down which its course extends for about 3 miles, where the excavated canal is again reached near the Seetumpett Lock.

"The mouth of the Turabaka River (to quote from Captain Haig's memorandum again) will be bunded across by the river flood bank; and about ½rd of a mile above the mouth, an outlet of a peculiar kind for discharging the flood water of the Tora as well as the surplus of all the canal above this point will be built.

"This outlet is a wall much like a calingulah wall, with a cut-stone floor in the lower side, and a rough stone apron.

"The wall is pierced with two rows of openings one above the other, the upper set being intended for discharging the floods and surplus waters, the lower for sluicing or scouring the channel above.

"The sills of the upper openings is to be laid at the 162 feet level. The top of the wall is to be raised to 170. The ordinary level of the canal water inside would be 161 feet 6 inches

(when no floods are coming down the Vagoos), and the highest flood level of the Godavery at the same point is 176.

"The canal is to be closed about $\frac{1}{4}$ or $\frac{3}{4}$ mile below this outlet by the Seetumpett Lock, the upper gates of which will be raised to 178.

"The water surface above the lock may, therefore, rise to any height short of this level without affecting the navigation.

"Now if my calculations are right, it need never rise above the 170 level (the top of the wall) to discharge all that the Vagoos will bring down.

"In rising from 161 feet 6 inches to 170, at least 6,000,000 cubic yards will be collected in the pool above the lock.

"I calculate that the greatest quantity that the Vagoos can throw into the pool will be 10,000,000 cubic yards in 24 hours, and as 6,000,000 cubic yards of this will be retained in the pool between the 161 feet 6 inches and 170 levels, it follows that the openings in the sluice wall must be of such dimensions as to discharge the other 4,000,000 cubic yards in the same time, or at the rate of $\frac{4,000,000}{24} = 166,660$ cubic yards per hour.

"Supposing the openings so arranged at the end of the 24 hours, 4,000,000 cubic yards will have been discharged, and the pool containing 6,000,000 cubic yards will be brimful to the 170 level. The openings continuing to discharge, it will be emptied down to the normal, or 161 feet 6 inches level in 36 hours more.

"Thus, if my calculations which are founded on rough measurements of the discharge of the Tora in floods are correct, this river which with its branches comes down at the rate of 1,400,000 cubic yards per hour at times, *may be completely restrained by a work discharging only* 166,000 *cubic yards per hour*. But there will be no objection to the water rising *above* the 170 level, and discharging over the top of the wall, in which case a great additional discharge would be attained, and a very large increase of *tanking* also."

19. The under row of openings being intended for sluicing or scouring only, will never be opened probably to discharge flood or surplus water, in fact, it would be dangerous to navigation to do so, and I think their area may be greatly decreased with advantage.

I would have a few *small* vents instead of three large ones, and in preference to the iron posts and wooden shutters, I would have iron shutters. The former are apt to break, and it might be very inconvenient, if not dangerous, if such an accident were to happen when the Vagoos are discharging in high flood.

This, however, is only by way of suggestion, and it may be left for Captain Haig's consideration when he returns, as the escape at Turabaka will not be built for sometime to come.

20. The point, which has now to be considered, is whether the *upper* row of openings in the escape affords sufficient vent for the discharge of the flood and canal surplus water. Mr. Isaac in para. 34 has calculated the discharges through these openings for different heads and tabulated them. From his table it would appear that the discharge through the upper openings where the level of the water rises to 170, will be 2,334·5 *cubic feet per second*, or 311,300 cubic yards per hour, or nearly double the quantity which Captain Haig considers sufficient to restrain the greatest floods of the Tora, namely, 166,000 cubic yards per hour. This proves that the area of the upper row of sluices is ample, even if the catchment basins drained by the Vagoos is 125 square miles, or half again as much as Captain Haig has assumed.

It would, however, not be very much greater expense to add one or two more such vents if it should be thought safer to do so, in which case it would be as well to raise the wall also, so as to prevent any discharge over it in either direction, as at present a very high flood in the Godavery would discharge over the wall 5 or 6 feet deep into the canal. I would also recommend that the upper row of openings be closed by shutters, and not left open as Captain Haig seems to propose, as it will not in the latter case be possible to shut out the floods of the Godavery when they rise to 162, and upwards.

It might be objected that a sudden flood in the Tora Vagoos might, if the shutters are in, prove disastrous, but as there will be plenty of time before the pool above the guard lock is filled, to open the shutters, I do not think there will be the least danger. An establishment of lascars should be kept at the escape for the four monsoon months, and the shutters need not be put down until the Godavery began to rise above 162', the level of the sills of the upper vents.

21. As this letter has already reached to such a great length, I am unwilling to add any thing more, except to state that there is every prospect of a larger number of work-people being obtained for the works this year than in any past year, and that it would be a great blow to the works, from which they would be long receiving, if sufficient funds are not provided as required. In this instance where labour has to be brought from a distance at great cost and trouble, and where sickness is so rife, it is the truest economy to complete them as fast as possible.

[No. 62.] *Revised Estimate No. 2 of* 1864-65 *by* T. Isaac, Esq., C. E., *Exe. Engr.*, 1*st Division, Upper Godavery Circle.*

1st.—Barrier Division Upper Godavery Works.

DOOMAGOODIUM.

Communications.

Constructing an anicut and head works and canal and tail works to overcome the obstructions to navigation of the River Godavery caused by the 1st or Sinteral Barrier.

Report.

The accompanying estimates have been prepared in supersession of the estimates submitted on 1st August 1863, for the 1st barrier project.

2. In consequence of the great cost, as shown by the estimates of August 1863, the Superintending Engineer decided on introducing several alterations and modifications of that project with a view to reduce the expense.

3. The main features of the project remain as before, and consist of a masonry anicut across the bed of the Godavery, and a canal 25 miles long with nine locks.

4. The alterations that have been made are as follows:—

1st.—The height of the masonry of the anicut has been cut down from 165 to 160, 162 and 163 feet, as shown on the Plan No. 2. A portion of the anicut between the sluices, and the shoot has already been raised to 163 feet, this will be allowed to remain. The portion between the sluices and the western bank is to be built to 160, and to be furnished with iron posts and wooden shutters to 163 level. The shoot on the eastern side of the river is to be finished off to 162 level.

2nd.—The dam, with scouring sluices across Lunkah Channel, is to be dispensed with, and in its place a perforated wall with sluice gates is to be constructed.

3rd.—The width on top of the flood embankment, in connection with the head-works, has been reduced from 15 feet to 9 feet, and the width of flood embankment, along the outer line of canal, has been reduced from 12 feet to 6 feet.

4th.—The alignment of the canal has been considerably modified. At about the 4th mile it has been taken away from the river bank inland into the western branch of the Turabaka Vagoo, the course of which it follows to the main Vagoo.

5th.—The aqueduct across the Turabaka Vagoo has, in consequence, been dispensed with, and the mouth of the Vagoo is to be closed with a lofty embankment of earth. An escape is also to be provided, as shown in Plan No. 6, to pass the drainage, which it was originally intended to pass under the canal, but is now received into and carried along its course.

6t. a double lock at the head, a single lock is to be constructed.

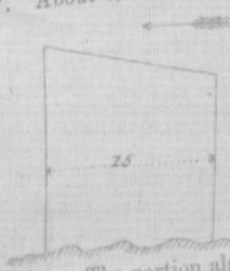
7th.— to be constructed at Seetumpett at the 10th mile just beyond where the al line leaves the Turabaka Vagoo.

8th.—The width of the locks is to be increased from 24 to 27 feet.

5. Of these alterations, I would remark in detail as follows:—

6. The anicut, as originally estimated for, was to be built up of solid masonry to 165 level for its whole length, with the exception of 1,000 feet close to the left bank. This portion called the shoot in which the rocky bed of the river is about three or four feet below 165, it was intended to build to 162 level, so as to admit of the easy passage of steamers, &c., early in the freshes. This part was to have, however, a groove along its top, in which short scantlings were to be driven in the dry season to raise the surface of the water above the anicut to 165 level. This shoot, in the revised plan, is to remain at 162, but as the anicut has been lowered, no groove will be necessary.

7. About 1,200 feet in length of the anicut between the shoot and the sluices was constructed to 163 level before the change was contemplated. As it was intended at the time of construction of this portion to put on top a massive coping of cut stone two feet thick, it was built entirely of rubble stone of the section shown in the accompanying sketch. This portion is to remain of the height of 163. If thought desirable hereafter, the crest edge can be cut down, and a cut-stone coping, as originally intended, can be put on, but this is not recommended now for various reasons amongst which may be noticed the following:—



1st.—The portion already constructed of the section shown above, although built with a view of being protected by a coping two feet thick, and, therefore, without

any care in the selection of the crest stones, many of which are very small, has stood the violence of the floods of two seasons without damage.

2nd.—Cut-stone coping is costly, and cannot be obtained here of a quality that will stand the constant wear and tear of the over-fall. None of the sand-stone quarries in this Division yield a stone sufficiently hard for the crest of an anicut, whereas rubble stone of moderate size can be obtained close to the anicut of any degree of hardness.

3rd.—The hydraulic cement manufactured in this Division is of excellent quality, and this cement alone, where exposed to the full force of the freshes, has retained the sharpness of its edges without injury. Hard rubble stone laid in this cement will stand the wear and tear of the over-fall better than the cut-stone.

8. The portion of the anicut between the sluices and the right bank of the river, measuring almost exactly a half mile in length, is to be built up to 160 level with a section as shown in the plan of the anicut. The crest of this portion is to be protected with a coping, two feet thick and eight feet wide, and is to be furnished with grooved cast-iron posts 3 feet 3 inches high, and 4 feet 6 inches apart from centre to centre. These posts are to be fitted with a joint to enable them to drop into groves cut for their reception in the stone coping.

Planks are to be inserted in the grooved posts during the dry season to dam back the water.

9. My own opinion regarding this arrangement of posts and planks is, that it is open to serious objections as regards the working. The raising and putting in place of a half mile in length of heavy iron posts and planks will of itself be a troublesome operation, but when this has to be done under a flow of water over the crest of the anicut, the difficulty will be considerably increased. If the posts are not raised, and the planks inserted, until the water falls nearly to the level of this part of the anicut (160), the canal will be unnavigable for boats drawing over two feet, as the sill of the head lock is 158. If raised, when there is a depth of a foot or more over the crest, the difficulty will be great. In addition to this, experience shows that the gravel brought down by the river gets jammed into crevices in the most extraordinary manner, and I believe that this gravel getting down into the grooves in the cut-stone coping during the freshes between the posts, and the stone will so jam the posts that it will be almost impossible to lift them.

10. The iron post arrangement cannot be recommended on the score of economy, inasmuch as this part of the anicut could be built up to 163 level, and be furnished with a cut stone coping for the same cost as it will take to carry out the iron post arrangements.

11. The principal reason urged for its adoption is, I believe, that it will reduce the height of over-fall at this point where the bed of the river is lowest, and thus diminish the wear and tear of the rocky bed below. I think, however, that whatever may be gained in this way, will be more than lost by the circumstance, that by lowering this part, some two or three feet below the crest of the anicut, the discharge will be more concentrated, and when the total discharge falls below about 100 millions of cubic feet per hour, it will be entirely cos[illegible] to this portion of the anicut, where the bed of the river is the lowest, and the over-fall greatest. When the total discharge also is 200 millions of cubic feet per hour, nine-tenths of the discharge will take place over this portion of the anicut, and when the discharge of the river is 300 millions, five-sixths will be confined to this portion, and so on.

I think that the effect of this concentrated discharge will be more injurious than the distribution of the total discharge over a greater length.

12. I would recommend, therefore, that the whole of the anicut, with the exception of the shoot, be raised to 163 level, and that, for the present, at least, the cut-stone coping be dispensed with altogether, and that the portion still unfinished be built entirely of rubble stone in the same manner, and of the same section as the part already raised to 163. By this modification a saving of Rs. 30,000 will be effected in the anicut alone.

13. That there can be no serious objection to raising this portion of the anicut to 163, is to be presumed from the fact that the original design and estimate contemplated a height of 165, two feet more than that now recommended.

14. The obstruction of water-way which will be produced by the anicut will be about three-tenths of the total water-way at the site of the anicut in an extreme flood of 189·5 above sea level.

There have been no observations taken of the velocity of the current in a maximum flood at Doomagoodium, but, from some observations taken by me during the past rainy season, I find that the mean surface velocity of the river on a 21·9 feet rise is 4·42 miles per hour, or 6·49 feet per second, and on a 30·7 feet rise, 5·96 miles per hour, or 8·75 feet per second. Now the rise of a maximum flood at Doomagoodium is 46 feet, or more than 15 feet above the height, at which the mean surface velocity was 5·96 miles per hour.

I do not think, therefore, that it will be safe to assume a less mean surface velocity in an extreme flood than 7½ miles per hour, or about 11 feet per second. This will give a mean

velocity of about 9·[illegible] feet, or for all practical purposes, we may assume a mean velocity, or an extreme flood of 10 feet per second.

15. The total water-way in an extreme flood at the site of the anicut is 205,300 square feet, of which the anicut and Lunkah Channel sluice obstruct about 59,500 square feet, or nearly three-tenths of the whole water-way.

The afflux produced by an obstruction of three-tenths of the water-way, with a velocity of 10 feet per second, taken from Gregory's tables, which are founded on Du Buat's formula is 1·83 feet.

16. An approximate estimate of the afflux can be obtained by a simple calculation of the difference of heads necessary to produce the velocities required to pass the total discharge through the obstructed and unobstructed channels respectively.

Taking the water-way unobstructed, as given above, and a velocity of 10 feet (v) per second, we have $205,300 \times 10 = 2,053,000$, or a discharge of 253,000 cubic feet per second.

To pass this discharge through the contracted area will require a velocity as follows :—

$$\frac{2,053,000}{145,800} = 14{\cdot}08 \text{ feet per second} = (V)$$

Now the heads necessary to produce these several velocities are respectively $\frac{V^2}{2g}$ and $\frac{v^2}{2g}$, hence

the difference of heads is $\frac{V^2 - v^2}{2g}$

Since V and v above are actual velocities, we must, by a proper co-efficient reduce them to theoretical velocities before we can obtain the theoretical heads. In rivers of such magnitude as the Godavery in full flood, it is probable that the actual velocity is $\frac{9}{10}$th of the theoretical.

Applying this correction, we obtain for V and v 15·65 feet, and 11·11 feet respectively.

Hence afflux $= \frac{(15{\cdot}65)^2 - (11{\cdot}11)^2}{64{\cdot}4} = 1{\cdot}9$ feet nearly.

17. If we test the afflux thus approximately found by Du Buat's formula for submerged weirs, we shall find that the discharge obtained will be almost identical with the discharge above using, of course, the co-efficient employed above.

The calculations are not given here as on account of the anicut being built in three portions with different heights, the calculations, though simple, will occupy more room there can be given in this report.

18. It may be safely assumed, therefore, that the afflux will not exceed two feet. Hence, since the height of a maximum flood at the site of the anicut, before its construction, was 189·5, an addition of two feet will increase the height to 191·5, and it is, with reference to this last height, that the head-works and flood banks in connection with the anicut have been arranged.

19. In lieu of the embankment or dam furnished with sluice culverts across the Lunkah Channel, a masonry wall perforated with sluice openings has been substituted. It was originally intended to construct the central portion of this wall up to 180 level only, with a thickness at top of only three feet, and the foundations of the wall were commenced for these dimensions. Captain Haig, however, just before his departure, increased the thickness at top to 8 feet, and added a foot in thickness at bottom. The height has also been increased from 180 to 186.

20. An extreme flood will overtop this wall by six feet, and as the machinery for working the sluices is intended to be on top of the wall, it will be exposed to serious injury from drift wood which comes down the river in great quantities in high flood. I think it would be better to raise the wall to flood level at once, and avoid all risk of damage to the machinery.

The arrangements for working the sluices have been designed by Captain Haig. On account of the great length of the screw bolts which raise the sluice shutters (nearly 30 feet), it will be very difficult to keep them from bending when closing the sluice gates under a head of water. As there will be a head of water, generally of about ten feet at the sluice wall, it is a pity that the power thus at command should not be used for working the sluices. A simple and economical adaptation of hydraulic machinery now so extensively used at home for opening dock gates, working cranes, &c., could easily be applied and with advantage.

21. The alteration in the alignment of the canal has introduced considerable modifications.

The line of canal, as originally proposed, followed the bank of the river to the Turabaka Vagoo as shown by the dotted line on the map which accompanies this estimate, and crossed Turabaka Vagoo by an aqueduct of masonry. By this original arrangement, the drainage water brought by the Turabaka was not interfered with, but was passed unobstructed under the canal into the river. In the modified project, the line of canal is taken from just beyond the third mile away from the river into the western branch of the Turabaka Vagoo, the course of which it follows for about three miles until it joins the main stream down, which also the course of the canal is taken for about three miles.

22. Considerable reduction in the quantity of excavation for the canal and flood banks has been affected by this change, and the aqueduct across the main channel of the Turabaka has been rendered unnecessary. On the other hand the length of the canal has been increased by about two miles. A lock has also been rendered necessary at the junction of the excavated portion of the canal south of the Turabaka with that stream. A lofty embankment is also required at the mouth of the Vagoo to dam up the water and keep the channel navigable, and an escape is also indispensable to pass the drainage.

23. In the modified project, moreover, all the drainage channels intercepted by the line of canal are to discharge their waters directly into the canal itself with the exception of the Vagoo, No. 30, called the Peunapilly Vagoo.

24. The areas drained by the streams received into the canal between the head lock and the Seetumpett Lock have been approximately estimated as follows:—

	Square miles.
Doomagoodium drainage channels	1
Vagoo No. 6	3¼
" " 8	2¾
" " 9	0¾
Western banks of Turabaka Vagoo	17
Main Turabaka River	60
	84¼

25. The area drained by the main Turabaka River is, I think, under-estimated. The country is all jungle, and the catchment basin has not been fully surveyed, nor has the stream been traced to its source. It rises in the Bejee country, and its length cannot, I think, be less than 25 miles. It is admitted that at a distance of about 13 miles from its mouth, the width of the catchment basin is about four miles.

26. If we take this four miles as a mean width, we get an area of 100 miles drained by this main branch of the Turabaka River alone.

If this latter estimate be correct, the total area of the drainage received into the 1st section of the canal between Doomagoodium and the Seetumpett Lock is about 125 square miles, and I do not think in the absence of a reliable survey that it will be safe to take a much smaller catchment basin as the basis of calculations for the discharge to be provided.

27. In calculating the quantity of drainage to be dealt with, a maximum rain-fall of six inches in 24 hours has been assumed, half of which is supposed to be discharged in 12 hours.

This will give a discharge to be provided for in cubic feet per second as follows:—

Supposing total area drained to be 85 square miles, 13,713 cubic feet per second.

" " " 100 " 16,133 " "

" " " 125 " 20,166 " "

It is proposed eventually to throw embankments across the drainage channels of some of the smaller streams, and of the western branch of Turabaka Vagoo to hold back part of the drainage, and a supplementary estimate will be submitted in case that detailed examination should prove the practicability of retaining a reasonable proportion of the rain-fall. Such examinations, as have already been made, however, do not seem to indicate that the physical conformation of the country drained will admit of retaining at a reasonable expense such a proportion of the rain-fall as will justify any reduction in the provision for escape. The escape provided for this large drainage is the Turabaka Escape shown in the Plan marked No. 6, which is from Captain Haig's design.

28. This escape admits of three independent methods of discharge. The lower openings, the floor of which is 7 feet below the bottom of the canal proper, are for the purpose of scouring, and were not intended to be used for any other purpose.

The arrangements for working the sluice gates in the grooved iron posts have not been decided on. They will involve some difficulty, as if they are put on the top of the wall at 170 level, they will be exposed to the direct action of the drainage water escaping above that level, and also to the action of the river freshes which in a flood like that of 1861 will flow into the canal at 176 level, or 6 feet above the top of the escape. In any case the arrangements for working these lower sluices will interfere with the upper arched openings.

29. The second method of discharge is by the upper arched opening in the wall. The bottom of these openings which is 162, regulates the level of the surface of the water in the canal, giving a depth of 4 feet above the sill of the Head Lock at Doomagoodium. It is by these three arched openings that the drainage of the 125 square miles mentioned above, will pass off until the accumulated drainage rising above the top of the wall will flow over it as a weir.

30. In order to show the quantity of water that these three methods of discharge will pass at different heads, the following calculations are given:—

The total area of the three lower openings, deducting for grooved iron posts is	266·58 square feet.
The centre of openings above sea	151·67
The total area of upper openings is	166·74 square feet.
And centre of openings above sea	163·78

31. On account of the obstructions offered by the grooved iron posts in the lower arched openings, no higher co-efficient than that allowed for ordinary sluice in lock gates, *viz.*, 625, is admissible, and this co-efficient has been used.

32. In the upper arched openings, although it is almost questionable from the shape of the opening, whether a larger co-efficient should be used yet inasmuch as the contraction of the fluid vein is partially suppressed, I have used a co-efficient of 700.

33. In calculating the discharge over the top of the escape as a weir, the co-efficient of 667 has been used, and inasmuch as the basin formed damming up the Turabaka River will be very large, the velocity of approach will be neutralized, and has not been taken into consideration.

34. The discharge from this escape under different heads will be found to be as follows in cubic feet per second:—

			Cubic feet.
1. From lower openings—			
Water at	162	ordinary canal level	4,295
Ditto	163	ditto	4,497·7
Ditto	164	ditto	4,692
Ditto	165	ditto	4,878·6
Ditto	166	ditto	5,058·3
Ditto	167	ditto	5,231·8
Ditto	168	ditto	5,399·9
Ditto	169	ditto	5,562·7
Ditto	170	ditto	5,720·9
Ditto	171	ditto	5,874·8
Ditto	172	ditto	6,025
Ditto	173	ditto	6,171·3
Ditto	174	ditto	6,314·3
Ditto	175	ditto	6,454·1
Ditto	176	ditto	6,591
2. From upper openings—			
Water at	163	ditto	168
Ditto	164	ditto	475·1
Ditto	165	ditto	873·9
Ditto	166	ditto	1,394·7
Ditto	167	ditto	1,679·7
Ditto	168	ditto	1,923
Ditto	169	ditto	2,138·7
Ditto	170	ditto	2,334·5
Ditto	171	ditto	2,515·2
Ditto	172	ditto	2,683·8
Ditto	173	ditto	2,842·3
Ditto	174	ditto	2,992·5
Ditto	175	ditto	3,135·5
Flood level	176	ditto	3,272
Over top of escape—			
Water surface at	171	ditto	245
Ditto	172	ditto	692·8
Ditto	173	ditto	1,273
Ditto	174	ditto	1,960
Ditto	175	ditto	2,868
Ditto	176	ditto	3,996

35. The contents of the great receiving basin are as follows:—

				Cubic feet.
Between	162	and	170	159,750,000
Ditto	170	"	171	28,500,000
Ditto	171	"	172	31,500,000
Ditto	172	"	173	34,500,000
Ditto	173	"	174	37,500,000
Ditto	174	"	175	40,500,000
Ditto	175	"	176	43,500,000

36. The first burst of the monsoon which brings the Turabaka discharge down with great violence generally occurs before the Godavery rises, and, as when the works are completed, the Godavery above the head-works will be standing at 162, the drainage running into the canal may be expected to open the gates of the head locks and escape in part into the Godavery above the head-works.

37. The escape will be constructed in the line of the flood bank, but is not intended to offer any impediment to the influx of the Godavery freshes which, when they rise above 162, will be admitted into the canal by the upper arched openings. A maximum freshet will pour into the canal six feet above the top of the escape.

38. But little change has been made from the original design in the portion of the canal between Seetumpett Lock, and the tail works.

The level of the water surface in this part of the canal will be higher than portions of the surrounding country. In one place an inner bank will be provided. This is where the course of the canal crosses the Vagoo No. 30, which it is proposed to drain by a culvert under the canal. To prevent the canal waters escaping as well as to prevent the river freshes from flooding the canal through the culvert, the inner bank is indispensable here. In other places the water will be allowed to take its own level. The land flooded by the water standing at 160 in this part of the canal is shown by the portions tinted blue.

39. The tail locks are seven in number, and are arranged in pairs, with the exception of the upper lock, which is to be a single one.

The plans accompanying furnish every information regarding them.

40. In conclusion, I would observe that this estimate does not include work done before the transfer of the Upper Godavery Circle from Madras to the Central Provinces. It makes no provision, moreover, for any expenses or losses connected with the Transport and Supply Department, or the improvement or repairs of its steamers and boats. The Transport and Supply Department being altogether a separate and independent Department, and not under the control of the Executive Engineer, who is entirely ignorant of its expenses and losses, it is manifestly no part of the Executive Engineer's duty to make provision for these expenses and losses in the estimate for the 1st barrier works.

41. The estimate, moreover, makes no provision for the cost of Establishment. In addition to the charges for Establishment disbursed by the Executive Engineer, there are other charges connected with Direction and Accounts, such as salaries of Superintending Engineer and his Office Establishment, proportional share of Central Office expenses, the annual amount of which cannot well be ascertained by me. The charges under these heads, moreover, will depend upon the number of years occupied in the completion of the works, and the rate of progress for the future will probably depend upon the rate in which funds are granted to this barrier.

42. The estimate, moreover, makes no provision for any work necessary for the improvement of the river channel above or below the barrier. It is highly desirable that a detailed estimate of the work necessary between the 1st and 2nd barriers should be prepared at once.

43. Regarding the rates, I have received official instructions from the Officiating Superintending Engineer to employ, in the preparation of the abstracts of cost, certain rates mentioned in a letter from Captain Haig to the Chief Commissioner. I do not know the data on which those rates were based, but an account of the very great difficulty connected with the obtaining and maintaining a force of labour in this Division, and the great and increasing expenses and losses connected with recruiting, I scarcely think that it will be possible to complete the work under a less rate for earth-work, including all charges, than Rs. 10 per 1,000 feet, for rubble work Rs. 28 per 100 feet, and for cut-stone Rs. 150 per 100 feet.

44. Regarding the time of completion, it is desirable, on account of the heavy cost of establishment, that the work should be pushed on as rapidly as possible. The delay of every year adds a large additional sum to the cost of the works. Had a larger grant been given to this division for 1864-65, I think it is highly probable that I should have been able to complete the works by the commencement of the rainy season of 1866. The works that will remain to be done, after the allotment of this year has been spent, will be more than can be done in a single season. Unless some unforeseen casualty should occur, there ought to be no difficulty in finishing the whole before the rainy season of 1867.

NOTE.—I take the liberty of stating, in a Note to this Report that, of the two projects, I think the original one, in which the canal was taken by a separate and independent channel to the Turabaka Vagoo, and across that stream by an aqueduct, as far more complete in an engineering point of view than the revised project, which proposes to occupy about six miles in length of the Turabaka, and one of its tributaries. The difficulties connected with drainage, and the admission of the flood waters of the Godavery into the canal through the Turabaka Escape, are altogether avoided in the original project.

The works necessary for the original project, slightly modified are, as follows :—

	Cost. Rs.	
Anicut	2,63,569	as per revised estimate.
Securing sluices	71,854	„ „
Head Lock	97,705	„ „
Budrachullum Escape ...	12,910	„ „
Upper Tail Lock	43,828	„ „
Upper pair of Tail Locks	79,318	„ „
Middle ditto ...	81,777	„ „
Lowest ditto ...	87,808	„ „
1st Section of Canal taken along river to Turabaka	4,50,000	partly from revised and partly from original estimates.
2nd Section of Canal ...	8,91,420	as per revised estimate.
Turabaka Aqueduct ...	2,00,000	
Total ...	17,80,189	
Deduct cost of revised project	16,23,465	
Excess of cost of original over revised project ...	1,56,724	

At the rates, therefore, on which the revised estimates are based, the more complete project can be carried out for an additional sum of but little more than a lakh and half of Rupees, and I think in a work of such magnitude the difference of cost is slight in comparison with the advantages that will be gained.

I would observe also that, neither project contemplates the formation of the banks of canal where the line passes through low ground.

I have always been accustomed, in the construction of canals, where the canal is above the level of the country, to raise the banks proper above the level of the water to be admitted into the canal.

In the second section of the canal between the Turabaka and the Tail Locks, the canal passes through a great deal of low ground, and the water standing at its intended ordinary level of 160, will flood large areas (as will be seen in the map) forming shallow lakes with nothing to define the channel, unless this be marked out by bamboos or buoyed off.

I think the flooding of so large an area of country objectionable, both an engineering and on sanitary grounds, and I would strongly recommend that the banks of the canal should be properly defined.

No. 996 A, dated 4th July, 1864.

[No. 63.] *From*—LIEUT.-COL. C. H. DICKENS, R. A., *Secy to Chief Commr., Central Provinces, in the P. W. Dept.*,

To—Secretary to Government of India, P. W. Dept.

I am directed by the Chief Commissioner to submit, for the orders of His Excellency the Governor General in Council, Captain Haig's project* for rendering navigable the 2nd barrier on the Godavery, with an estimate, amounting to Rs. 11,34,139.

2. In Mr. Temple's Report, on the Godavery, (paras. 108 and 110), it is mentioned that at that date the intended project was an anicut with a short canal of five miles with locks; that the original project of an anicut with locks in the river bed had been abandoned; and that a revised project had been thought of by Captain Haig of an anicut with a canal of 40 miles, which, though more expensive, was deemed to have certain advantages. This was the state of the question as to the passage of the 2nd barrier up to January 1863.

3. In his letter No. 467 of 22nd October 1863, of which a copy was submitted with this Office No. 528, dated 23rd May 1864, Captain Haig reported that he had, for reasons explained, been induced to give the preference to a project with two anicuts, and this project he has actually worked out and estimated for. The probable cost he finds to be Rs. 12,69,697. But the result of his present detailed surveys and investigations is to inducee him to return to the original project of an anicut with locks in the river bed, (as already mentioned in para. 20 of my predecessor's letter No. 1239 of 17th December 1863) at the smaller estimated cost above-mentioned.

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* Captain Haig's letter No. 58, dated 24th May 1864.
F.—Drawings—
(in case by Dak Panghy.)
1 Estimate.
1 Abstract of Estimate.

4. In the present project, therefore, unlike that adopted at the 1st barrier, Captain Haig, instead of avoiding the dangerous part of the river and passing round it by a canal, adapts it to navigation by means of the pool formed above the anicut, conducting the navigation from the pool to the river below by means of locks which terminate upon a channel in the rocky bed of the lower portion of the barrier, which a little blasting will render a safe easy passage for steamers and boats.

5. The locks are to be placed at the bank on the Central Provinces or British side of the river, and the approach to them is to be secured by a guard wall to be raised above flood level of which a portion, 570 feet in length, including the lock head, runs in continuation of the anicut, and a length of 300 feet projects up-stream, forming a harbour for the reception of steamers and boats in floods. This harbour is to be preserved from silting up by a series of 15 under-sluices in the guard wall.

6. There are three lock chambers overcoming 41 feet of fall. They are each 190+27 feet in size. The gates of the upper chamber are in two parts, the upper parts being only needed in very high floods.

7. The anicut itself is to be raised 17 feet above the bed of the river on the average, the height varying in places from 8 to 27 feet. The length is 3,675 feet, and it is to extend obliquely across river bed. The anicut is to be constructed of loose blocks of stone of all sizes from 10 tons downwards, and to have a slope of 1½ to 1 up-stream, and of 8 to 1 down-stream. On the crest is to be a dressed stone pavement and receptacles for posts with shutters by which to raise the water 3 feet higher if desired. The details of this part of the arrangement are to be furnished hereafter, but the cost of the posts and shutters is included in the estimate. The fall in the rocky bed of the river, at the intended site of the anicut and depth of the channel of approach from below are such, that a dam, of which the height varies from 27 to 8 feet, gives a fall of 41 feet from the upper water level to the dry season water below, which, as already mentioned, is the fall to be provided for the locks.

8. The anicut will form a pool extending 11 miles up the Godavery, and 7 up the Indravutty, and Captain Haig refers to the possible use of this as a reservoir for feeding the irrigation works below, as well as assisting in increasing the volume for navigation.

9. Captain Haig gives full details of his reasons for adopting the rates of works assumed in the estimate, and these appears to the Chief Commissioner to be quite satisfactory.

10. Captain Haig does not require at present any additional establishment for the first operations in commencing the works; but will require some more subordinates hereafter.

11. The scale of establishment will, however, require revision, and a report on this subject, as well as on the financial requirements for carrying out the work next season, will immediately be prepared and submitted for orders.

12. The Chief Commissioner has already sanctioned, in anticipation of the orders of the Government of India, the immediate construction of the buildings for the shelter of the establishment, for which a provision of Rs. 20,000 has been sanctioned in the Budget Orders for the current year.

13. The objects and advantages of the provision of navigation past the 2nd barrier have been frequently and fully explained. It only now remains to add that it appears to Mr. Temple that this project, which is the result of so much careful thought on the part of Captain Haig (who appears to have considered all possible modes of overcoming the difficulties of the barrier) is not only very skilfully designed, but well got up, and clearly submitted for orders; and he, therefore, earnestly recommends it for the early sanction of the Government of India.

14. The return of the original plans and estimate is requested.

[No. 64.] *From*—Captain F. T. Haig, R. E., *Supdg. Engr., Upper Godavery Circle,*

No. 58, dated 24th May, 1864.

To—*Secretary to Chief Commissioner, Central Provinces, in the P. W. Dept.*

I have the honour to submit herewith plans and estimates for the works proposed for the 2nd barrier on the Godavery.

2. My letter No. 467 of 22nd October last, contain so full a description of the rocky reach of the river, which these works are intended to render navigable, that it will not be necessary for me to enter much into detail upon this part of the subject on the present occasion. It will be of use, however, to recal to recollection the main features of this part of the river.

3. About 14½ miles in all are obstructed, in a greater or less degree, by rock. The total fall in this distance is 45 feet, giving a mean declivity of 3·1 feet per mile. In ascending the river, rock is first met with near the village of Tariagoodiem on the left bank, but for the

greater part of the navigation season, steamers have no difficulty in ascending three miles further, to opposite the village of Enchampilly, on the right bank, and the removal of a very few isolated masses of rock will render this piece of the river perfectly navigable all the year round, as the channel, which runs along the left bank, is deep and broad. It is, therefore, between Enchampilly and Bodaigudium, a village 12 miles higher up, that the obstructions to navigation are most serious. This piece of the river, in its natural state, is only navigable in high floods, and then the ascent is made with difficulty owing to the rapidity of the current.

4. The plan of improvement originally proposed, was to build an anicut a little above Enchampilly, of height sufficient to submerge the whole of the rocks above it as far as Bodaigudium, and to make the connection between the pool above and below it, by means of locks placed at one end of it in the river bed.

The subsequent discovery of serious errors in the levels assumed, led me to revise this scheme, and to recommend, in preference to it, another consisting of two anicuts, instead of one, furnished with locks as above described.

By this plan, two distinct pools would have been formed, one extending from the lower anicut which, it was intended to place at or near the originally proposed site, up to the junction of the Indravutty; the other from second anicut, which was to have been thrown across the Godavery immediately above that point up to Bodaigudium.

The principle of the two schemes was the same, *viz.*, the submersion of the rocks which obstruct the passage, and the construction of the locks required to complete the communication in the river bed, instead of in a lateral canal.

5. In my letter above referred to, arguing from such data as I was then in possession of, I gave the preference to the scheme, involving two anicuts; and though the detailed surveys and levels subsequently taken, brought to view several serious difficulties and objections to this plan, it had nevertheless so much to recommend it, that I thought it right to work it thoroughly out, and to make an accurate estimate of its probable cost. Some months were thus occupied; all the detailed levels required were taken; the necessary works, anicuts, and locks were designed; the plans drawn, and quantities taken out.

Enclosure No. 2. An abstract of these, and of the estimate, is appended.

6. The result is to shew that, while the double anicut project possesses seme serious defects, its cost would be in excess by 1¼ lakhs of that of the original, and far simpler project of one anicut only. Thus in point of expense it had nothing to recommend it.

Its defects chiefly were—

1st.—That the rocky bed of the river, a short distance above the proposed site of the lower anicut, was found to be much higher than was at first supposed, and consequently that either a very heavy outlay in addition to the total estimated cost of Rs. 12,70,000 would have been required to cut a passage through it, or that a more tortuous passage liable to silting and difficult of navigation, must have been adopted instead.

2nd.—That though the average height of the rocks at the proposed site for the upper anicut was as great as supposed, still from the excessive evenness of the bed, a great height of anicut would have been necessary at some points, and the position consequently was much less advantageous than the original rough section had led me to anticipate.

3rd.—The great height required for the lock gates, and walls connecting with them, was objectionable. The floods rise, it will be remembered, 70 feet above the summer level of the stream.

I enclose* the drawings of the locks and sluices which were designed as part of this scheme, and request that they may be returned. The locks of the upper anicut were to have been placed in a short cut half mile in length in the angle of the left bank, at the junction of the Godavery and Indravutty.

* Forwarded separately.—Plans A & B.

7. Finding that this project, which was in certain respects defective in itself, was likely to prove even more expensive than its rival, I again directed my attention to the latter, and have decided on recommending it for adoption, with two modifications only, a slightly diminished height of anicut, and the shifting of the site to a point half a mile higher up the river.

The position now selected, affords a good site for the locks on the left bank, and a higher level of the bed on the transverse line, which the anicut will follow, than is met with at any other point. I have already mentioned that the difference of level between the summer surfaces of the river, above and below the barrier, *viz.*, between Bodaigudium and Tarlagudiem is 45 feet. As the lower four miles, however, of this reach may, as above explained, easily be render navigable by the removal of a few rocks, the fall, 1 foot 3 inches, in this piece may be struck off, and there remains in round numbers, 44 feet to be overcome between the extremities of the unnavigable part of the river.

Now, taking the surface of the water at the lower extremity, *viz.*, a mile above the village of Enchampilly as zero, the average height of the river bed at that point, on a line crossing it obliquely as shown on the Plan No. 2 is 21 feet. A dam built upon this line would therefore have to be raised 44'—21'=23 feet, in order to raise the water above it to a level with that at Bodaigudium. Such a work would, however, be of a somewhat more formidable description than these figures would seem to indicate. The river bed being lower on the left than on the right bank, about half the anicut would have to be 27 feet, and the other half 19 feet in height.

Taking, however, 23 feet as the average height, the obstruction which a dam of these dimensions would offer to the floods would be only $\frac{3}{5}$ths, or less than one-half the full flood section of the river, and as the mean current of the river in full flood is only between six and seven miles an hour, the velocity over the work would not be greater than is met within other places. The Kistna Anicut, for instance, built on sand, bears a velocity of at least 12 miles an hour over it in high freshes without injury. There would, therefore, be no serious objection whatever, on any other ground than that of expense, to a dam even of 23 feet in height.

8. The use of shutters, however, removable during the flood seasen, makes it practicable to reduce the height of any dam by 3 feet without inconvenience.

On the Dowlaishwarum anicut, shutters of $2\frac{1}{2}$ feet in height are used on top of a masonry dam of $12\frac{1}{2}$ feet, thus giving 15 feet of rise during the summer months, with a work which only presents $12\frac{1}{2}$ feet in height of obstruction to the floods.

By a simple contrivance of this kind, therefore, the height of the solid part of the dam may be reduced 3 feet, or from 23 to 20 feet.

9. In this way, a dam of 20 feet in height, placed about a mile above Enchampilly would raise the water above it to a level with that at Bodaigudium, which is the condition which I originally determined that any dam or dams, intended completely to remove all the natural defects of this rocky reach of the river, should fulfil. I propose, however, not to attempt quite this degree of improvement, but to limit the height of the dam to 17 feet only, which will be quite sufficient to overcome all the difficulties of the barrier, properly so called, though it will not improve, to the same extent as a higher work, the navigation of the next mile or two of the broad part of the river immediately above.

It would certainly be advantageous if the back-water above the anicut could have been made to extend a little further up river, where the bed is broad and the channel shoal, but in every case of this kind, there must of necessity be some limit to the amount of improvement practicable, if the outlay is to be kept within reasonable limits, and I am of opinion that though the dam might, without difficulty or objection, be made 3 feet higher, the benefit resulting would not compensate for the increased expense which it would involve. An anicut of 17 feet in height will submerge the whole of the rocks, forming a still pool of 10 miles of the river which is now a succession of rapids, and in so doing, practically fulfil all the conditions required.

10. The extreme simplicity of this plan of overcoming the difficulties met with at this part of the river, is one of its chief recommendations. No side canal is required.

Steamers ascending the river, will run without the slightest difficulty up to the left end of the anicut, and the passage of three locks only, occupying half an hour, will conduct them into an open pool, extending for ten miles up river, completely submerging what now forms the all but impassable 2nd barrier. The site selected affords the means of forming a perfectly secure harbour for boats and steamers, just above the locks, at all times of the flood.

The approach to the locks from above will be along the sloping bank of the river perfectly clear of rock, and will lead into a sort of basin formed by the bank on one side and a guard-wall, extending up-stream from the left end of the anicut at a distance of 570 feet from the bank, on the other.

The walls, enclosing this basin, will be raised above the highest flood, and consequently enclose a still-water harbour in all states of the river.

The passage past the anicut will, therefore, be made with perfect safety.

11. The facilities for the construction of such a dam as that now proposed are remarkable.

It will rest upon a bed of rock, which, though not of sufficient hardness to bear exposure to a vertical fall, such as that at the 1st barrier anicut, will form a secure and immoveable basis for the description of work I propose to erect.

A range of hills on the right bank, at a distance of half a mile from the river, will furnish any quantity of stone in masses of any size that it may be possible to lift. The face of the hill is strewn on many places with blocks of from 2 to 10 tons in weight, which may be had for the mere cost of lifting and removal, and cliffs of 50 to 100 feet in height, from which these have fallen, will afford the means of obtaining as much more of the same description as may be required.

12. I propose, therefore, to make the anicut simply a great bank of loose stone thrown in, in blocks and pieces of all sizes, from what a man can carry up to 10 tons in weight.

The stone will not be in any way packed or arranged after deposit, though care will be taken to lay the largest blocks on the surface.

The dam will have a top width of 50 feet, with a down-stream slope of 8 to 1, and an up-stream slope of $1\frac{1}{2}$ to 1.

When its formation to this profile has been completed in the manner described, its surface will be brought to a level over a width of 150 feet, extending over both the top and part of both slopes, with concrete rammed into the interstices between the top course of stones.

The object of this precaution is not so much to secure the stones in their position, as to cover over all the projecting points and surfaces which a mass of loose blocks would present to the stream, and on which it would impinge with greatest effect.

We have the materials for making a concrete, which appears to be almost as indestructible as stone.

An excellent hydraulic cement is made from the limestone found at the 1st barrier, and a block of concrete made with it has been exposed to the force of the strongest current among the rocks without the slightest injury. The same stone abounds here, and may be quarried within $1\frac{1}{2}$ mile of the anicut.

13. A dam of this description is practically indestructible.

That across the Kistna at Bezwarra, which is 16 feet to 20 feet in height, is formed in a very similar manner, only that there the surface stones are packed, and no concrete is used. It rests upon sand, and consequently has a longer slope, 1 in 12, given to its down-stream face.

It has been built about 10 years, and the annual repairs, which consist merely in replacing a few stones on its surface, are insignificant.

Wherever this mode of construction is practicable, it possesses advantages which render it far superior to any other, and it is one of the chief recommendations of the project now proposed, that it offers in a remarkable degree facilities for the construction of such a work.

14. The height of the anicut will vary from 8 feet to as much as 27 feet, but a reference to the detailed estimate will show that there will be but 50 feet in length of it of the latter height.

Its total length will be 3,675 feet, of which about one-half will be from 12 to 16 feet in height, and the other half 18 feet to 24 feet.

15. The shutters, by means of which I propose to keep the water up to a height of 3 feet above the crown of the work during the dry months, will run in grooved wooden posts, let into holes cut in the top surface of the work. These posts will be removed at the end of the hot weather, on the approach of the flood season, and their holes covered by an iron cap to prevent their being choked with silt, or the stones being injured during the freshes.

I propose to make the shutter posts thus moveable, instead of permanent fixtures (as in the Dowlaishwarum Anicut) in consequence of the liability of the latter to injury from the immense masses of drift timber which pass down during floods.

On the subsidence of the freshes in the month of October, the iron covers will be lifted, and the posts and shutters placed in position so as to retain the water at the full height.

16. The difference of level between the pool above, and that below the anicut, will thus be 41 feet, the rocky bed itself forming a broad platform, or natural dam, 21 feet in height, on which the artificial dam of 17 feet, with shutters giving another 3 feet of height, will be raised.

There is no single objection to such a work in an engineering point of view, the facilities for its construction are great, and it may be raised hereafter, if that should be thought necessary, with ease.

17. I pass on now to the description of the masonry works on the left bank.

These consist of a three-fold lock overcoming a rise of 41 feet, a wing-wall connecting it with the bank at a point where a rocky spur projects abruptly from the hill, a wall of feet in length pierced with sluices, connecting the lock with the anicut, and a guard-wall extending up-stream from the extremity of the latter, and so enclosing a basin or harbour immediately above the locks.

18. The locks require no special notice; their construction is simple. The dimensions given to them are those recommended in my No. 467 of 22nd October last, *viz.*, 190 feet × 27 feet in the chamber.

The two lower locks of the tier have nothing in their general mode of construction different from ordinary works of this class, except that on the river side a backing of loose stone takes the place of the usual filling in of earth.

The upper lock has its upper gates raised slightly above the level of the very highest floods, but its chamber walls rise only to within 15 feet of this height, both on account of the unfrequent occurrence of floods of even that diminished height, and because when the river has risen to that level, steamers will be able to pass over the anicut without the help of locks.

The height from sill to top of gates being in this lock 38 feet in the upper, and 35 feet in the lower bay; it is proposed to make the gates in each case in two pieces.

In the upper bay, a gate of 15 feet in height will be placed above one of 23 feet, while, in the lower bay, the top gate will be 12 feet, and the under one 23 feet. The top gates in each case will be made of slightly greater width than the under ones; their heel-posts being placed as much further back in the wall as will leave those of the lower gates and the adjusting wedges of their anchor irons clear.

Each separate leaf will thus rest upon its own pintle, and move independently.

From what has before been said of the unfrequency of very high floods, it will be understood that the upper tier of gates will very rarely be used at all.

19. The method I propose to adopt for filling and emptying the locks is by means of culverts passing *under* instead of *round* the gates.

The openings in the floor above each gate through which the water will descend into the sluice chamber beneath, and thence out by the culverts into the lock chamber, will be closed and opened by means of flat iron valves, about 3′ × 2′, turning on axles working in bearings bolted down to the floor, and connected by means of a wheel and chain with a small winch placed on top of the wall. The arrangement is common in American locks, and have some advantages where silt has to be dealt with.

20. The sluice wall is a plain wall rising from the bed to a little above the highest floods, pierced with sluices, the floors of which are to be laid 10 feet below the tops of the shutters on the anicut, and having a heavy stone apron on its lower side, and a backing of the same material of somewhat greater height on the upper side, so arranged that by means of temporary planks, a platform can be laid in front of the vents from which the sluice shutters can be worked.

By means of these sluices, and of those in the locks, any silt that may deposit in the basin above the locks will be effectually removed.

By the same means it will be possible, if at any time it should be found necessary, to keep the water surface above the anicut below the level of its crown, to facilitate repairs.

I may mention in passing that as the anicut will form a pool extending for 11 miles up the Godavery, and another seven miles up the Indravutty, if at the close of the navigation season, the upper 10 feet in depth of this basin be drawn off by the sluices, about 50 million cubic yards may be thrown into the river below.

I do not stop now to calculate what this may be worth, but the Madras Government would probably be glad to purchase it for the summer irrigation of the Delta, for which the river supply is altogether insufficient.

21. The channel along the left bank, leading to the locks below the anicut, will require clearing, and for a short distance widening.

A few detached rocks must also be removed at other points, both above and below the anicut. The estimate includes an item of Rs. 39,463 for this purpose.

22. The works above described, are all that are required in the river bed.

The estimate, however, provides in addition to these, Rs. 21,550 for the accommodation of Europeans and establishments; Rs. 10,100 for stores, workshops, and other temporary buildings; and Rs. 16,000 for various improvements to the station which will be formed near the village of Enchampilly. Detailed estimates will hereafter be submitted for these works.

23. The rates adopted have been chiefly deduced from those of the 1st barrier estimates.

Those for rubble and dressed stone masonry are less in proportion to the much greater facilities met with at this barrier for procuring materials.

Limestone, which at the 1st barrier, is quarried at a distance of 16 miles from the works, and can only be carried by water during three months of the year, and then with difficulty and interruptions is here found within 1½ mile of the anicut, and with the means of water carriage all through the working season to the site of the locks. Stone may be quarried close at hand.

Labour has always been more plentiful here than at the 1st barrier, though the wages are lower by one Rupee per month in the case of common coolies, and probably Rs. 2 in the case of masons.

I should also mention that dressed stone may be obtained here from quarries close to the limestone, instead of as the 1st barrier from points ten miles distant by water, or six miles by land carriage.

If then Rs. 70 and Rs. 21 were considered sufficient for dressed stone and rubble masonry at the 1st barrier, it will be admitted that Rs. 50 and Rs. 18 are likely to be ample here.

24. The only other important rate requiring notice, is that for the loose stone of which the anicut will be built. I derive this chiefly from data furnished by the Kistna Works, and a Memorandum given me by Colonel Orr, R. E., at the time those works were in progress. The rate allowed, Rs. 6-8 per 100, should cover all expenses for plant, housing the work people, and other contingencies, as well as for railroads, quarrying, and transport.

The following are the items composing the rate mentioned :—

	Rs.	A.	P.
Cost of quarrying on Kristna Works, per ton	0	5	0
Loading and draft, per ton	0	1	9
Unloading and terminal charges, per ton	0	1	0
Total per ton	0	7	9
Or per cubic yard	0	9	8
Or per 100 cubic feet ...	2	3	6
Allow double this for 2nd barrier...	4	7	0

Add for—

	Rs.
Railroads	60,000
Cranes and machinery	25,000
Hutting work-people	20,000
Clearing jungle and opening quarries	15,000
Total	1,20,000

On 9,430,000 cubic feet, per 100...	1	4	4
Sundries	0	12	8
Total per 100 cubic feet	6	8	0

I consider this rate ample.

In doubling the cost of quarrying as compared with that at the Kristna, I am giving largely beyond what the difference in wages would amount to, and almost every other expense is separately and liberally allowed for besides. Some cranes and railroad wagons are already available, as well as about ¾ths mile of line of heavy rails, and three miles of light, so that the whole of the machinery and plant required has not now to be purchased.

25. It will be observed that the estimate includes an item for contingencies of 5 per cent., amounting to Rs. 54,007.

26. With regard now to the prosecution of the works proposed. We have, or shall very shortly have, as large a staff of Officers and Subordinates as cover can be found for, during the approaching monsoon months. Lieutenants Montgomerie and Harvey, R. E., are already attached to the 2nd Barrier Division, and I suppose it probable that Mr. Scott will also be so attached, as well as Major Allen, though I have not yet been informed of the destination of the latter Officer.

Of Subordinates there are now on the spot a Sub-Engineer and Assistant Overseer.

There is also an Apothecary and Dresser. We shall have great difficulty in providing shelter for this party during the rains, and the cold season will probably be well advanced before houses can be ready for the accommodation of any additional Europeans.

I have, therefore, no application to make at present for any increase of the existing staff. We have in fact Officers enough, in any case, but some addition to the Subordinate Establishment will be required as the works proceed.

27. The station, where most of the houses must be built, is situated near the southern end of the range of hills which terminates at the village of Enchampilly.

Two temporary bungalows, one for Officers, and one for Subordinates, were built last year, as well as eight houses for the Native members of the Office Establishment. A short piece of road has also been laid out, and the drains cut.

The site, however, selected for the European bungalows, was bad, and a much better one has recently been found on a spur projecting from the hill near Enchampilly.

On this, two bungalows are now in course of erection, one of them being that originally built on the low ground, and which has been removed to the more elevated site. There is room for three or four houses in this slope at heights of 80 to 100 feet above the surrounding country and river bank, and in a dry gravelly soil. It is hoped that these two bungalows will be completed by the commencement of the heavy rains, and a third well advanced.

This amount of accommodation must suffice for the European Establishment until the close of the rainy season.

28. Meantime the clearance of jungle, opening a road to communicate between the station and the site of the works, construction of a magazine, and of workshops and stores, which are to be roofed with corrugated iron, may be proceeded with, as well as the lining out and commencement of railroads from the quarries to the anicut, and probably also the quarrying of stone and limestone.

Not much can probably be done in the river bed this year, though this will chiefly depend upon whether a supply of iron rails for the quarry can be procured in sufficient time. A good deal of stone may, in all probability, be deposited in the anicut, and possibly the foundations laid of one of the locks and sluice wall on the left bank.

29. I cannot until I have consulted the Executive Engineer, 1st Division, state whether the Budget allotment for the year is likely to be sufficient for the requirements of both the 1st and 2nd Barrier Divisions, or whether it will be necessary to apply for an additional grant.

Revised lists must now be submitted for the 2nd Division Establishments, and in forwarding them, I shall have an opportunity of stating in detail the probable financial requirements of the Circle for the year.

An early intimation of the decision of the Government of India upon the question as to whether the Godavery works are to be prosecuted upon the plan recommended by the Chief Commissioner, or whether the modification proposed in the 1st barrier project should be adopted, and preliminary surveys for the 3rd barrier and Wurda works be put in hand, would greatly facilitate my arrangements.

Until this question is settled, it is difficult to say what portion of the total Budget allotment may be available for any one Division.

30. Meantime, as the Budget includes an item of Rs. 20,000 for accommodation of establishments for the 2nd barrier, I request immediate sanction* to proceed with such preliminary works as building houses, clearing jungle, and opening roads, as are most urgently required.

* By telegraph.

P. S.—I observe that in describing the anicut, I have omitted to mention that its connection with the *right* bank is to be made simply by pitching the face of the bank with heavy stone, instead of by a masonry wing-wall. The rock of the bed rises high up into the bank, which needs but little protection.

No. $\frac{1242}{90}$, dated 15th July, 1864.

[No. 65.] *From*—Lieut.-Col. C. H. Dickens, R. A., *Secy. to Chief Commr., Central Provinces, in the P. W. Dept.,*

To—*Secretary to Government of India, P. W. Dept.*

In continuation of my letter No. $\frac{\text{xx A}}{181}$, dated 4th instant, forwarding the project for the 2nd barrier of the Godavery, I am now directed to submit, for the orders of the Government of India, the following proposals for the prosecution of the work.

2. At the time of the submission to Government of the Public Works Budget of the Central Provinces, the 2nd Barrier Estimate had not been received; and the only provision made for this barrier was a sum of Rs. 20,000 for preparing accommodation for the establishment. Now that the project with detailed estimate is before the Supreme Government, the Chief Commissioner hopes that some provision may be made for the works in addition to the allotment of eight lakhs already sanctioned, and the addition, I am desired to request, may be of two lakhs; raising the Godavery allotment to 10 lakhs of Rupees.

3. In case it should not be possible for the Government of India to provide this additional sum, the Chief Commissioner will desire Captain Haig to have ready, for submission, a re-cast of his Budget within the original allotment, giving to each barrier the share which he may judge to be most proper under such circumstances for the progress of the work generally. But at the same time the Chief Commissioner trusts it will not be necessary so to restrict the expenditure and retard the progress of the works generally; nor, on the other hand, to suspend the commencement of works on the 2nd barrier for another year, in order to allow to the 1st the full sum originally contemplated.

4. The reasons for the vigorous prosecution of the works are many and strong. It will be seen from what follows that Captain Haig has already nearly all the establishment he

requires; and that he does not anticipate so much difficulty in obtaining labour as he has had at the 1st barrier. And while there are these facilities for beginning at once, there is, in addition to the ordinary advantage of carrying on work vigorously, the special consideration that prices are rising rapidly, and so far as can be foreseen, must continue to rise, since land employed in producing cotton gives six times the profit that it does if used for grain. The work, under these circumstances, will be done the more cheaply the sooner it is put in hand.

5. On the Godavery country again, if work can be carried on at both barriers simultaneously, then the available local labour can be better utilized.

If work be *entirely* concentrated at one point, there is difficulty in congregating such very large gangs. If the second barrier be not taken in hand next season, the labour which might have been got for that will be lost altogether to the works, as it could hardly be transferred to the 1st barrier.

6. Under these circumstances, then, and with reference to the readiness expressed in your letter No. 422 C of 2nd instant, on the part of the Government of India, and, in its enclosure, on the part of the Home Government, to provide all needful means for prosecuting the works with vigour, Mr. Temple hopes that it will be considered that a special case has been established for an additional grant of two lakhs of Rupees.

7. The Establishment proposed by Captain Haig for the 2nd barrier is—

		Rs. Monthly
	Divisional.	
* Supposed to be Major Allen, Staff Corps a first Class Executive Engineer.	1 Executive Engineer's salary* ...	1,241
	Office.	
	Head Clerk ...	70
	2 Clerks ...	75
	Cashier ...	50
	Peons, Office-guard and Escort-guard for cash ...	70
	—	265
		1,506
	1st Sub-Division, Quarry and Anicut.	
† Lieutenant Montgomerie, R. E.	1 Assistant Engineer, 1st Class† ...	516
	1 Subordinate with rank of Sub-Engineer, 3rd Class ...	250
	Office.	
	2 Clerks ...	80
	1 Store-keeper ...	30
	4 Peons, Office and Store ...	28
	—	138
		904
	2nd Sub-Division, Lime Stone and Cut Stone Quarries.	
‡ Lieutenant Harvey, R. E. not yet graded.	1 Assistant Engineer, 2nd class‡ ...	466
	1 " Overseer ...	80
	1 Clerk ...	30
	4 Peons (including stores) ...	28
	—	58
		604
	3rd Sub-Division Workshops and General Store.	
§ Mr. Scott, at present Probationary, but nearly qualified for promotion.	1 Assistant Engineer, 2nd class§ ...	250
	1 Overseer (not yet appointed) ...	100
	Office.	
	2 Clerks ...	80
	1 Store-keeper ...	50
	1 Mohurrir ...	25
	6 Peons and Chowkeedars ...	42
	—	197
		547
	4th Sub-Division, Sironcha Civil Station.	
	1 Overseer ...	100
	Clerk and Store-keeper, 2 persons ...	45
	2 Peons ...	14
	—	159
	Medical Establishment.	
	1 Assistant Surgeon ...	457
	1 " Apothecary ...	70
	1 2nd Dresser ...	29
	2 Peons ...	12
	—	568
		4,688
	Grand Total monthly ...	
	or annually Rs.	56,256

This charge, with an addition of about Rs. 8,744 for travelling allowances and contingencies, will be covered by the allotment already made in the Budget for that purpose.

8. But farther, there will be a saving of about Rs. 20,000 in revised arrangements made by Captain Haig, which will be reported on separately. Then, again, there is Rs. 20,000 for works in sheltering the establishment allowed in the Budget. These sums, and Rs. 20,000 which the Chief Commissioner will endeavour to provide for the Sironcha Station in re-distributing the Central Provinces Budget (as will be separately reported), being added to the two lakhs proposed, the expenditure will stand thus :—

				Rs.
Works—Allotment applied for ...	...	...	...	2,00,000
Saving on Establishment ...	...	...	...	20,000
Buildings for Establishment ...	...	...	...	20,000
To be given for Sironcha ...	...	...	...	20,000
Total, Works ...				2,60,000
			Rs.	
Establishment charges, salaries ...	...	...	56,256	
Travelling and contingencies ...	...	...	8,744	
				65,000
Total ...				3,25,000

of which the establishment charges are 20 per cent., excluding the share of Captain Haig's own salary and Office charges. This is not high for the first season's operations, seeing that a Medical Establishment is included.

9. The Establishment is, no doubt, unusually strong in Engineers and weak in Subordinates, especially of the lower grades. But as it appears, on the whole, not to be excessive in cost for the work contemplated, the Chief Commissioner is not disposed to object to the peculiar distribution of the charge which Captain Haig considers most suitable to the circumstances of his Circle.

10. In regard to the necessity for appointing a Medical Officer, Captain Haig urges the isolated and inaccessible position of the place and the unhealthiness of the climate. The distance from Doomagoodium is 82 miles, and from Sironcha, 35.

11. The whole of this establishment is now present under Captain Haig's orders, with the exception of the Medical Officer, one Overseer and the Executive Engineer. The services of the first, no doubt, can be obtained on receipt of sanction; the second can be supplied from the establishment in these Provinces; and the third will, it is hoped, be obtained from Madras under the 16th para. of your letter $\frac{422\ R}{2677}$ of the 2nd instant. This latter arrangement is presumed to be in substitution of that under which Major Allen was posted to the Godavery Circle; Notification No. 92, dated 2nd April last.

12. The foregoing proposals are based upon a letter from Captain Haig, No. 126 of the 4th June 1864, which further submits Tabular Statements for an entire revision of the Engineer and Subordinate Establishments of his Circle. This subject, the Chief Commissioner has thought it better to reserve for a separate report, confining the present reference entirely to the proposals for carrying on work at the 2nd barrier.

13. The Tabular Statements connected with the Office Establishments, having reference to the 2nd Godavery Division only, are herewith submitted for sanction, in case these proposals should receive the approval of His Excellency the Governor General in Council.

No. 1935, dated 19th August, 1864.

[No. 66.] *Memo. from*—Lieut.-Col. C. H. Dickens, R. A., *Secy. to Chief Commr., Central Provinces, in the P. W. Dept.*,

To—Secretary to Government of India, P. W. Dept.

Referring to para. 4 of his No. $\frac{582\ C}{3535\ 2}$ dated 30th July 1864, forwards copy of Captain Haig's Report on the 2nd barrier, Upper Godavery Works, No. 467, dated 22nd October 1863.

No. 467, dated 22nd October, 1863.

[No. 67.] *From*—Captain F. T. Haig, R. E., *Superintending Engineer, Upper Godavery Circle,*

To—Secretary to Chief Commissioner, Central Provinces, in the P. W. Dept.

With reference to your letter No. 866 of 27th August, I have the honour to submit the following Report.

2. My letters of 19th instant, No. 458, and 22nd instant, No. 466, regarding establishments and the works in hand at the 1st barrier, have already dealt with that portion of your letter under reply which refers to that Division of this Circle.

3. With regard to the 2nd barrier, I am now able to submit a project for the improvement of this part of the river, with an approximate estimate of its cost. I, therefore, proceed to do so in accordance with the instructions conveyed in para. 4 of your letter, leaving the detailed estimates to be prepared and submitted hereafter.

4. This barrier comprises a length of 14½ miles of the river, commencing at Wadagudium, two miles below Bodaigudium (Pullamilla) the upper terminus of the tramroad, and ending at Gungaram, a village on the right bank in the short sharp turn which the river takes to the eastward, six miles above Deodoola.

Section plan accompanying.

Memo.—The plan, so far as we know, has not been received in the Public Works Secretariat Office, Central Provinces.

The bed of all this part of the river is a mass of rock from end to end, through which the stream, excepting during floods, flows in a deep channel, sometimes hemmed in to a width of only 30 yards; sometimes expanding in deep pools to a width of 300 yards.

5. The Indravutty joins the parent stream at Somnoor, a village on the left bank, three miles below Wadagudium.

Taking the confluence of the two rivers as our stand-point, an important feature in the general distribution of the levels of the bed presents itself, *viz.*, that the fall below this point is slight, being only eight feet in 11½ miles, while that above it is rapid, being 28 feet in three miles.

6. These differences of level are those of the water surface in summer. If we follow this from the top of the barrier downwards, we first descend 15 feet in three miles, by a tortuous channel winding among the rocks. We thus reach a point half a mile above the Indravutty.

Here occurs a sudden drop of 14 feet in a length of only 100 yards, leading by a short narrow channel 40 feet deep into the broad deep pool, which extends from the junction of the Indravutty, three miles to Sindoor. The rocky sides of the basin here approach one another so closely, as to hem the stream in to a width of a few yards. A short deep pool below this leads to the head of the narrow channel through which the river finds its way from the right bank at Neelumpilly across to the opposite bank, two miles below, and then in a very deep and gradually widening channel, along the base of a range of hills, to the open water below Gungaram. In all these pools depths of from 40 to 150 feet are to be met with.

7. The bed is, of course, extremely rugged and uneven, the rock being mostly a vitrified slate, with occasional out-crops of granitic and other igneous rocks.

The important points to notice in regard to it are, 1st,—that, immediately above the junction of the Indravutty, the average level of the bed on a cross section is 24 feet higher than the surface of the pool just below, and only 5 feet below the water level at the top of the barrier; 2nd, that, at a point two miles below Neelumpilly, the average level is, in a similar manner, 9 feet higher than the surface of the pool below the Indravutty. The levels thus indicate two points particularly favourable for the construction of anicuts, one of 5 feet only in height at the first place, and one of 9 feet at the second, being sufficient to form two deep pools submerging the greater part of the rocks, and rendering this most impracticable portion of the river perfectly navigable.

8. Now in regard to the best method of improvement. The total fall in the barrier is 36 feet, in a length of 14 miles, or an average of 2·6 feet per mile, a slope not greater than might be given to a canal, supposing it possible to excavate one through the rock from end to end.

The extreme inequalities, however, in the distribution of the levels of the bed render the formation of such a canal impracticable. Explanation would be tedious; it needs only a glance at the profile of the bed in the accompanying section, and a slight consideration of its general formation as above described, to understand how perfectly impracticable such a work would be.

9. The only alternative method is an anicut, or anicuts, with locks to overcome the fall, and, perhaps, a canal.

10. My first proposal, as detailed in my Report of May 1856, was to construct an anicut at the point below Neelumpilly above indicated, as peculiarly favourable for the purpose, which should raise the water above it to a level with that at the head of the barrier, and to lock direct from the left bank extremity of the anicut into the deep channel which, as already described, runs along that shore.

I gave this project the preference to the alternative one of constructing two anicuts, one at this point and the other immediately above the Indravutty, because of the difficulties which I then conceived would attend the construction of the locks, in consequence of the great height to which the floods rise.

Judging from the imperfect levels which were then available, it appeared that a single anicut, 18 feet in height, at Enchampilly, would be sufficient for the object intended, and this in a river where the flood-rise is 55 feet above the average level of the bed, would have been a perfectly safe work exposed to no particular trial.

11. This plan, however, had reference to the improvement of the navigation of the barrier only. It would affect the river no higher up than Wadagudium. But I was not then aware of the great defects of the open part of the bed immediately above that point, defects

which subsequent observation has shown it to be most desirable to remove, if possible, by the works intended primarily for the barrier below. There is, in fact, a fall of 8 feet* in the bed between the terminus of the tramroad and Wadagudium, a declivity incompatible with good navigation, and which I have since found renders that part of the river impassable as early as the 1st October.

* Two miles.

This part of the river is also not quite free from rocks.

Above Bodaigudium (terminus) the river resumes its usual slope, and requires no other works for its improvement than those common to all the open parts of the bed.

12. The cause of this singular formation of the bed, so different from what is met with at the other two barriers, which, acting like great dams, have each a long deep pool of still-water above them, appears to be that, for a distance of 23 miles above Wadagudium, the river has, in former years, by a succession of attacks upon its banks, widened its bed in many places to nearly double what may be assumed, judging from other parts of the bed, to be its normal dimensions.

At Bodaigudium the width attained is nearly two and quarter miles. The consequence is a proportionate elevation of the bed which, instead of being gradually sloped off to the level of that at Wadagudium which the rock bottom renders invariable, continues with no increase of slope down to Bodaigudium, where the extreme breadth between banks peculiarly favours the deposit of sand. Hence arises the rapid descent from this point to the head of the barrier.

13. The discovery of this defect made it evident that an anicut, constructed below Neelumpilly, would have to be raised 8 feet more than was originally deemed necessary, or else that a second work of the same kind would have to be constructed above. Unfortunately it happened, as I regret to be obliged to mention here, that the levels subsequently taken in 1862-63, expressly to determine finally all the essential points connected with this barrier, gave results which have since been found to be altogether erroneous.

In March last, I came up to this place expecting to find every thing ready, all the necessary data at hand, for a final decision upon the project. To my mortification, I found that the levels could not be trusted, and that there were doubts about the accuracy of some of the most important ones. I was obliged then to abandon the idea of bringing forward definite proposals for the works required, and ordered Mr. Tyndall, who shortly afterwards took charge of the 2nd Division, to have the whole of the levels taken over again. The result has been to show that those taken by his predecessor were wrong, by as much as 10 feet in so important and essential a point as the difference between the height of the bed at the proposed site of anicut, and the top of the barrier, a discovery which completely reversed most of my former conclusions, and necessitated an entire revision of previous schemes. Had it not been for this, the letter, which I am now writing, would have been sent in last April, and orders to proceed with the works would, no doubt, have been received ere this.

14. The amended levels showed that an anicut, placed on the originally proposed site below Neelumpilly, would require to be raised to a height of 28 feet to throw the water back to the Bodaigudium level.

15. I must now notice a modification of the original scheme, which I suggested to the Chief Commissioner at the time of his visit to the works in 1862.

I had not then made the discovery above mentioned of the inconveniences in the levels, but I had inspected the barrier a second time in the hot season of that year. I proposed to retain the anicut, as originally proposed, but to add to it a canal of five miles in length on the right bank af the river, which would avoid the navigation of the deep channel along the left shore. I roughly estimated the cost of the works at 7 lakhs.

Levels and surveys for computing the actual cost were carried out under Mr. Tyndall's orders this year, and finished about two months ago, when he placed all the plans and drawings in my hands. These containing, as they did, the correct configuration of the bed, rendered it at once very questionable whether the scheme just described ought to be adopted. It appeared, 1st, that an anicut, 28 feet in height, would be necessary as above described; and 2nd, that the average depth of cutting in the canal would be about 20 feet, involving an amount of excavation in five miles only equal to two-thirds that of the 23 miles of the canal at the 1st barrier.

16. An anicut of the height mentioned would only obstruct about half the flood section of the stream, and the current over it in full flood would not have exceeded 10 or 11 miles an hour; but it would, even on a rock basis, have been a formidable and expensive work, which it was most desirable to avoid, and the plan involved a mass of earth-work which, in the present difficulty about labour, would have so much tended to prolong the time of execution.

17. It became, therefore, evident on my arrival here at the latter end of last month, that a careful revision of the whole project was necessary, and in conducting it I kept in view the instructions of the Chief Commissioner conveyed in para. 4 of your letter under reply, regarding a re-examination of the alternative and much more expensive project (mentioned to him by me in 1862, and referred to in his Report upon the Godavery) of an anicut placed many miles up-river above the barrier with a canal some 40 miles in length to the foot. I will first notice the latter project, as it is easily disposed of.

18. I have carefully inspected all the part of the river between Bodaigudium and Birasagaram, (seven miles below Sironcha) the navigation of which such a project would have superseded; and I am fully satisfied that there is no necessity for any such expensive undertaking. It is true that the part of the river mentioned has been, as above stated, widened much beyond its normal limits, but it is also the case that, for many years past, the tendency to spread has been along the left bank only, and that a limit appears now to have been reached in a rocky stratum which the river has uncovered at foot of the bank, and along which the stream now flows with comparative harmlessness. I shall have occasion to notice this formation more in detail hereafter. At present the main point to be observed is, that the stream, instead of meandering through a wide sandy bed, hugs closely the left bank the whole distance from opposite Birasagaram to Adadthium, from whence it crosses over the river, at the same time narrowing to Lunkulgedda, and so on to Bodaigudium. The dry bed of the river gradually rises from the water's edge over towards the right bank, and all that is needed is that, by means of planting, and a few stone groins, the present configuration of the bed should be rendered permanent, and the contour of the banks retained. This part of the river is, in fact, quite as capable of improvement as any other, and to supplement it by a canal would be a gratuitous waste of money. This is the main point regarding this project, and quite decisive, in my opinion, about it. There are, however, practical difficulties connected with its execution, such as the site of the anicut in an extremely wide part of the bed, and where no stone could be procured within a distance of many miles. I may remark also that, until the scheme for the improvement of the shoal-navigation, by means of reservoirs, has been shown to be impracticable, it is altogether premature to supersede the navigation of any of the open parts of the river by canals. The same stream of water, which artificially provided, will render 100 miles of the river navigable, will equally benefit 500.

It would, therefore, be not not only unnecessary, but altogether a loss to substitute canal navigation for any part of the river, which is equally capable of improvement by the above means with the rest.

19. I dismiss, therefore, any further consideration of this project. I have not investigated its probable cost with much care, but it would be heavy. The whole drainage of the country would have to be crossed, and were the canal carried down to the foot of the barrier, that also of a chain of hills some miles in length running close along the right bank.

There would be heavy cutting also at one or two places.

20. I revert, therefore, to the original plan of improvement by means of anicut or anicuts in the barrier itself, and I have no hesitation or doubt as to the particular project which should be adopted.

I abandon the idea of a 28 feet anicut, and a canal five miles in length with 2,000,000 cubic yards of excavation. There are serious objections to both, and moreover, as regards the anicut, it must strike any one, after a little attentive consideration of the general levels of the barrier, that, in raising the water to the height required by means of one anicut only, placed near the foot of the barrier, we sacrifice entirely the advantages offered by the remarkable configuration of the bed immediately above the Indravutty, where the average level of the rock is itself 24 feet above the surface of the pool below, and consequently equivalent to an anicut of that height.

21. I propose to take advantage of this site, and to have two anicuts; one placed at this point, its crest level with the summer water two miles above Bodaigudium; the other placed at the original site below Neelumpilly, and raised as little as possible above the general level of the bed. No canals will be required, the locks may be placed in the river bed, (in both cases on the left bank) as originally proposed.

A steamer descending the river would then meet with still-water first a little above Bodaigudium.

It would descend this pool to the upper anicut, pass by its locks into the pool below formed by the lower anicut, and then by the locks in the latter into the deep channel leading along the foot of the left bank to the open water at Gungaram.

22. The height required for the upper anicut would be 15 feet, and for the lower not above 10 feet at most; possibly less. Of this latter point I cannot be quite certain until a few more levels have been taken immediately above it; but for all present purposes it is immaterial, as a 10-feet anicut would be a trifling work, and owing to the great height of the rocks on the right bank, would extend across only about two-thirds of the width of the bed. The length of the upper anicut would be 1,200 yards, if the longest line on which the section has been taken is followed, and that of the lower 800 yards. There would, therefore, be two extremely simple works, which require no further notice. They would lift the water the same height as a 30-feet anicut on the site of the lower one.

23. There are, however, two important parts of this scheme which I must notice; one is the navigation of the river channel below the lower anicut, the other the construction of the locks.

With regard to the former, while it is true that some improvement of the channel is very desirable, it is equally plain that the construction of the anicut above it, which will distribute over the whole width of the bed, the stream which now rushes in concentrated volume down this one passage, will remove the chief of its natural defects, and also that a fraction of the sum required to cut a canal as a substitute will, if expended on the river channel, render it a much superior navigation.

A powerful sluice placed in the anicut will always keep the channel, which varies in width from 30 to 80 yards, and in depth from 40 to 80 feet in summer, perfectly clear. I am quite satisfied about this part of the project, and have no hesitation in adopting it.

24. Next, with regard to the locks. My original difficulty about this project, as stated in my Report of May 1856, had reference to the height the lock walls would have to be raised to prevent their submersion in high freshes. The rise of the river at this barrier is indeed very great. Measuring from the summer level of the water, the rise of the highest floods at the mouth of the Indravutty is 74 feet, and at the proposed site of the lower anicut 71 feet. But taking the average level of the bed as the datum, the rise at the former place is 50 feet, and at the latter 54 feet. Supposing, then, the upper anicut to have a height of 15 feet, and the lower one of 10 feet, if the lock sills are laid 5 feet below the crests of the anicut, the lock walls in the first case must be 40 feet high to shut out the flood, and in the second, 49 feet.

25. Now, it is important to notice that in the case of low anicuts like these, obstructing so little of the flood waterway, the passage over them either up or down, will be practicable long before the flood has reached its full height; in other words, the locks will not be required to pass boats from one level to another at all heights of the flood, but will be needless for this purpose after the river has attained a certain level. So far, therefore, as their own peculiar function is concerned, the locks need not have walls higher than this level would require. The question then arises whether there is any necessity for raising them higher. I believe that there is scarcely any. The fear of the obstruction of the locks from silting when submerged, originally made me far too cautious upon this point. Generalizing from what I had seen and read of low locks rising only a few feet above the bed, the conclusions I drew, as to high locks such as would be required here, were altogether erroneous. It is quite evident that the sedimentary matter held in suspension by the upper strata of the river, when in flood, is of a very different character from that which is swept along by the stratum immediately above the bed. By the latter, sand and gravel are carried down, but never lifted more than a few feet.

The deposits along the sides of the river, at different heights above the bed, are conclusive upon this point, which, indeed, might have been enforced *a priori*.

The deposit from the upper stratum is a fine impalpable silt, and it is not till within a few feet of the level of the bed that the materials which compose it are to be met with. Now, it is only the former description of deposit that would take place in locks of considerable height, and it is of a kind which a very trifling velocity imparted to water is sufficient to remove. Moreover, high floods are of rare occurrence, and when they do come, maintain the last few feet of their rise for only a few days. I am, therefore, satisfied that to build up the walls of the river locks to a height much exceeding what is required for the actual purposes of the navigation, merely to shut out the floods with their deposits, would be an altogether unnecessary expense incurred to prevent an imaginary evil, and that the objections once urged to the submersion of such works in high floods are immaterial.

26. Even, however, when silting does take place, it is of far less importance than is generally imagined. The locks round the falls of the Ohio at Louisville, are raised very little above the summer level of the river. They are consequently submerged to a considerable depth in floods, and very frequently the deposit of silt in them is consequently very copious.

I saw them just after the subsidence of a flood when there was a depth of 10 feet of silt in them; yet these locks are on a line of traffic of enormous importance, with a tonnage of 2 or 3 millions. I mention this case as an illustration, but it is not to be supposed that there is any parallel between the Ohio locks and those proposed for this river. The cases are very different, the walls in the one case being raised much higher than in the other.

27. The exact height to be given to the locks will require a little careful consideration. For the purpose of framing the approximate estimate now submitted, I have assumed a height of 30 feet above the crests of the anicuts, an elevation which would certainly not be *exceeded*, and will probably be reduced by 8 or 10 feet in the case of the lower anicut.

28. The summer surface of the pool at foot of the barrier is 230 feet above the sea, that to which it is proposed to raise the water by the upper anicut is 277 feet. There will therefore, be altogether 47 feet of lockage, 23 feet less than that at the 1st barrier. This will be distributed thus,—at the lower anicut 20 feet; at the upper 27 feet. I propose to construct a double lock at the latter, in each case the walls of the uppermost lock only to be raised to the height above mentioned.

The locks will be placed close to the left bank, their foundations resting on the rock. They will connect on the land side by a wing wall with the bank (which at the lower anicut is the foot of a rocky hill), and on the other side with the anicut, in the end of which next, the lock, the sluices will be placed.

29. I propose to make the gates in pieces, instead of one pair of gates the full height, to have tiers of gates, one above the other, each leaf being hung independently. There will be considerable advantages in this plan, and it would be applicable to gates of any height. I give no details of it now; they will be furnished with the detailed estimates.

30. With regard to the anicuts, their construcion will be simple, though the precise section to be given to them, and the materials to be used, cannot be positively determined until quarries have been opened, and the exact description of stone available been ascertained.

There are, however, remarkable facilities for the construction of such works. The bed alone will, perhaps, furnish the stone required, as in the case of 1st barrier anicut. If not, there is an abundance in the hills on both banks close to the river, that on the left bank at the lower anicut rising with a steep slope from the water's edge. Limestone, I at first supposed, would have to be brought from Bodaigudium, where it is met with by the tramroad; but quite lately the same stone, which is found in the Tol, and which yields the excellent cement with which the works at the 1st barrier are being constructed, has been found in the left bank, at a point only three miles distant, about midway between the two anicuts, whence, once carted to the river, it can be conveyed by boat without difficulty to either site at all times from October to June.

31. The facilities for building are thus very great; nor are the sites less favorable. So rocky are the banks that, only one wing wall will be required for the two anicuts, while the bed on which these works will rest, forms not only the most solid and durable of all foundations, but will, perhaps, supply the material required for their construction.

32. Now as to the estimates. I have prepared an approximate one, based upon the data afforded by the 1st Barrier Works. 1st, the *anicuts*. I have already said that the exact section to be given to these works cannot be determined until quarries have been opened, and we have ascertained the precise description of stone available. They will, however, be either masses of loose stone covered by a heavy pitching of large slabs laid, in the case of the upper anicut, in cement, or solid rubble masonry with a dressed stone coping as at the 1st barrier.

The last mode of construction is unquestionably practicable, and at a cheaper rate than at the 1st barrier, because while the stone is procurable with equal or greater ease, the limestone is nearer at hand, and more accessible.

Moreover, there will be no necessity for any dams to shut off the river here, an item of cost which figures prominently in the estimates for the work below.

33. Now, the estimate for the work yet to be done, at the 1st barrier, to the anicut, is Rs. 2,77,000 for about 900 yards of anicut, averaging 18 feet in height, including wing walls and dams.

This is at the rate of Rs. 300 per running yard of anicut. I have calculated the cost of the upper anicut here, which will have no wing-walls (the only one wing-wall on the left bank being included in the estimate for the locks) and will require no temporary dams in its construction, at Rs. 280 per yard, the height being 15 feet.

I have also adopted the greatest *length* of anicut in my calculations that any of the cross sections will give.

34. The lower anicut, which will be only 10 feet in height, I calculate at Rs. 150 per yard. It will be an extremely simple work, its length not above 800 yards.

35. For the locks, I found that there is such a material difference in the cost of construction between works placed on the land with heavy earth excavations, and those founded on rock in the river bed, that I have been obliged to work out the estimates in some detail. The greater height given to the lock walls here also renders comparison more difficult.

The result, however, is, that my estimate for the locks here comes to Rs. 8,500 per foot of lift, while those at the lower barrier are estimated to cost Rs. 8,480, or about the same.

36. As to rates, I have assumed Rs. 18½ per 100 cubic feet for rubble masonry, instead of Rs. 22½ as in the 1st barrier estimates; and for dressed stone the same rate as in them, *viz.*, Rs. 70 per 100 cubic feet. Considering the greater facilities for building here, I do not think these rates can be deemed below the mark. The cost of the gates is calculated, as in the other estimates, at Rs. 5 per superficial foot.

37. The abstract of my estimate is as follows:—

	Rs.	Rs.
Upper Anicut and Locks.		
Anicut, 1,200 yards long, at Rs. 280 per running yard ...	3,36,000	
Locks, including wing-wall	2,00,000	
Five per cent. for work Establishment	26,800	
		5,62,800
Lower Anicut and Locks.		
Anicut, 800 yards long, at Rs. 150 per running yard	1,20,000	
Locks, including wing-wall	1,80,000	
Five per cent. for work Establishment	15,000	
		3,15,000
Blasting and removing rock at various points in the barrier ...	...	50,000
Accommodation for Establishments	15,000	30,000
Tools and Plant already purchased	30,000	
Still required, probably	10,000	
		55,000
Boats	Total ...	10,12,800

38. I cannot expect my estimates to be received with much confidence, but I have given above the means of comparing this one with the detailed one for the 1st barrier. I may add that, taking the total cost of the works at that barrier at 21 lakhs, the declivity surmounted is 70 feet; that at this barrier is 47 feet, and the estimated cost 10½ lakhs. In the former case there is an immense mass of earth-work in a canal 23 miles in length, with heavy flood embankments; in the latter no earth-work in a canal 23 miles in length, with heavy flood from the manner in which funds were supplied during the first two years, the cost of work was largely increased; in the latter there is no reason to expect that the works will be carried out from the first with vigor.

If we compare the cost by the unit of fall overcome in each case, we have—

1st barrier $\frac{21,00,000}{70} = 30,000$ Rs. per foot.

2nd barrier $\frac{10,12,0\ 0}{47} = 21,530$ Rs. per foot.

Bearing in mind that the earth-work alone, remaining to be done at the 1st barrier subsequent to 1st May last, is estimated to cost Rs. 6,33,000, the difference is not more than we might expect.

39. The detailed estimates will be put in hand as soon as ever Mr. Tyndall returns, or as soon as I can myself return to this barrier from the lower one, to which I am about to proceed. They will be very simple, and I would recommend that they should be submitted in parts, to save time; first the locks, then the anicut, in case the quarries should not have been sufficiently opened to enable me to design the latter works in detail by the time the estimates for the former are ready.

The estimates for the locks cannot, I think, occupy more than a fortnight in their preparation.

40. Some men have recently been employed in clearing the hills, on both sides of the river, of jungle, and uncovering the rock, to enable me to form some opinion as to the description of material available.

This, though an unsanctioned work, was so essential to the preparation of even the approximate estimate now submitted, that I thought myself justified in ordering it. There are still a few men, about 20 in number, employed, who quite lately came down from Nagpoor for work, and whom it would have been perfect folly to dismiss, as their return to their houses at this time would have created a general impression that no work was to be undertaken here this season. There are also a few maistries, who have proved themselves useful, who are retained, though with almost nothing to do, all work being stopped. I trust I have not done wrong in retaining these men.

41. The arrangements I would now propose, with respect to this barrier, are as follows, supposing that the Chief Commissioner should feel sufficiently satisfied as to the general accuracy of the above estimate to sanction the commencement of preliminary operations. The portion of this year's Budget allotment, which I had assigned to the 2nd barrier, is Rs. 168,000 for work and establishments. I have not the means here of ascertaining what portion of this has been spent, but it is not much.

I would propose to devote the balance to the following works, which I would request sanction to commence *immediately*:—

1.—Construction of houses for work-people, and accommodation for establishment, including the requisite clearing of jungle. I believe that, favourable sites for the two stations that will be required can be obtained, and I shall take pains in their selection, getting Doctor Houston to inspect the ground before-hand. The whole of these I propose to make of the same temporary nature as those for which estimates have lately been submitted, excepting any likely to be required permanently after the completion of the works. Estimates for the whole of these buildings will, of course, be submitted.

2.—Opening limestone quarry, and, perhaps, the transport of stone to the river bank.

3.—Construction of lime kilns.

4.—Opening stone quarries.

5.—Laying any tramroads required; a considerable length of rails, about two miles, has already been delivered at Deodoola.

6.—Purchase of any tools or stores, which it may be desirable to bring up next navigation season.

42. The above would, probably, be the work of the present season, though building may also be commenced in the river bed, if funds are available. I cannot offer more definite recommendations upon this point until I have ascertained whether the prospects of the supply of labour at the 1st barrier are such as to render it advisable to assign a larger share of the Budget grant than originally intended to that barrier, or not. If, however, permission be given for the commencement of the works above enumerated, then no time will have been lost, and when once the detailed estimates have been passed, we shall be in a position to make the

most of such funds as may be available for the rest of the season. Such works as the construction of houses for Europeans and lime-kiln must be put in hand at once, or little can be done this season, whatever amount of money may be available.

43. Some addition to the present executive staff must be made to replace recent vacancies, but I shall have occasion to notice this presently.

44. The only other point requiring notice, in connexion with this barrier, is the tramway. I would request to be informed of the Chief Commissioner's wishes regarding it. It has been completed all but three or four miles, the roadway and ballasting of which have yet to be done. It has lately been breached in several places, and a few culverts carried away; but the damage is not important. Is it the intention of the Chief Commissioner that it should be completed and kept in working order, or not? I question myself the expediency of doing so, now that the transit operations, for which it was originally made, have been abandoned, and its use for the conveyance of limestone from Boodaigudium for the works is superseded by the discovery of stone nearer at hand.

The transport operations certainly cannot be resumed, if ever, before the completion of the works at this barrier, simply because no steamers will be available, the existing Flotilla being fully occupied by the works alone. When first the tramroads were proposed, I requested that three additional steamers might be ordered out from England, and entered an item of Rs. 1,50,000 in that year's Budget for the purpose; but my proposals were only adopted in part, no steamers were ordered, the tramroads were commenced, never finished, and are now without a use or object. I see nothing to be gained in completing the road here. It cannot be a permanent one. It was constructed expressly on the contrary principle. The first six miles between Deodoola and Temetgudium, a village one mile from this place, might be kept in repair, but I question whether even this piece of the line will be of any service as the works are now planned.

45. All work at the 3rd barrier has been suspended since last February.

46. This letter has already reached such a length, that I will reserve the other topics in your letter of 27th August, No. 866, requiring notice, for a separate communication.

P. S.—Since the above was written, the receipt of a letter, which had been nine days on its way from Doomagoodium, reminded me again of the great want of telegraphic communication along the Godavery in connexion with the works.

The delays caused by the dilatoriness of the post, whichever route it follows, whether up river or round by Ellore and Hyderabad, are a most serious obstruction, and I cannot help again urging the necessity for a line of telegraph. I observe in Colonel Strachey's letter of 14th July 1863, that the Supreme Government have referred the question from the Public Works to the Home Department, but the answer conveyed a few months ago in that Department, to the application of the Madras Government on the subject, *viz.*, that there are other lines of more pressing importance which must be constructed first, leads me to believe that there is not much hope of our obtaining this most valuable auxiliary to the works in the usual way. I would suggest that the cost of a line connecting Sironcha with Doomagoodium should be included in the estimates for the 1st and 2nd barrier works. It would not exceed Rs. 30,000, according to an estimate which I prepared in 1860, and which was approved by the head of the Telegraph Department in Madras. This would be only 1½ per cent. on the amount yet to be spent on those works.

Surely this would be much more than repaid by the advantages which the works alone would derive from such a line, to say nothing of its value as a permanent line after their completion. If necessary, I would undertake to superintend its construction. Only one additional station would be required at Doomagoodium. This barrier is near enough to Sironcha.

No. 2860—701, dated 15th September, 1864.

[No. 68.] *From*—Lieut.-Col. C. H. Dickens, R. A., *Secy. to Chief Commr., Central Provinces, in the P. W. Dept.*,

To—*Secretary to Government of India, P. W. Dept.*

I am directed to submit, for the orders of the Supreme Government, copy of a letter, with enclosures, as per margin, from Captain Haig, Superintending Engineer, Upper Godavery Circle, on the subject of arrangements to be made during his absence from India, and while in England, for the progress of the navigation works, especially of the 2nd barrier.

No. 416 of 24th August 1864, with 3 enclosures.

2. Captain Haig, in the first place, (para. 11), requests permission to order plant, chiefly consisting of rails for ballast wagons, to the amount of Rs. 83,690, which, if necessary, for financial reasons, he begs may be charged against the two lakhs applied for to carry on the works of the 2nd barrier.

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3. In the next place, (para. 12), Captain Haig asks permission to entertain in England a Quarry Superintendent, if he can obtain one on the salary of a Sub-Engineer.

4. In the third place, (para. 13), Captain Haig asks that the extra Overseer, promised for the 2nd barrier, may be sent down. This will be attended to as soon as the season permits.

5. In the fourth place, (para. 14), Captain Haig requests that two, or at least one, Company of Madras Sappers may be placed at the 2nd barrier. He promises a good supply of provisions, and expects to find the locality healthy.

6. In the fifth place, (para. 15), Captain Haig requests sanction to proceed with the clearance of rocks between the 1st and 2nd barriers, at a cost not exceeding Rs. 10,000, directly the estimate shall have been framed and sent off. He explains that the period of extreme low water is so short, during which both estimate and work must be done, that to await sanction would be to defer the work for a year. The Chief Commissioner has sanctioned this.

7. After explaining the present state of the Flotilla, Captain Haig, in the sixth place, (para. 20), proposes that he should be allowed, while in England, to purchase two steamers, two cargo boats, and a set of engines for one of his present steamers, at a cost of Rs. 1,55,000; but the charge for which will probably not come into the present official year's accounts.

8. All these proposals appear to the Chief Commissioner to be deserving of favourable consideration for the reasons stated in full by Captain Haig. The Chief Commissioner, however, has no means of judging whether the Sappers can be spared. Considering the services to be required of the steamers during the progress of the works, and the circumstance that they will be useful for traffic afterwards; considering also the deficiencies of the present Flotilla, of which Mr. Temple has some personal knowledge, he can support Captain Haig's recommendation. Further information in regard to the steamers will be found in this Office No. 1209 of 5th December last, (duplicate sent on 24th June).

9. In regard to the proposals for obtaining plant, steamers, and a Quarry Superintendent, it appears only necessary for His Excellency the Governor General in Council to make known his wishes to the Right Hon'ble the Secretary of State, and for Captain Haig to call at the India Office for orders. This will be intimated to Captain Haig, who, accordingly, need not wait for orders before leaving India.

10. The question of the employment of Sappers must, of course, await the orders of the Supreme Government on the 2nd barrier project, and must then be referred to the Government of Madras; on that point, therefore, early orders cannot be expected.

11. The other two matters have been disposed of by the Chief Commissioner, subject to the approval of the Supreme Government.

[No. 69.] *From*—Captain F. T. Haig, R. E., *Superintending Engineer, Upper Godavery Circle,*

To—Secretary to Chief Commissioner, Central Provinces, in the P. W. Dept.

No. 416, dated 24th August, 1864.

Having just returned from a visit to the 2nd barrier, I have the honour to submit the following report upon the works now in progress there, and to state the plan of operations which I have decided upon for the year during which I shall probably be absent from this Circle.

2. The existing establishment is now well housed. The sites selected for the Europeans' houses are excellent, being on a spur of a hill raised from 80 to 100 feet above the ground on the bank of the river.

The most important drains have been opened, and portions of the roads laid out, and their side drains cut.

Clearing jungle is also going on, but the present funds now available being but small, the expenditure will not admit of much progress. The station is thus becoming prepared for the residence of Europeans, and we have no reason as yet to suppose that it will prove less healthy than that at the 1st barrier.

The office establishments, and the few work-people now employed, are also well housed.

Everything is, therefore, in readiness for the vigorous prosecution of the navigation works.

3. The first thing to be done, and that which will form an important part of the operations of the present year, is the erection of all the necessary buildings for the accommodation of establishments, work-people, and stores. These comprise officers' houses, subordinate Europeans' houses, writers' and coolies' lines, a hospital with out-houses, a divisional store, a provision store, workshops, and magazine.

These works, together with the clearing of jungle and formation of roads, are estimated to cost Rs. 47,785. Considerable attention has been paid to the planning of all these buildings. It has been decided to build lines for the work-people of a more substantial description than those at the 1st barrier, a system, which it is hoped, will conduce to greater comfort, health, and economy.

Corrugated iron will be used as much as possible on the workshops and store buildings, and, on the completion of the works, will, together with a large quantity from the 1st barrier, be available for the works which will probably be commencing by that time at the 3rd barrier.

4. The next works to be undertaken will be the opening of quarries for rough stone, dressed stone, and limestone, and the construction of the tramroads connecting them with the anicut.

The directions, which the several lines required for this purpose should take, have been determined, and laid down upon the map. It will be in remembrance that the quarries, from whence the rough stone of which the anicut will be composed, must be derived, are situated opposite the west end of the anicut on the right bank, extending over about two miles or more in length of a hill, distant half a mile from the river. A double line of Railway will be carried up from the anicut to these quarries, and extend in various branch lines along the face of the hill.

5. The limestone and dressed stone quarries are situated on the same side of the river, 1½ miles lower down. A railroad of lighter construction than that proposed for the other quarries will connect these with the river in front of them, and will be carried out over the rocks in the bed to the deep water channel, where the stone and lime will be shipped on boats for the heavy masonry works at the east end of the anicut on the left bank.

Another line will then connect the one just described with those leading from the rough stone quarries to the anicut, passing through the workshops, and close by the landing place on the river bank, and the two general stores.

This line will also be of a light description, forming a connecting link between the different working points serving for the carriage of stores, tools, &c., and for the conveyance of the dressed stone and lime required for the anicut.

The cheapest possible mode of carriage will thus be provided to every part of the works, and as iron rails only will be used, these will be available after the anicut is finished for other works. There will be in all about nine miles of railroad—seven of heavy line in the rough stone quarries and on the anicut, and two miles of a lighter description of line as above described.

Of the rails required for this purpose, only those for the light lines, and three-fourth mile of those for the heavy lines, are in hand. The rest have to be procured from England, and cannot be delivered at the 2nd barrier for a year. The formation, however, of the roads, and the completion of those to be laid with light rails, will be proceeded with, so that everything may be in readiness for laying down the heavy rails as soon as they arrive.

6. Simultaneously with the construction of the railroad, the quarries will be cleared and opened.

The limestone, and a description of sand-stone suitable for dressing, are found very near the river, and I expect that both will be worked very economically.

7. The only other work to be done this year, and that only if time and funds admit of it, is the building of 78,336 cubic feet of rubble masonry, in the foundations of the sluice wall and guard-wall. It would, perhaps, have been desirable that no work in the river bed should have been undertaken this year, and that a commencement should have been made next year when all the preparatory operations had been completed; but the bed on which the sluice wall will rest lies so low, that it will not be uncovered until late in the season, and a great part of next working season would be lost, if a portion of the foundations were not laid in this year, so as to enable the workmen to get at the work soon after the subsidence of the next freshes. As the quantity of masonry required for this purpose is not large, and the means of conveyance of materials required will be in readiness by January, there ought to be no difficulty in accomplishing this much work.

8. If the Executive Officer in charge is successful in carrying out the above programme, (and there seems to be no reason why he should not be so, if only funds are supplied in proper time), then, supposing the rails and machinery required to be received during the freshes of 1864-65, the whole of the arrangements would be complete for the commencement of the anicut in September, and for carrying the masonry of the sluice wall and locks about two months later.

9. The quantities of work to be done in the river bed are as follows:—

	Cubic feet.
Rough stone in anicut sluice wall and locks	10,670,131
Rubble masonry	1,004,022
Dressed stone and arch-work	115,393
Blasting and removing rock in navigable channel	979,200

It will be practicable to deposit stone in the river bed during nine months of the first year, and eight months of the next.

The working season for masonry in the bed would be seven months the first year, and six months the second. If, therefore, the works were to be completed in two years, *viz.*, 1865-66 and 1866-67, this would require the execution of the following quantities per day, reckoning 25 working days to the month :—

	Cubic feet.
Rough stone	25,100
Rubble masonry	3,090

I omit the other items of work, as the progress that may be made will depend almost entirely upon the rate at which the rough stone and rubble masonry can be finished.

10. Now 25,100 cubic feet of rough stone is abont 1,240 tons. This is the quantity which used to be deposited daily in the bed of the river, when in full work, during the construction of the anicut at Dowlaishwurum ; 3,090 cubic feet of rubble masonry would be the work of 152 masons, a number which there would be little difficulty in collecting.

I think it probable, therefore, that, if the requisite funds can be provided, *viz.*, two lakhs for the present year, and five lakhs for each of the two following, the works may be completed in three years. At any rate, supposing that actual completion were not accomplished, the *navigation* would be opened by that time for some months, as this will not require either the raising of the anicut to its full height, or the completion of the lowest of the three locks.

I would recommend, therefore, that the works should be carried forward upon this plan, with a view to the opening of navigation in June 1867.

11. I would now request sanction for the following arrangements, which I consider absolutely necessary for the effective prosecution of the works :—

1st.—I request permission to order, on my arrival in England, the greater part of the plant required.

My reasons for this, is as follows :—It will be remembered, from the description given in my No. 58 of 24th May last, forwarding the estimates for the 2nd barrier works, and from the specification which accompanied, that it is intended to construct the anicut entirely of a mass of rough stone in blocks of large size. The question then arises as to what should be the limits as to size of the stones used, for upon this will depend the description of quarry plant to be used.

As far as the security of the work is concerned, I consider that five ton blocks would be sufficiently large. A top course of stones of this size would, in my opinion, afford ample security against displacement and consequent injury to the work. But is is questionable whether this would be the *economic* limit to the dimensions of the stone, and whether 8 or 10 tons might not be substituted with advantage. The larger the blocks used, the less the expenditure of quarrying and of transport, and of course the greater (in the proportion of the cubes of the dimensions) the resistance offered by the stone to displacement.

On the other hand, there is a limit to the weights which can be conveniently and cheaply handled, as the cost of the apparatus increases in a high proportion with the increase of the mass moved.

Now as the rails, wagons, and cranes required *must* be procured from England, I propose to take advantage of my temporary sojourn there to make a few enquiries at two or three places where large works of the kind have been in progress, in order to determine the question as to what description of apparatus should be used, and then to order it and see to its immediate despatch.

Two objects will be gained by this arrangement : 1st, that the plant ordered would be really the most suitable to the work to be done ; and 2nd, that it would be sent out with much less delay than if procured through the ordinary channel. In saying this, however, I should explain that I have no wish to take the work out of the hands of the Department in London which usually transacts such business, but simply to ascertain what description of plant will be most suitable ; and having done so, to see to its despatch to this country ; either in the same manner as all other Public Works stores, or in whatever way best conduce to speed.

This proposal seems to me so simple and reasonable, that I feel assured that it will meet with the Chief Commissioner's approval and support.

I attach much importance to it, for without some such enquiries as I propose to make, we must, to some extent, act in uncertainty, and may run the risk either of ordering a quantity of expensive plant which may not prove very suitable, or of procuring a description which may not give the best economic results.

I would, therefore, request sanction with as little delay as possible to this arrangement.

An estimate of the probable cost of the plant required is appended. A considerable part of the expense might, if necessary, be met from the two lakhs asked for, for the present year, but it might be sufficient to include the amount required in next year's Budget.

12. I have next to recommend that, in the event of my finding in England a man, who from practical experience in such works as those at Holy-Head and Portland, would make a good Quarry Superintendent, I may be allowed to engage him for the purpose, upon such salary as may be deemed reasonable by the Home Authorities, or the Government of India may be pleased to fix.

A good Foreman in the grade of Sub-Engineer of practical experience in quarrying and transporting large stone would be the sort of man required, and would be invaluable to the works, which, I may here remark, are of a description which it is not possible to execute by contract, and for which, therefore, skilled superintendence is most indispensable. Such superintendence is not to be had in this country, and the efficiency of the Department Public Works would, I believe, be greatly increased by the introduction of more of it.

13. Thirdly, I would request that the additional Overseer applied for in my No. 126 of 4th June last, and who, I observe, the Chief Commissioner thinks, may be drafted from the Central Provinces Establishment, may be sent down as soon as possible. The Assistant Overseer, hitherto employed at Enchampilly, has left on sick leave, and the Officer in charge has now the assistance of one man only in the subordinate grade. It will be necessary, I may remark, that the establishment in this grade should be considerably strengthened next year.

14. Fourthly, I would request that a Company of Sappers may be procured from the Madras Government, and stationed at the 2nd barrier.

For the quarrying, managing the large blasts, and the working of the railroads, such assistance would be of the utmost value, and I trust that the magnitude and great importance of the works will be held to fully justify the detachment of a Company of Sappers for the purpose. It is true that the Company formerly employed at Doomagoodium was removed on account of sickness, but this was chiefly owing to the want of proper food, through the failure of the supply of rice, and the generally defective state of the arrangements for provisioning the people, consequent on the inadequate supply of funds, and the then imperfect organization of the Supply Department. But I would submit that another failure of the sort is now an extremely remote contingency.

Since the time that the works were [illegible] transferred to the Central Provinces, and a fixed annual allotment of adequate amount made to them, the supply of food has been abundant and unintermitted.

The greatest care shall be taken that the men and their families are comfortably housed, and the Company should not be sent until the houses are ready, which, if the funds lately applied for are granted, will be by December or January at latest.

Good, high, and dry sites can be found. The locality cannot so far as we yet know be deemed remarkably unhealthy, and at Sironcha, only 40 miles distant, there are now two Companies of Native Infantry stationed.

The last Company of Sappers left, I believe, with regret, and had it remained a little longer, would have found that the inconveniences from which it then suffered were but temporary, while the advantages in the shape of working pay, at a rate double or treble that usually allowed, were unmistakeable.

I would most strongly urge, therefore, that a Company or two Companies should, if possible, be stationed at Enchampilly during the progress of the works.

15. The next recommendation I have to make, has reference to the river communication between the 2nd barrier and the coast, and to the Transport Department.

With the commencement of the 2nd barrier works, importance of the river transport will be increasingly felt. The communication with the 1st barrier and Coconada will be of vital consequence to the works, and it must be kept in proper order. The navigation between the 1st and 2nd barriers would be available for about six months for steamers of two feet draught, were it not for rocks met with in the channel at two points, Albaca and Byaram—the former 32, and the latter 20 miles above Doomagoodium.

These rocks, though comparatively insignificant in extent, obstruct the channel to such a degree, that navigation is already dangerous in the beginning of October, and soon afterwards becomes impracticable.

It is absolutely necessary that these rocks should be cleared away to such an extent as will render navigation practicable for six months. The quantity of rock to be removed for this purpose is but small, and the work must be put in hand this season, or ten times the expense will be incurred, besides the delays and inconvenience which will be caused, if the machinery and stores, which must be sent up to the 2nd barrier in the next freshes, are delayed, or it should become necessary to send them by land.

With the utmost exertions that can be made with such steam-power as is available, I do not see how all the stores which have to be sent up next season are to be conveyed by water, even supposing the rocky obstructions referred to, to have been removed ; and it, is therefore of the utmost importance that these should be cleared away before the present season closes.

I propose to detach an Officer for the purpose of preparing an estimate of the cost of the work required, but this will not be practicable before December, and it will be necessary therefore that sanction should now be given for commencement of the work previous to sanction, as soon as the estimates shall have been despatched.

The funds, which would probably not exceed Rs. 10,000, might be given from the Reserve, or from the 2nd barrier allotment. I beg to give most distinct warning of the inevitable consequences in hindrance to the progress of the works, and a greatly increased expenditure on the transport of stores, if this work is not done.

16. With regard to the Transport Department, I have to state that the existing Steam Flotilla is altogether inadequate to the requirements of the service. In my Report of 19th January last, No. 865, I pointed this out, and stated my intention of calling for tenders from makers in England for one or two new steamers.

Since then, however, it has become increasingly evident that, unless immediate steps are taken to strengthen the present Flotilla, it will become impossible to convey the increasing quantity of stores and food which the works, as they extend further up-river, require.

With the exception of two small steamers, the "Rose" and "May Flower," which are stationed respectively in the reaches above the 2nd and 3rd barriers, the whole of the available steam-power is fully occupied with the transport of stores, food, and materials for the 1st barrier works, and even for that is altogether insufficient. Two steamers, the "Prince" and the "Hope," are below the barrier, plying between it and Dowlaishwurum. They cannot convey the stores that are annually sent up. Native boats have to be hired in addition. Other three steamers, the "Queen," "Shamrock," and "Arthur Cotton," are fully occupied during the freshes in towing down limestone for the works, and have never yet succeeded in bringing down the quantity required. This will excite little surprise when the small power of all our steamers is remembered, as was shown in a tabular statement in my Report of January last.

Against the current they can do but little.

Two of them were originally built for still-water canal navigation, and another two were intended chiefly for very similar navigation in the pool above the Dowlaishwurum Anicut. A fifth is a light draught boat for the shoal navigation, unable to tow against stream.

17. Were our steamers all new, they would be inadequate to the demands of the service, but the most of them are much worn, and constant delays and interruptions are now caused by the frequent breaks or derangement of the machinery, and these interruptions are becoming more and more frequent and serious, because, while the machinery becomes, from age and wear, less able to bear the strain put upon it, the increase of the traffic tends continually to increase that strain by compelling the Transport Agents to load the engines to the utmost extent of their power.

Within the past month, two steamers, the "Queen" and "Hope," have broken down. In each case a connecting rod broke, and the result was, in the case of the "Hope," that the bottom was knocked clean out of one of the cylinders, while, in the "Queen," fortunately, the injury was less serious, and was limited to an extensive crack round one side of the cylinder.

The "Hope" is completely disabled, and the only way of getting her to work again will be, by taking a cylinder out of the "May Flower," and replacing the fractured one; the engines in both being of the same size and power. The "Queen's" machinery has been patched up, and she is at work again; but this steamer has, on other occasions, been laid up for repairs during the present navigation season.

18. And not only are the engines gradually wearing out and giving way, but in all the steamers there is, of course, an ever-increasing risk of the most frightful accidents from explosion of the boilers.

In almost all the steamers the pressure of steam is, at times, increased from sheer necessity, beyond the proper limit. In the "Prince," the most powerful and valuable of all, the increase is sometimes as much as 20, or even 30 per cent.

This is, of course, a most objectionable practice, and it is discouraged as much as possible, but at times there is no help for it.

A certain amount of work has to be done, and it must be done at whatever risk.

The navigation season is of limited duration; a certain quantity of goods and stores *must* be carried in it, and if the ordinary steam-power proves inadequate, it must at times be increased.

Now, this cannot be allowed to continue. In two of the steamers the steam is now limited to a lower pressure than was used in former years, with, of course, a corresponding loss of power, but from considerations of safety which could not be overlooked, and every year the steamers generally must either work with increasing risk or with diminishing power.

19. With the Flotilla in this state, we have now, in immediate prospect, the commencement of the 2nd barrier works, which will require annually the transport of several hundred tons additional of stores and food, *over nearly double the distance* which our stores are now carried.

Next year about 700 tons of stores will have to be sent up, and I do not see in the least how this is to be done.

The only possible way at present of increasing the available steam power is to bring down the "Rose" from above the 2nd barrier, and this I have accordingly ordered to be done, though it will stop all river communication above that point. But this one little steamer will not be enough.

We have also, of course, to bear in mind the probability of works being commenced at, and above, the 3rd barrier a few years hence, when most of our present steamers will be past work.

20. It seems, therefore, very evident that an addition of at least one or two new steamers to the Flotilla can no longer be delayed, and what I have now to recommend is, that I should be permitted to order them, when in England, in communication with the proper Department in London.

In reply to letters addressed to a few of the best known building Firms in England, I have received letters which leave no doubt in my mind that very suitable vessels for this stream can now be supplied on a very light draught of water; but one Firm only, Messrs. Blythe of London, have made definite tenders as to price. The following is a description of three classes of steamers, all with stern-wheels, which they offer to supply:—

1st.—A steamer to tow 240 tons nett, at the rate of 8 miles per hour, in still water—

Extreme length over paddle-wheel	176 feet
Beam	25 „
Draught, with fuel on board and in working trim, price £ 5,750	2 „

2nd.—A steamer of similar dimensions to the above, but with a draught of 3 feet to tow about 500 tons at 8 miles, price £ 7,350—

3rd.—A steamer 120 feet long, 24 feet beam, draught 14 inches to 180 tons nett, at 6 miles per hour; price £ 2,770.

A copy of Messrs. Blythe's letter is appended.

Another Firm offers to supply steamers of similar dimensions, but with still greater power, on the same draught of water, excepting in the case of the light draft steamer. I do not feel at all satisfied that much higher power might not be obtained without any increase of draught even in the smallest steamer; and as my intimate acquaintance with the requirements of the Godavery navigation will enable me to describe precisely the description of steamer required, and to point out any alterations which might be desirable, it seems of importance that advantage should be taken of my stay in England to order a steamer which shall give the best possible results in her performance, compatible with the nature of the navigation. I would suggest, therefore, that I should be authorized, after full enquiry as to what Firm should be employed, to order two steamers of some such dimensions and power as those above specified. It would be advisable, at the same time, to order a pair of iron barges, the price of which would be about £5,000 extra.

I have further to request permission to order a new pair of engines of 16 horse-power nominal, for the steamer "Queen."

The hull and boiler of this steamer are both in excellent condition, having been built at Dowlaishwurum in 1859, and worked but little until last year; but the engines are old and worn out, having previously belonged to another steamer in which they had been worked for some years.

The cost of the engines, at present prices (£30 per horse-power) will be only about £500, and with them the steamer will be nearly as good as new, being in all respects the most effective steamer, excepting the "Prince," which is of much larger dimensions in the river.

I now submit two estimates, one for tools and plant required for the 2nd barrier Division, amounting to Rs. 83,690; the other for two steamers and a new pair of engines, if the steamer "Queen" is required for the Transport Department, amounting to Rs. 1,55,000. The estimate for the 2nd barrier is for the present year, and the amount will be available from the two lakhs for which sanction has lately been requested. I would, therefore, request that credit to *this* amount may be given to me on the Home Government, and that I may be authorized to make the necessary purchases as soon as possible after my arrival in England, in order to ensure the arrival of the articles in India in time for use in the next working season.

From the outline above given, of the plan of operations proposed at the 2nd barrier, you will observe that, unless the articles specified in this estimate are received at Enchampilly during the freshes of 1865, *a whole year's work will be lost*. It is, therefore, of the utmost importance that I should be authorized to make the necessary purchases without delay, and I would, therefore, particularly request that, whatever the decision of the Government of India may be on the application for the two lakhs for the present year, the amount required in England may at least be granted.

The estimate for the steamers and engine for the Transport Department belongs to the year 1865-66, as it is probable that no payments would have to be made until then. This estimate is of necessity drawn up in very inadequate terms. As soon as the steamers have been ordered, or as soon as the specifications have received the sanction of the Home Government, a correct estimate can be framed and submitted.

[No. 70.] Dated 26th April, 1864.

From—Messrs. J. and A. Blyth, *Steam Engine Works, London,*

To—*Superintending Engineer, Upper Godavery.*

We have the pleasure to acknowledge the receipt of your esteemed favour, dated 27th February last, requesting us, by desire of the Chief Commissioner of the Central Provinces, to send you a description of the steam vessels we would propose for the navigation of the Godavery, and giving us a very full and clear account of the nature of the navigation, and of the various conditions necessary to be known in designing vessels qualified to perform the service efficiently.

We have the pleasure to send you enclosed a tracing, No. 9370, of the description of steam vessel we think most suitable for the purpose, and a tracing, No. 9368, of a cargo barge, together with a detailed specification of the latter, which, in respect of the various scantlings of the ribs, plates, beams, &c., will apply also to the steamers.

We would propose to use a superior quality of iron (*best*) for building the hulls of the vessels, in preference to steel, as being superior in toughness—steel plates being very liable to crack; but, in the construction of the engines, steel would be freely used to get the necessary strength with the least possible weight.

The stern-wheel we prefer to the screw as a propeller for such shallow water.

No. 1.—The tracing, No. 9370, shows a steamer of the following dimensions:—

Extreme length over paddle-wheel	176 feet.
Length of vessel alone	159 „
Breadth extreme	25 „
Draught of water when ready for service, with 12 tons fuel on board ...	2 „

to be fitted with a pair of non-condensing engines of the collective nominal power of 70 horses, the general arrangement of which is shown in the tracing. The boilers to be on the locomotive construction, and capable of being worked at a pressure of 100lbs. per square inch. The engines to be provided with a separate cut-off valve, by which the expansion of the steam may be regulated according to the velocity of the current to be surmounted, the ordinary working condition being with the steam cut-off at one-fifth of the stroke. The boilers are placed as far forward as practicable, so as to balance the machinery at the after-end; the intermediate space being used as a hold for cargo, whenever the condition of the river may admit of a draught of water exceeding two feet. Upon the part of the deck, a light cabin is shown for passengers. The vessel is to be steered by three stern rudders, worked from one tiller, the ropes or chains of which are to be led to an elevated pilot-house forward where the steersman is to be placed.

This steamer will tow two barges (one on each side) of the dimensions shown in tracing No. 9368, drawing three feet water, and carrying 240 tons, at the rate of 18 miles per hour in still water, and by increasing the mean pressure of steam throughout the stroke, the current of eight miles will be overcome.

No. 2.—A steamer of the same length and breadth as No. 1, but adapted to a minimum draught of three feet when ready for service, and with 16 tons of fuel on board, and fitted with a pair of non-condensing engines of the collective nominal power of 90 horses, would tow, at the above-mentioned rate, a proportionately greater load than No. 1, say two barges each 176 feet by 23 feet loaded to 5 feet draught of water. We, in this case, increase the length of the barge, but not the beam, any increase of the breadth presenting the most formidable impediment to towing.

No. 3.—A steamer of the following dimensions:—

Length over all	120 feet.
Breadth	24 „
Draught of water when ready for service with 5 tons fuel ...	14 inches,

fitted with a pair of non-condensing engines of the collective nominal power of 30 horses, would tow at the rate of six miles per hour four barges each 120 feet long and 20 feet beam, carrying 45 tons each on a draught of two feet.

We have not yet received your promised sketch of this small steamer, but, in its absence, we send you the above particulars for your guidance. Of course, this vessel and its barges would be lighter in scantling than the larger ones.

The effective power of the engines in each case would be, as nearly as possible, four times the nominal power.

It is hardly necessary to observe, for, in your experience of shallow river navigation, it cannot fail to have come under your notice that, in such cases as we are now considering, the performance of the steamer depends greatly on the comparative depth of water under her bottom, whilst she is in motion, and when that depth approaches the minimum, a serious obstruction is offered to speed, in addition to the mere resistance offered by the form of the vessel as experienced in deeper water.

We annex an estimate of the approximate costs of the iron hulls of the steamers with their engines and boilers, and of the iron hulls of the barges, all shipped in pieces, ready for putting together. We do not include any timber work, assuming that it can be provided in India.

We shall be very happy to receive orders for the construction of some of these vessels, and we need not say that the most careful attention would be given by us to the execution of your orders, with the view to obtaining the most satisfactory and successful performance.

ESTIMATE.

	£
No. 1.—The iron hull of the steamer—	
No. 1. With the engines of 70 horse-power delivered here in pieces, packed and ready for shipment about	5,750
No. 2.—The iron hull of the steamer—	
No. 2. With the engines of 90 horse-power, delivered here as above described, about	7,350
No. 3.—The iron hull of the steamer—	
No. 3. With the engines of 30 horse-power, delivered here as above described, about	2,770
The barges, 160 feet long by 23 feet beam, delivered here in pieces packed and ready for shipment, each	2,500
The barges 176 feet long by 23 feet beam, delivered as above described, each	2,750
The barges 120 feet long by 20 feet beam, delivered as above described, each	1,600

CENTRAL PROVINCES.

[No. 71.] Upper Godavery Circle, Public Works Department.

Estimate framed by Captain F. T. Haig, R. E., *Superintending Engineer, of the probable cost of certain Steamers and Iron Barges required for the Transport Service.*

Description.	Number now on hand.	Additional number required.	Rate.	Cost.	Remarks.
			£	£	
Steamers with iron hulls, length about ... ... 150′ Breadth ... ... 25′ Depth ... ... 6′	...	2	5,000	10,000	
Nominal horse-power ... 90 Iron Cargo Barges about 150′ × 25′ × 6′	...	2	2,500	5,000	
Engines of 16 nominal horse-power	...	1 pair	500	500	
Total	...	...	...	15,500	or Rs. 1,55,000

F. T. HAIG, *Captain, R. E.,*
Supdg. Engr., Upper Godavery Circle.
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CENTRAL PROVINCES.

UPPER GODAVERY CIRCLE, PUBLIC WORKS DEPARTMENT.

Estimate framed by CAPTAIN F. T. HAIG, R. E., *Superintending Engineer, of the probable cost of obtaining Tools and Plant required for use in the 2nd Barrier Division.*

DESCRIPTION.	NUMBER NOW ON HAND.	ADDITIONAL NUMBER REQUIRED.	RATE.	COST.	REMARKS.
		Tons.	£	£	
Rails of iron for 6 miles of line	...	450	7½	3,375	
Turntable for ditto ...	...	6	20	120	
Cranes, travelling iron-work for ditto	...	10	54	540	
Chains of sizes for cranes and slings ...	...	2	50	100	
Locomotives' Contractors ...	...	3	500	1,500	
Railroad trucks, wheels, axles, and bearings for ditto	...	60	10	600	
Portable-engine	...	1	250	250	
Mortar mills, steam, with engines, complete	...	4	176	704	
Pug-mills, iron	...	4	20	80	
Corrugated-iron	...	sqr. ft. 15,000	per 100 ft.		
Patent Fuze	...	yds. 800,000	2 p. 1,000 yds.	300	
			1	800	
Total ...	...	...	...	8,369	or Rs. 83,690

F. T. HAIG, *Captain, R. E.,*
Supdg. Engr., Upper Godavery Circle.

[No. 73.] *From*—LIEUT.-COL. W. MAXWELL, R. A., *for Secy. to Chief Commr., Central Provinces, in the P. W. Dept.,*

To—Secretary to Government of India, P. W. Dept.

No. 5094 A, dated 6th December, 1864.

I am directed to submit, for the orders of Government, estimate, &c.,* for the following works, being supplementary to the 2nd barrier project, submitted with my No. 996 A of the 4th July last :—

* 1 Estimate.
1 Roll of plans.
1 Copy of Captain Haig's No 410 of 1st September 1864.
1 Copy of Secy. to Chief Commr., No. 3344 of 1st October 1864.
1 Copy of Secy. to Chief Commr., No. 3344 of 1st October 1864.
1 Copy of Major Stoddard's No. 627 of 31st October 1864, with enclosure.

					Rs.	
Station.						
Jungle clearing					10,672	
Station Roads					3,598	
,, Bridges					779	
,, Drains					345	
Contingencies					770	
						16,164
Accommodation for European Establishment.						
Executive Engineer's Bungalow					1,518	
3 Assistant Engineers' ,, ...					3,588	
8 Subordinates' ,, ...					4,768	
Servants' houses for all these ,, ...					3,264	
						13,138
Carried over						29,302

Brought forward ...		Rs.	29,302
Accommodation for Native Establishment.			
Office for Executive Engineer	1,145		
2 ,, Sub-Divisions	424		
20 Writers' houses	4,540		
300 Running feet of Peons' lines	2,880		
			8,989
Divisional Buildings.			
2 Workshops	3,008		
1 Store	1,813		
1 Rice Store	1,813		
1 Hospital with dead-house	2,548		
1 Powder Magazine	605		
			9,787
Total			48,078

2. The amount of these estimates was included in the project submitted with my letter above quoted ; and the present estimates merely supply the details which were for the time omitted.

3. It will be perceived that explanation has been afforded of this large sum set down for jungle clearing which is due to the size and closeness of the trees, and the necessity for digging out roots.

4. The cost of the accommodation for the Native Establishment appears high, and the Chief Commissioner will point this out, and endeavour to get such reduction made as is consistent with the provision of comfortable dwellings, the provision of which is, no doubt, a necessity when Establishments are carried to such wild places.

5. In other respects, the estimates appear moderate and suited to the circumstances of the case. The provision for road drainage appears to be an approximate one, the actual works being divided between the road and the tramway.

6. The Chief Commissioner recommends these estimates for sanction, with permission to substitute brick-in-mud in the walls to such extent as may be possible without exceeding the estimate.

7. This recommendation is, of course, to be understood as subject to such modification as may be requisite under the orders of the Government of India, now shortly expected on the 2nd barrier project, as intimated in your No. $\frac{1096 C}{6015}$ of the 25th ultimo.

8. Meanwhile, the most urgent portion of the work has been put in hand under para. 26 of the Budget Orders of 1864-65.

No. 523, dated 26th May, 1865.

Memo. by LIEUT.-COL. W. MAXWELL, R. A., *Secy. to Chief Commr., Central Provinces, in the P. W. Dept.*

The undersigned greatly regrets to find that this letter, and the papers referred to, were not submitted last December ; they have been retained by mistake by the Head Native Estimator, unknown to Lieutenant Angelo, or any one else. This man has been severely reprimanded and warned that, another instance of neglect such as this, will call for his immediate dismissal.

No. 410.

[No. 74.] *From*—CAPTAIN F. T. HAIG, R. E., *Supdg. Engr., Upper Godavery Circle, To—Secy. to Chief Commr., Central Provinces, in the P. W. Dept.*

With my No. 58 of 24th May last, I submitted estimates for works at the 2nd barrier, amounting to Rs. 11,34,139 ; of this amount Rs. 10,86,489* was the total of a number of detailed estimates for works in the river bed. The remaining Rs. 47,650 was the aggregate of approximate estimates for the following works, for which it was stated (para. 22) that detailed estimates would afterwards be submitted :—

	Rs.	
* Amount of Estimate ...	10,32,482	
,, of Contingencies ...	54,007	
Total ...	10,86,489	
Accommodation of Europeans and Establishments		21,550
Stores, workshops and other buildings		10,100
Station improvements...		16,000
Total ...		47,650

2. I have now the honour to submit detailed estimates* for these works, amounting to Rs. 47,755.

* In separate cover.

The works included are as follows:—

Accommodation for Europeans and Establishments.

1 Executive Engineer's bungalow.
2 Assistant " "
8 Subordinate Europeans' " "
Out-houses for the above.
1 Divisional Office.
2 Sub-divisional ditto.
20 Writers' houses.
Peons' ditto.

		Rs.
Total for accommodation of Establishments	...	22,125

Divisional Buildings.

2 Workshops.
1 General Store.
1 Rice Store.
1 Hospital with Out-houses.
1 Powder Magazine.

Total for divisional buildings	...	9,630

Station Improvements

Clearing about half a square mile of jungle.
Making, 3¼ miles of roads.
Opening drains.

Total for station improvements	...	16,000

3. With regard to the accommodation for establishments, I would observe that the estimates provided for as large an establishment as will be required for the prosecution of the works, but that the description of building adopted is temporary, and therefore cheap. The works ought to be completed in three years; the station is on the right bank, out of British Territory, where no one will be located after the works are finished, and there is, therefore, no object in building houses likely to last more than three or four years.

Comfort and health are, I think, sufficiently provided for in the style of construction proposed.

The sites for the Europeans' houses will all be well elevated above the surrounding country. The roofs will be of thatch; the walls of mud, properly finished and whitewashed; the floors pucka, raised at least two feet above the ground; and the doors and windows partly glazed, and partly battened; all the principal timbers in the roof, and in the walls supporting it, will be of teak. Such houses will last well for three or four years with very little repair, and can be made abundantly comfortable.

Provision of a somewhat less expensive character is made for the Office Establishment.

4. In the divisional buildings, it is proposed to use corrugated iron chiefly in the roofing. This material, with teak timber supports, affords a cheap and very durable description of building.

5. The works proposed for the station generally, are—

1st.—Clearing about half a square mile of jungle. It will be observed that it is intended to have a total area of about one square mile, with a river front of two miles, and a breadth of about half mile, thoroughly cleared; about half this has been already done; the remainder is provided for in the estimate.

2nd.—Roads and drains. Only those absolutely necessary have been included.

A plan of the station, showing the proposed improvements, accompanies.

6. With regard to rates, the Officer in charge of the 2nd Division points out that, unless he is enabled to commence work on a comprehensive scale, so as fully to utilize the means at his disposal, the rates adopted in the estimates may prove insufficient.

There is, however, too much uncertainty altogether about rates at the 2nd barrier to warrant my pronouncing a decided opinion as to the sufficiency or otherwise of those in the estimates. So far as I am now able to judge, I think those adopted should be sufficient, labour being there about 20 per cent. cheaper than at the 1st barrier, and the facilities for procuring building materials much greater. I think, therefore, that Lieutenant Montgomerie's rates may be retained.

7. With these estimates, the Government will now have before them the whole of the estimates for the 2nd barrier works in full detail. I would, therefore, most strongly urge that sanction should now be given for the vigorous prosecution of the works included in the

present estimates, to the extent at least of the balance remaining of the reserve (Rs. 25,000,) after deduction of the Rs. 10,000 already sanctioned as an advance for this purpose. If the Officer in charge could spend about Rs. 10,000 or Rs. 15,000 per month, he might make fair progress with these preparatory works, and would be better able to take full advantage of the larger allotment of two lakhs applied for when the sanction of the Government of India shall be received.

I would, therefore, request that the balance of the reserve, Rs. 25,000, may be placed at Lieutenant Montgomerie's disposal as an advance, pending the sanction of the Government of India, and that intimation to that effect may be sent him direct by telegraph, if my proposal meets with the concurrence of the Chief Commissioner.

No. $\frac{3335}{903}$, dated 1st October, 1864.

From—Lieut.-Col. C. H. Dickens, R. A., *Secy. to Chief Commr., Central Provinces, in the P. W. Dept.,*

To—Superintending Engineer, Upper Godavery Circle.

In reference to your letter No. 410, dated 1st September, transmitting estimates for the Station accommodation, &c., at Enchampilly, Rs. 47,755, I am directed to bring to your notice that the rate for clearing jungle by thrice cutting and burning, Rs. 10,000 for one square mile of ground, requires very full explanation or modification before the estimates can be submitted to Government, also digging roots for a width of 12 yards to a roadway, at Rs. 600 per mile. I am also to ask whether it would not be better that the culverts should have openings of a sectional area adapted to the drainage each has to carry off, instead of being all restricted to one foot square, and whether walling of a semi-permanent character might be better and not much more expensive than plain wattles and dab and teak framing. If you will be good enough to favour the Chief Commissioner with your views on these matters, the necessary corrections can be made in this Office, and communicated to you hereafter.

No. $\frac{3336}{904}$, dated 1st October, 1864.

Endorsed by Secy. to Chief Commr., Central Provinces, in the P. W. Dept.

Copy forwarded to Lieutenant Montgomerie, with a request that he will at once afford the necessary information to Major Stoddard.

No. 627, dated 31st October, 1864.

From—Major J. F. Stoddard, *Offg. Supdg. Engr., Upper Godavery Circle,*
To—Secretary to Chief Commissioner, Central Provinces, in the P. W. Dept.

In acknowledging the receipt of your docket No. 3335—903, dated 1st instant, I do myself the honour of forwarding, in original, a letter to my address, from Lieutenant P. Montgomerie, the Officer in charge of 2nd barrier Division, explaining in detail on all the points referred to by you.

2. I have no experience of cutting such dense jungles, as grow on the banks of the Godavery, myself, and, therefore, referred to those Officers here who have had more or less to do of such work; and one of them, Mr. Tyndall, who is well acquainted with the 2nd barrier Division, informs me that the trees near Enchampilly are *very large*, and very close together, and that to clear the ground well of them, and extract partially the stumps, would be very hard work, and he is of opinion that Lieutenant Montgomerie's estimate is very moderate.

3. I consider the estimated cost of digging up roots for a width of 12 yards to a roadway at Rs. 600 a mile is excessive; Rs. 200 per mile should, I think, be found sufficient, and I would recommend no more than this.

4. I am of opinion that you will consider Lieutenant Montgomerie's explanation regarding the road-culverts being all made of one size, satisfactory.

It would not be worth while calculating to a nicety, the discharge of each of such unimportant vents, if, indeed, that were possible under the circumstances mentioned by Lieutenant Montgomerie.

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5. With reference to the last point mentioned in your letter, you will observe that Lieutenant Montgomerie gives very good reasons for adopting your suggestions, as to the nature of the walling to be given to the buildings.

He states that the improvements would cost about one-third more only, and that, in fact, it will be necessary to use bricks or stone, instead of sticks and "wattle and dab," owing to the rocky nature of the ground.

No. 350, dated 18th October, 1864.

From—Lieut. P. Montgomerie, R. E., *1st Class, Asst. Engr., Upper Godavery Circle,*

To—*Acting Superintending Engineer, Upper Godavery Circle.*

I have just received from the Chief Engineer, Central Provinces, a copy of his No. $\frac{350}{999}$, dated 1st October 1864, to your address, and as requested, I have the honour to furnish you with the following information regarding the estimate for the Station improvements, &c., on the several heads required by the Chief Commissioner :—

1. With reference to the "rate for clearing the jungle by thrice cutting and burning, Rs. 10,000 for one square mile," I must inform you that this includes the digging up of roots around the buildings, and in such other places as may be necessary for the health of the residents, as mentioned in the 1st para. of the specification. These places can only be found out by experience. I would further draw your attention to the instructions I received from Captain Haig in his No. 210, dated 22nd June 1864, when I was directed not to exceed the approximate amounts given in the general estimates. In the general estimates, Captain Haig allowed Rs. 10,000 for three-fourths of a square mile alone, and Rs. 609 for roads. On more fully examining the *contour* of the country, it appeared that the area required for the station would be nearly one square mile. And, as I was too well aware of the consequences of living in an uncleared or partially cleared jungle, I increased the amount for clearing to Rs. 10,672-3-2, and reduced the amount on the roads, so that the total would still be Rs. 10,000 as directed. With regard to this most important subject, I request you will use your best endeavours, and obtain the favourable consideration of the Chief Commissioner in sanctioning the full amount required for clearing jungle.

2. As to digging roots for a width of 12 yards to a roadway, at Rs. 600 per mile," all I have to say is that, the work might be done partially for a less sum, but the effect would be but slightly better than if the jungle was merely cut down; the young roots would spring up quite as strong, and would require constant cutting.

3. "That the culverts should have openings of sectional area adopted to the drainage each has to carry off, instead of being all restricted to one foot square." In the plan of the station, I have indicated, by a strong black line, one of the tramways that will be required in connection with the barrier works, and which would run along the side of the proposed main station road, as this crosses one or two considerable drainages besides the Enchampilly Nullah; it would be unfair to charge the entire constructions of the culverts that would be required to the improvements of the station. For all the other culverts, a sectional area of one square foot appears ample, as the roads are generally taken along the water-sheds with the exception of the road connecting the Writers' lines with the Officers' houses, where a drain is crossed. A wooden bridge of sufficient water-way has already been constructed over this, at a cost of Rs. 160 without materials. This road was constructed by order of the Superintending Engineer in para. 4 of his No. 167, dated 13th June 1864.

4. "Whether walling of a semi-permanent character might be better, and not much more expensive than plain wattle and dab and teak framings," I have the honour to inform you that walls consisting of bricks-in-mud, including foundations, would only increase the cost of the buildings by one-third, and would be much better both as to durability and appearance. In fact, should any more buildings be erected on the spur of the hill, as indicated on the map, bricks or stone will have to be used on account of the difficulty in planting posts in the rock.

[No. 75.] *From*—Lieut.-Col. C. H. Dickens, R. A., *Secy. to Chief Commr., Central Provinces, in the P. W. Dept.,*

No. $\frac{1368}{455}$, dated 21st July, 1864.

To—*Secretary to Government of India, P. W. Dept.*

I am now directed to report, for the information of His Excellency the Governor General in Council, the proceedings taken under this Administration in regard to the Establishment of the Upper Godavery Circle.

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2. The orders of the Government of India, conveyed in your Office Nos. 970—2 of 6th, and 1063 of 15th June 1863, were communicated to Captain Haig on the 23rd July, and he replied in his No. 234 of 15th August, submitting a proposal as follows :—

Divisions, &c.	Rupees, monthly, omitting fractions.				
	Engineer Establishment.	Upper Subordinates.	Lower Subordinates.	Office Establishment.	Total.
	Rs.	Rs.	Rs.	Rs.	Rs.
Superintending Engineer	1,094	...	...	302	1,396
1st Barrier Division	3,117	1,443	50	1,285	5,895
2nd Barrier Division	550	714	125	184	1,573
Total Public Works Establishment ...	4,761	2,157	175	1,771	8,864
Transport and Supply Division	941	1,222	50	596	2,809
Medical Establishment	...	...	...	...	1,158
Grand Total	5,702	3,379	225	2,367	12,831
Or annually					1,53,972

3. He represented that the then existing establishment was—

	Rs.
Engineer	4,761
Upper Subordinates	2,157
Lower Subordinates	225
Office	1,771
Transport Department	2,809
Medical	1,158
Total monthly	13,881

4. He explained in detail the difference between these Establishments, and those sanctioned in the Government Resolution above quoted, and observed that the excessive amount of Subordinate Establishment referred to by the Government of India, was owing, in a great measure, to the Officers of the steamers and Supply Agents, who, though graded with the Public Works Establishments, were not really chargeable to "Construction," and that a great deal of this kind of Establishment charges was ultimately recovered in the payments made from the wages of work-people for provisions supplied, and so also of the transport of stores for the works.

5. These proposals of Captain Haig's not being accompanied by the prescribed Tabular Statements, these were called for, and received with his letter No. 656 of the 27th November last.

The scale included for the Superintending Engineer and two works Divisions—

	Rs.
Annually	
Controller's Office	1,27,000
Medical Establishment	24,000
Transport and Supply	12,000
... ...	38,000
Total annually	2,01,000

In this was included an Executive Engineer for the 2nd barrier, together with an establishment for carrying on the works there. In the event of a proper contractor being procured, a modified proposal for the Transport and Supply Department would be submitted.

6. In preparing the Budget, it appeared that the scale proposed in the tables would be too high; and they were accordingly returned by Colonel Elliot's order with a letter No. 102 of the 27th January last, for revision to meet the proposed Budget expenditure, with an intimation that when the 2nd barrier estimates had been submitted, an application would be made to Government for a farthe rgrant of money, with a proposal for the necessary establishment for carrying on the work.

7. Captain Haig replied on the 23rd February (No. 998) saying that the 2nd barrier estimates were nearly ready, and that even with an allotment of eight lakhs, he thought he could make important progress in the works, but that he would defer his proposals till the estimates had been sent in. He, therefore, forwarded Tabular Statements, of which the following is an abstract:—

		Rs.	Rs.
	Engineer Establishment.		
1 Superintending Engineer		1,094	
1 Executive Engineer, 1st Class		900	
1 Special Assistant		500	
7 Assistants		2,663	
	Upper Subordinates.		5,157
4 Sub-Engineers, 3rd Class		861	
13 Assistant Supervisors, Overseers, and Assistant Overseers		1,357	
5 Persons			2,218
	Lower Subordinates.		
Total for construction			175
	Offices.		7,550
Superintending Engineer		518	
1st Barrier Division		1,374½	
2nd Barrier Division		487	
Postal Establishment for both Divisions		108	
	Medical.		2,487½
1st Barrier		810	
2nd ,, ...		111	
	Transport and Supply.		921
Superintendent		941	
Assistant Agent		250	
2 Steamer Captains		400	
1 do. do.		150	
		1,741	
Sub-Engineer, 3rd Class		250	
3 Overseers and Assistant		276	
		526	
29 Serangs, engine-driver and lascars		500	
			2,767
Grand total ...			13,725½
or annually ...			1,64,706

for this, as a scale to work up to, retrospective sanction was asked from 1st August 1863.

8. In his subsequent letter No. 126 of 4th June last, Captain Haig modifies this scale as follows, in reference to his proposals for carrying on the works at the 2nd barrier, as already submitted to Government in my letter No. 1242—90 of 15th instant:—

	Rs.	Rs.
Engineer Establishment.		
Superintending Engineer	1,094	
2 Executive Engineers, 1st Class	2,141	
1 Special Assistant Engineer	500	
8 Assistants	3,168	
		6,903
Upper Subordinates.		
4 Sub-Engineers	1,000	
14 Assistant Supervisors, Overseers, and Assistants	1,390	
		2,390
Lower Subordinates.		
As before	175	
		8,374
Offices.		
Superintending Engineer	518	
1st Barrier	1,374½	
2nd Barrier	717	
Postal Establishment	108	
		2,717½
Medical.		
1st Barrier	810	
2nd ,, ...	568	
		1,378
Transport and Supply.		
Not altered		2,767
Total monthly		15,236½
or annually		1,82,838

9. This scale of establishment, which is not excessive for an expenditure of 10 lakhs of Rupees annually, would have been referred, with remarks to the Government of India for orders, but for the receipt of a telegram dated the 10th instant, in which Captain Haig, referring to the orders of the Government of India on the Budget for the current year, begs that the matter may be held over until a revised scale is submitted by him. It may, therefore, be necessary to address you further hereafter on this subject. Meanwhile, the Chief Commissioner believes that Government will be glad to have this statement of the establishment framed according to the best information at this moment available.

No. $\frac{1000}{1000}$ dated 14th October, 1864.

[No. 76.] *From*—Lieut.-Col. C. H. Dickens, R. A., *Secy. to Chief Commr., Central Provinces, in the P. W. Dept.,*

To—*Secretary to Government of India, P. W. Dept.*

In continuation of my letter No. $\frac{1288}{1311}$, dated 21st July last, I am instructed to forward letter No. 317, dated 22nd idem, from the Superintending Engineer, Upper Godavery Circle, and six statements marginally noted, containing particulars regarding the proposed scale of establishment for the works under his charge.

No. 1. Engineer and Upper Subordinate Establishments, Tabular Statement, Distribution Return, and Abstract.
„ 2. Showing the proposed Establishment for the Superintending Engineer's Office Tabular Statement.
„ 3. Proposed Office and Petty Establishments, 1st Barrier Division, Tabular Statement and Distribution Return.
„ 4. Proposed Office and Petty Establishments, 2nd Barrier Division, Tabular Statement and Distribution Return.
„ 5. Proposed Medical Establishment Tabular Statement.
„ 6. Proposed Establishments for the Transport and Supply Department Tabular Statement, Officers and Office Establishment.

I also submit the Controller's Report upon the proposals made in No. 681 of 11th August last, and General Tabular Statement in two parts as required by your Office Circular No. 36 G of 1863.

2. It will be remembered that, in the communication above referred to, it was explained that the scale previously proposed had been returned by Colonel Elliot's order for revision, to meet the proposed Budget expenditure. Captain Haig, in reply, first proposed an establishment at the cost of Rs. 1,64,706, having retrospective effect from 1st August 1863, and subsequently, in reference to his proposals for carrying on the works of the 2nd barrier, the amount was in his letter No. 128, dated 4th June last, amplified to Rs. 1,82,838; intimation, however, being subsequently given that the matter should be held over until a final scheme then in preparation could be submitted.

3. I am, therefore, briefly to refer to the leading points of this ultimate proposition which the Chief Commissioner desires me to submit for the sanction of Government.

The numerical strength of the proposed Engineer and Subordinate Establishments are as follows:—

	Government Resolution.*	Present Proposals.	Difference. More.	Difference. Less.
Engineer Branch.				
Superintending Engineer, 1st Class	1	1	...	...
Executive Engineer, ,, ...	1	2	1	...
Special Assistant Engineer	...	1	1	...
Assistant Engineer, 1st Class	5	4	...	1
,, ,, 2nd ,, and Probationary	4	4	...	...
Upper Subordinates.				
Sub-Engineer, 3rd Class, and Officers ranking with such	1†	5†	4	...
Supervisors	3	1	...	2
Assistant Supervisors	4	2	...	2
Overseers	3	3	...	...
Assistant Overseers and Probationers	16	8	...	8‡
Lower Subordinates.				
Sub-Surveyors or Overseers, 1st Class	11	...	...	11
,, ,, 2nd ,, ...	3	6	3	...
,, ,, 3rd ,, ...	20	...	...	2
Transport and Supply Department.				
Superintending Engineer	1	1	...	...
Assistant Superintending Engineer	1	1	...	...
Steamer Captain, 1st Grade	2	2	...	...
,, ,, 2nd ,, ...	1	1	...	...
Sub-Engineer	...	1†	1	...
Sub-Agents	...	3	3‡	...

4. It will be perceived that the Engineer and Upper Subordinate Establishments contain a larger proportion than usual in the Upper Grades. As regards the Engineer Establishment, this was unavoidable, since both the Executive Engineers posted to the Godavery Circle were of the 1st Class. If the second Officer to be appointed under para. 16 of your letter No. 4240 of 2nd July last, should be of a lower grade, some reduction may be made in the cost of this part of the establishment.

* No. 970 of 6th June 1863.

† One is the Mechanical Engineer graded by Government of India as Sub-Engineer, included by Captain Haig in the Transport Department. Four Sub-Engineers are, therefore, in excess of previous sanction.

‡ Reduction effected agreeably to para. 11 of the Government of India's orders; see however, three Sub-Agents in Transport and Supply Establishment.

5. The Special Assistant Engineer is Mr. Tyndall; his promotion has been recommended; but orders were deferred pending revision of the Godavery Establishment (Public Works Department Circular No. 53 of 1864).

6. According to the scale laid down in Circular No. 83 of 1862, Captain Haig's scale shows as follows:—

	Government Circular.	Captain Haig's proposal.	Difference. More.	Difference. Less.
Executive Engineer, 1st Class	...	2	2	...
,, ,, 2nd ,, ...	1	...	...	1
,, ,, 3rd ,, ...	1	...	...	1
,, ,, 4th ,, ...	...	...	...	...
Special Assistants	1	1	...	...
First Class Assistants	2	4	2	...
Second ,, ,, ...	6	4	...	2
Total ...	11	11	4	4

But if the note to Circular No. 53 of 1864 be carried out, then the Special Assistant must be struck out, and the number of 2nd Class Assistants increased to five.

7. One of the proposed posts for Sub-Engineer is vacant. Of the other three, two are held by Sergeants Stephenson and McGregor, and Mr. Midford is named for the third. It will be observed in the Circular No. 53 of 1864, just quoted, that the latter Officer has been raised to the rank of Supervisor. The other two have (Government No. 970 of 6th June 1863) received the temporary rank of the grade in which they are now placed by Captain Haig, and Mr. Gilshman was also allowed that work, and in his place Mr. Midford is proposed. The Chief Commissioner would be glad if the same advantage could be conferred on Mr. Midford. With regard to the vacant post, a further communication will follow.

8. According to the scale laid down in your Office Circular No. 43 of 1862, the following is the excess in the scale of rank proposed by Captain Haig:—

	Government Circular.	Captain Haig's proposal.	Difference. More.	Difference. Less.
Sub-Engineer, 1st Class	...	...	...	1
,, 2nd ,, ...	1	...	...	...
,, 3rd ,, ...	1	4*	3	...
Supervisors	1	1	...	1
Assistant Supervisors	3	2	...	3
Overseers	6	3	...	...
Assistant Overseers	6	8	2	...
Total ...	18	18	5	5

* Excluding the Mechanical Engineer.

9. Possibly the Government of India may be disposed, however, to make some exception of these scales in the case of the Godavery Establishments; see on this subject No. , dated

10. The proposed expenditure aggregates—

	Rupees monthly, omitting fractions.					
	Engineer.	Upper Subordinates.	Lower Subordinates.	Office and Petty.	Monthly Total.	Annual Amount.
Superintending Engineer ...	1,094	...	...	404	1,498	
1st Barrier	3,370	1,881	120	1,391	6,762	
2nd Barrier	2,290	474	65	717	3,546	
Attached to Transport and Supply	...	250	...	...	250	
Total P. W. Dept. ...	6,754	2,605	185	2,512	12,056	
Transport and Supply Department	...	...	...	...	2,763	
Medical	...	...	...	...	1,308	
Grand Total ...	...	...	...	...	16,127	

or annually Rs. 1,93,524.

11. A comparative statement is annexed marginally. It exhibits a net increase of Rs. 12,276 annually on Government Resolutions Nos. 970—72, dated 6th June 1863, but this amount is calculated to meet the requirements of an establishment for an outlay of 10 lakhs or 10¼* lakhs, including the amount that will probably be expended at Sironcha.

	Government Resolution.	Proposed Expenditure.	Increase.	Decrease.
	Rs.	Rs.	Rs.	Rs.
Engineer Upper and Lower Establishments	8,048	9,511	1,196	...
Office	1,858	1,744	...	114
Petty Establishment ...	644	744	100	...
Establishment	...	24	24	...
Medical	692	1,308	616	...
Transport Establishments ...	2,862	2,763	...	99
Total ...	14,104	16,127	2,236	213
N. B.—Rs. 640-14, omitted in the table to the Government Resolution, has been added. For details of re-distribution of the table, see Tabular Statement.				
Net increase per month, Rs. 2,023. Annually, Rs. 12,276.				

* 8 lakhs Budget allotted.
2 ditto since applied for.
1 ditto for Sironcha.

12. The Controller has recorded his opinion that he does not consider it excessive under the peculiar circumstances of the case. The English writers and peons are in excess of the usual number, but, in the first instance, sickness is to be provided for, and, in the second, duties connected with the issue of grain to work-people, case of stores, &c., must be taken into consideration.

13. On the entire P. W. Expenditure, the proposed establishment gives a percentage of 23·45 per cent. out of an outlay of 8¼ lakhs, or 18·87 out of 10¼ lakhs. But if the cost of the Transport and Supply Department and of the Medical Establishment, which are unusual and peculiar to this Circle, be deducted, the percentages for comparison with ordinary P. W. Establishments will fall to be 17·15 and 13·80 on the above amounts respectively. This seems moderate, and the Chief Commissioner trusts that the Government of India will feel disposed to concur with Captain Haig that the proposed establishment is fairly allowable.

14. The Chief Commissioner solicits your attention to Captain Haig's 14th para., giving his unqualified assurance that the orders of Government in Resolution Nos. 970—2 were at once carried into effect on their receipt nearly a year ago, and that there has been no lack of effort to bring the establishment within the lowest possible limits compatible with efficiency.

15. I am instructed also to point out that, as the proposed scale is the one that has been actually in force as a maximum to work up to during the past year, sanction is requested with effect from the 1st May 1863.

No. 317, dated 22nd July, 1864.

[No. 77.] *From*—Captain F. T. Haig, R. E., *Superintending Engineer, Upper Godavery Circle,*

To—*Secretary to Chief Commissioner, Central Provinces, in the P. W. Dept.*

With reference to para. 33 of the Central Provinces' Budget Orders for 1864-65, extract of which has been received with your docket No. 853 of the 21st ultimo, I have the honour to submit lists of Establishments, as per margin, required for the Upper Godavery Circle.

Engineer and Upper and Lower Subordinate Establishments.
Office Establishment for Superintending Engineer.
Ditto for 1st Division.
Ditto for 2nd ,,
Medical Establishment.
Establishments for Transport and Supply Departments.

These lists are to supercede all previously sent, which, it is presumed, have not yet been submitted to the Supreme Government for orders.

2. With reference to these lists, I beg to observe—

1st.—As regards the Engineer Branch, the scale sanctioned by the Government of India in their Resolution, dated 6th June 1863, Nos. 970—2 was—

1 Superintending Engineer, 1st Class.
1 Executive ,, ,,
5 Assistant Engineers ,,
4 ,, ,, 2nd Class, and Probatfoners.

11

at a cost of Rs. 5,010-14 per mensem.

The scale proposed is—

1 Superintending Engineer, 1st Class.
2 Executive Engineers, ,,
1 Special Assistant Engineer, ,,
4 Assistant Engineers, ,,
4 ,, ,, 2nd Class.

12

at a cost of Rs. 6,753-9 per mensem, causing a monthly increase of Rs. 1,742-11.

This increase is owing to—

	Rs.	A.	P.
Appointment of an Executive Engineer, 1st Class, Major Allen,	1,241	0	0
Increased Military allowance of an Assistant Engineer, 2nd Class, (Lieutenant Begbie) owing to his promotion as Captain	148	4	0
Proposal to promote an Assistant Engineer, 1st Class, (Mr. Tyndall) to the grade of Special Assistant	150	0	0
Appointment of a Military Officer (Lieutenant Harvey) in place of a Civilian (Mr. McKennie)	103	7	0
Promotion of two Probationers	100	0	0
	1,742	11	0

No new appointments will have to be made to raise the Establishment to this strength, one Executive Engineer, 1st Class, and one Assistant Engineer, 2nd Class, (Major Allen and Lieutenant Harvey) having already been appointed to this Circle.

The only change contemplated is the promotion of one Assistant Engineer, 1st Class, (Mr. Tyndall) and of two Probationers (Messrs. Rhind and Scott,) to Special Assistant Engineer, and Assistant Engineers, 2nd Class.

The promotion of the two former Officers, I have already, on more than one occasion, strongly recommended. Mr. Scott not having yet joined, I am not acquainted with his qualifications.

3. As regards the Upper Subordinate Branch, some changes have taken place since the date of the Resolution of the Government of India above referred to, and others are now proposed—

(*a.*)—Instead of one Sub-Engineer, 3rd Class, and two Supervisors with the temporary rank of Sub-Engineers, sanctioned by the Government of India, it is now proposed to have—

One Sub-Engineer 3rd Class, and three Supervisors with temporary rank of Sub-Engineer.

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The change is brought about thus :—

1st.—It is proposed to transfer Mr. Walker, Sub-Engineer, 3rd Class, from the Public Works Establishment to the Transport Department, if this can be done, as is supposed, without injury to his prospects. Mr. Walker is by profession a mechanical Engineer. He was sent out from England under covenant, and with the rank of Warrant Officer, and though well qualified as Engineer, and very useful in taking charge of engines, in which capacity he is solely employed upon the Godavery steamers, he does not possess the departmental experience, or professional qualifications, which would be expected from men of the same rank in the Department of Public Works. His salary in his present position appears to be rather less than what he would receive, if paid according to the terms of his covenant, and his transfer to the Transport Service would, therefore, it is believed, involve no hardship or loss of emolument.

2nd.—In the room of Mr. Walker it is proposed to place a Foreman of masonry, the necessity for more skilled supervision of the important masonry works in progress having been much felt.

3rd.—Assistant Supervisor Midford having, it is believed, been recommended by the Chief Commissioner for promotion to the rank of Supervisor with temporary rank of Sub-Engineer, he has been transferred to the higher grade in the present lists.

The above changes account for the increased number of four Sub-Engineers and temporary Sub-Engineers, instead of three as originally sanctioned—

(*b.*)—No change is proposed in the number of Supervisors, which remains, as before, one only, but the incumbent is not the same, Mr. Gilshnan, who was appointed to that grade by the Government of India, having resigned shortly after the transfer of this Circle to the Central Provinces. In his place it is proposed to retain, for the present, Mr. Farley, whose case has already formed the subject of the letters noted on the margin.

Letter, No. 600 c, dated 18th May 1864, from Secretary to Chief Commissioner, Public Works Department.
Reply No 146 c, dated 7th June 1864.

(*c.*)—Instead of four Assistant Supervisors, as originally fixed, the number now proposed is only two, one man, Mr. Harris, having resigned, and Mr. Midford, who held the other appointment, having been transferred to a higher grade, as above explained, in anticipation of his promotion.

(*d.*)—The number of Overseers remains the same as above, but there are changes of incumbency as follows :—

1st.—Mr. Jameson has resigned, as reported in my No. 152 of 10th June ; another man must now be appointed in his place.

2nd.—It is proposed to transfer Mr. Eaton from the regular Public Works Establishment to the Transport Service. Mr. Eaton is employed solely in that service, and as he has declined the examination recently held of all the Upper Subordinates on the temporary list, with a view to their being brought on to the permanent strength of the Department, there appears to be no special reason why he should be retained in any other staff than that of the Transport Service on which he is actually employed. An additional Overseer being required for the 2nd Barrier, supposing active operations to be commenced there as recently proposed, Mr. Eaton's place is intended to be filled up by the appointment of a man to that Division.

(*e.*)—The number of Assistant Overseers was fixed by the Government of India at Sixteen. Of them five were very shortly afterwards sent back to their Corps ; others have resigned, and the number now proposed is eight only.

The cost of the Upper Subordinate Establishment, sanctioned by the Government of India, was Rs. 3,127.

That of the Establishment now proposed is only Rs. 2,355.

4. With regard to the Lower Subordinate Branch, 34 Sub-Overseers were sanctioned by the Government of India, but under a misapprehension. The greater part of these men being only common maistries, whose pay is chargeable to the works, their names have been removed from the list and it is now proposed to retain six only in this grade, of whom three have yet to be appointed.

The cost of this branch of the Establishments will thus be Rs. 185 per mensem, instead of Rs. 990, as sanctioned by the Government of India.

5. The total cost of the Executive Establishment now proposed will be Rs. 9,293-14 per mensem, against Rs. 9,128-13-8 sanctioned in Resolution Nos. 970—2 of 6th June 1863.

The proposed changes, therefore, involve an increase of Rs. 165 per month, but provide for an efficient staff of Officers and Subordinates, consisting of—

2 Executive Engineers, 1st Class.
1 Special Assistant Engineer, and
8 Assistant Engineers, as well as
18 Upper and 6 Lower Subordinates.

This Establishment is intended for the expenditure of 10 or 10½ lakhs, *viz.*, the Budget allotment of 8 lakhs, and two lakhs more since applied for.*

* Besides the amount that will probably be expended at Sironcha.

It should be distinctly understood, in regard to all these Establishments, that the numbers shown under the head of "present scale" are those fixed by the Government of India in their Resolution Nos. 970—2, and not those that have been retained during the past year, or that are now in existence. The latter are, and have been, very nearly the same as those now proposed.

6. Office and Petty Establishments, Tabular Statments for the Office of the Superintending Engineer, and for those of the two Executive Engineers, including the Sub-Divisional Offices, are herewith submitted—

1st.—As regards the Superintending Engineer's Office, no remarks are necessary, as the scale proposed is, I believe, much below that usually allowed for similar Offices, that is, Offices of Chief Engineers, 3rd Class, and Superintending Engineers having the powers of such.

0·8 per cent. on the total expenditure is considered very fair on account of such Offices. Taking, therefore, the expenditure for the current year, 10 lakhs, the amount available for Superintending Engineer's Office Establishment is Rs. 8,000 or Rs. 666 per mensem, or supposing that the extra grant of two lakhs applied for is not sanctioned, still the amount is, calculating on the eight lakhs allotted, Rs. 6,400 or 533 per mensem. The proposed scale will cost only Rs. 404. This being a new Office and no Establishment, properly so called, having yet been sanctioned for it, that shown under "present scale" is only a part of the late District Engineer's office with which the Superintending Engineer opened his new Office. This can, therefore, bear no comparison with the proposed scale, and is only put down with a view to show the total of such Establishments for the whole Circle on 1st May 1863, so that a general comparison may be made with those now proposed.

7. The Tabular Statement for the 1st Barrier Division shows the proposed Office and Petty Establishments for the Executive Engineer's Office and those of the four Assistant Engineers in charge of Sub-Divisions. The number of Clerks proposed for the Executive Engineer's Office alone, is, as will be seen from the Distribution Statement attached, four, at a cost of Rs. 235. This might, in comparison with the scales allowed for similar Offices in other Districts, seem excessive, but when the peculiar circumstances under which these works are carried on, and the difficulty of obtaining efficient men are considered, the scale of salaries proposed, *viz.*, Rs. 100 for the Head Clerk, and Rs. 60, Rs. 40, and Rs. 35 for the other three will not be thought too high. Besides the four Clerks, there have been proposed for this Office, a Draftsman on Rs. 50, a Cashier on Rs. 50, Treasure Guard and four Office Peons costing Rs. 62, making a total of Rs. 397 per mensem for the Executive Engineer's Office.

8. The Establishments proposed for the Sub-Divisional Offices are according to their several requirements, and the details for each Sub-Division will be found in the Distibution Statement.

To each of these Offices it is proposed to attach, on an average, four Clerks (English and Vernacular) on salaries ranging from Rs. 50 to 15, a Store-keeper on Rs. 20, and a number of Office and Store Peons, and Chowkeedars on Rs. 7 and 6 per mensem.

It is only for the third Sub-Division Office, which is about 20 miles distant from the Executive Engineer's Office, that a Cashier and a Treasure Guard, the necessity for which will be apparent, have been proposed.

For the Divisional store which is, to some extent, the general store of the whole Circle, a Store-keepeer on Rs. 50 has been put down.

The cost of Establishments for the four Offices is Rs. 955, or an average Rs. 239 for each.

The total cost for Office and Pety Establishments, as proposed for the 1st Barrier Division, is Rs. 1,376 per mensem, or Rs. 16,512 per annum, for an expenditure of 4¾ lakhs on works, thus giving a percentage of 3·45.

10. The Office and Petty Establishments proposed for the Executive Engineers and the Sub-Divisional Offices of the 2nd Barrier Division, amount, in all, to Rs. 717. The details for each Office are shown in the Distribution Statement attached. The Establishments proposed will not be entertained in full until the additional grant of two lakhs applied for is sanctioned, and the anicut works commence.

The probable expenditure in this Division during the current year being about 2½ lakhs, including the works at Sironcha, the percentage for these Establishments will be like that of the 1st Barrier Division, about 3·48 on the expenditure on works.

11. The entire Public Works Establishments proposed for this Circle would, therefore, cost Rs. 11,790-14 per mensem, or Rs. 1,41,490-8 per annum, giving a percentage of 17·68 on an expenditure on works, of eight lakhs, and of 18·15 on the proposed total allotment of ten lakhs.

12. Along with the above proposals for the organization of the regular Public Works Establishments, I beg to submit a Tabular Statement showing the Establishments required for the Medical Department attached to this Circle.

It has been proposed to place an Assistant Surgeon in each of the two Divisions. There is already a Medical Officer (Dr. Houston) in the 1st Barrier Division, and it is proposed to have another such Officer for the 2nd Division also. The unhealthiness of the climate, and the number of European Officers and Subordinates, and of Natives, that will be attached to the Division, render it highly desirable that there should be an experienced Medical Officer on the spot. In my letter No. 126 of 4th ultimo, I have entered in detail into the causes which have led me to recommend the appointment of such an Officer, and I beg now to refer to it.

The Assistant Apothecary, now in the 2nd Division, will not then be required, and may therefore be transferred.

The proposed Medical Establishment, consisting of two Assistant Surgeons, eight Dressers, and Hospital Assistants, and a number of inferior servants and attendants, will cost Rs. 1,307-10-6 per mensem, or Rs. 15,691-14 per annum.

13. The only other Miscellaneous Department attached to this Circle is the Transport and Supply Agency.

The Establishments proposed for this Department are shown in the Tabular Statements.

It has been proposed above to transfer a number of Subordinates, *viz.*, one Sub-Engineer, 3rd class, one Overseer (temporary) and one Assistant Overseer, also temporary, now borne in the lists of regular Public Works Establishments, permanently, to the Transport and Supply Department to which they are already attached.

The Establishments now proposed for this Department are the same, with scarcely an exception, as those which have been employed for the past year.

Having in previous communications entered at full into the questions of the necessity for, and constitution of, this Department, further reference to the subject on the present occasion appears to be unnecessary.

14. With regard to the remarks in the latter part of the 32nd para. of the Budget Orders, on the supposed delay of much required reforms in the Establishments of this Circle, I beg to point out that the orders of the Government of India, in Resolution Nos. 970—2, were at once carried into effect on their receipt very nearly a year ago. The Establishments were cut down to the fixed limits, and have been so retained ever since.

The Government of India may not have been fully informed as to what has actually been effected in this way, but it is an entire misapprehension to suppose that the re-modelling of Establishments, in accordance with instructions received last August, has been at all postponed, or that there has been any lack of effort to bring these Establishments within the lowest limits compatible with efficiency.

I do not think the scales now proposed can be considered otherwise than moderate, and if so, it should be borne in mind that they represent, with only very trifling differences, those actually in operation for the past year.

Lists, prepared in communication with the Deputy Controller, were submitted for sanction on the 28th November 1863. They were returned for revision in February, and sent back in the course of a week. Nothing has since been heard of them.

Lists, for the present year were also submitted along with the Budget for this Circle, and as the scales therein proposed were intended for a total allotment of 14 lakhs, it is not surprising that they should appear excessive for one of eight lakhs.*

15. As regards the organization of this Circle in separate Executive Divisions, I would observe that, my letter No. 451 of the 16th March 1863, contained distinct detailed propositions to this effect, and as the arrangements therein proposed have actually been carried out, I presumed that the matter was settled.

* Upon what information the statement made in the Budget Orders, that one Executive Engineer had 16 Clerks in his Office and another 12, was based, I cannot conceive.
The number should be divided by four to arrive at the truth.

I will now, however, repeat what I then proposed.

The river is divided into three sections; the 1st, extending from the Madras Frontier in the Eastern Hills up to the head of the 1st barrier, forms the 1st Division; the 2nd, extending from the top of the 1st barrier, to that of the 2nd, forms the 2nd Division; and the 3rd, similarly defined between the 2nd and 3rd barriers, forms the 3rd Division.

As, however, the operations are at present limited to the 1st and 2nd barriers only, the 1st and 2nd Divisions do practicably include only the rocky reaches of river which the works at these two points are intended to improve.

The Distribution Statement which accompanies, gives the names and rank of the several Officers and Subordinates attached to each of these Divisions.

These are, I presume, all that are required for publication, and that similar details are not wanted for the Transport and Supply and Medical Departments.

16. In requesting sanction for the Establishments now proposed, from the 1st May last, I would point out that a portion of the expenditure on Establishments during the past year, and up to the present time, remains unsanctioned.

I propose to submit bills, which the Executive Engineers will be instructed to furnish for this amount, for sanction, at an early date, with a view to the adjustment of the past expenditure.

No. $\frac{776 \text{ A}}{2859}$, dated 18th March, 1865.

[No. 78.] *From*—Lieut.-Col. W. Maxwell, R. A., *Secy. to Chief Commr., Central Provinces, in the P. W. Dept.*,

To—Secretary to Government of India, P. W. Dept.

I am desired by the Chief Commissioner to acknowledge receipt of your letter No. 1048C —5489, dated 21st November last, calling for a full report on the Transport Service of the River Godavery.

2. The previous correspondence on this subject is quoted in the margin. In that correspondence a general outline of the character of the Transport Agency, and its operations, present and prospective, was given. The orders of Government recorded thereon was, that the Agency which was essential to the works in progress should be limited to a scale that would suffice for the requirements of the Engineering Department; that until the works were completed, the Government must doubtless keep whatever vessels were wanted for its own transport business connected with the works, quite irrespective of any commercial traffic; though at the same time it might accept all freight that could be carried without inconvenience to the prosecution of the works, so as to make the most of its position and means. It was further remarked that, the freight of the Engineers would be mainly upwards—the downward trips of the vessels being available for the freight which might be economically accepted at a trifle above the rates that would pay the actual extra expenses. But to enable Government to deal properly with this, among other questions connected with the important undertakings on the Godavery, a detailed report on the present condition of the transport branch of the operations, and of the systen followed in all its transactions, was called for.

To Secretary to Government of India, Department Public Works, No. 125, dated 31st January 1863.
Government in reply, Nos. 1350-53, dated 10th July 1863.
To Secretary to Government of India, Department Public Works, No. 85, dated 24th January 1863, forwarding printed Godavery Report (paras.—126 to 130).
Government in reply, No. 1388, dated 14th July 1863 (para. 19).

3. I am to express Mr. Temple's regret at the delay which has occurred in the submission of the required Report, partly owing to the unfortunate confusion in which the Secretariat records had fallen last year, and partly to the impression that the subject had already been fully laid before Government in the previous correspondence. But from the papers since put together, and the more recent information on points of detail obtained from the Superintending Engineer of the Godavery Circle, I am now to submit as follows, in further and fuller detail on the subject, for the information and orders of His Excellency the Governor General of India in Council.

4. The Transport Agency then was called into existence soon after the commencement of operations on the Godavery in 1861. It was designed for the conveyance, by means of a Flotilla of Steamers and Boats, of materials and Public Works stores, of Officers and employés, to the several points on the river where works were in progress, and for the conveyance of food to the large bodies of workmen there employed.

5. The Flotilla consists of 8 Steamers, and 22 Flats and Cargo boats, besides a few Punts of smaller size, thus described :—

Name of Steamer.	Length.	Beam.	Draught.	Gross Tonnage.	Nominal horse-power.	Present speed in still water.	Age.	Present value.
	Feet.	Feet.	Feet. Inches.	Feet.		Miles per hour.	Years.	Rs.
"Prince"	150	24	2 6	194	60	10	3	45,000
"Hope"	114	13·4	1 3	46	15	6½	3	9,860
"Arthur Cotton" ...	119	16	2 0	45	25	7	7	2,000
"Trevelyan"	175	24	2 3	225	40	8½	5	30,000
"Shamrock"	92	12	2 3	38	15	7	5	10,000
"Queen"	114	13	2 4	47	22	7	5	10,080
"Rose"	92	12	2 3	38	15	7	5	10,000
"May Flower"	95	9	2 2	25	15	6	5	8,000
						Total ...	...	1,25,940

The boats are as follows :—

	Tonnage.
8 of 80 tons	640
1 of 55 ,, ...	55
13 of 45 ,, ...	585
Total ...	1,280

6. The Flotilla is distributed as follows :—

	Steamers.	Boats (Tonnage).
In the 1st Reach of the river, between Dowlaishwurum and the 1st barrier.	"Prince" ... "Arthur Cotton" ...	480
In 2nd Reach	"Hope" ... "Trevelyan" ... "Shamrock" ... "Queen" ...	575
In 3rd Reach	"Rose" ...	180
In 4th Reach	"May Flower" ...	45

7. The steamers in the 1st Reach are employed in bringing up rice and stores from the Coast. Those in the 2nd Reach are almost entirely employed in towing down lime-stone from the quarries on the Tol River to the 1st barrier. In the 3rd Reach, the steamers are not fully made use of, and will not find full employment till the works on the 2nd barrier are commenced with. In the 4th Reach, a small steamer (the "May Flower") is idle and laid up.

8. The Establishments employed are as follows :—

	Total.	Transport.	Supply.
	Rs.	Rs.	Rs.
1 Superintendent	940	470	470
4 Assistant Superintendents, 1 @ 245, 2 @ 100, and 1 @ 50	495	247	248
1 Mechanical Engineer	250	125	125
3 Commanders of Steamers ...	550	275	275
Office and Petty Establishments ...	406	184	222
Subordinate Transport Establishment :—			
	Rs.		
2 Store-keepers	50		
1 Mohurrir	14		
3 Maistries	36		
7 Peons	44		
	144	144	...
Carried over	2,785	1,445	1,340

Brought forward ...	2,785	1,445	1,340
Temporary Establishment for retail sale of food :—			
	Rs.		
3 Purveyors	80		
2 Mohurrirs	40		
8 Gomashtas	120		
140 Peons	280		
	520	...	520
Total monthly ...	3,305	1,445	1,860
Per annum ...	39,660	17,340	22,320

9. The duties of this Establishment are two-fold : (1) the performance of actual transport operations, and (2) the purchase, storage, and retail sale of food to the work-people. Thus the charge is debited in the accounts against the Transport and Supply branches in the proportions above shown. There are yet other charges of a contingent and fluctuating character, such as repairs of steamers, and the like, loss in the retail sale of grain, whether by dryage, accidents on the river, &c.

10. For the past year, 1863-64, the cost incurred may be abstracted thus :—

	Rs.
Transport Department Establishments :—	
Permanent	14,780
Temporary	1,502
Contingencies	536
Total ...	16,818
Supply Department Establishments :—	
Permanent	14,600
Temporary	10,290
Contingencies	536
Total ...	25,426

11. During the current year, the Superintending Engineer has found it practicable to limit the duties of the Supply Department to the purchase and storage, at the upper and lower end of the works, in two buildings, of the year's supply of grain and other necessaries; the retail sale, at a fixed price, being farmed to Contractors—thus relieving the Government Agents of the duties and expenses connected with the transport of food from point to point of the barrier, and the loss from storage and retail sale. The charges for the year 1864-65 may accordingly be thus stated :—

	Rs.
Transport Department Establishments :—	
Temporary	
Permanent	13,352
Contingencies	982
Total ...	14,334
Supply Department Establishments :—	Rs.
Permanent	13,216
Temporary	6,677
Contingencies	982
Total ...	20,875

12. Now, it will be remembered, that these supply operations were first undertaken from the very necessities of the case. No private agency could be induced to come forward to supply food, although every effort was made by advertisement in the Local Gazettes of the Coast Districts, and otherwise. The country along the river is poor, sparsely populated, and only raising sufficient food for its own consumption. Thus an establishment from the very first had to be organized to collect food from the Coast, and from distant markets in the interior; to make advances to the Bunjara traders to bring in grain, to store this food at convenient places, and to convey it for distribution to the work-people where employed. Coolies and labour could not be obtained without the guarantee of a regular supply of food at a fixed and cheap rate. Thus, to enable the Department to supply rice at sixteen seers the rupee, and pay its own expenses, it was incumbent on it to purchase in the cheapest market; these

lay hundreds of miles away—on the Coast; in the interior of the Nizam's country; in the wilds of Bustar. It was supposed that the Agency could perform the duties expected of it without cost to Government, *i. e.*, that the difference between the purchasing and selling price of the grain would cover all charges on account of establishment and contingencies. The result has certainly been all but attained during the past year. During the current year it is confidently expected to be more than attained, as will be seen from the following statement:—

	Rs.
During 1862-63, the selling price of grain to the workmen was fixed at 20 seers the rupee. The outlay on account of grain and necessaries, inclusive of transport charges, establishments, and contingencies, was	1,83,620
The receipts, at 20 seers per rupee	1,68,750
Loss ...	14,870

13. For this result two causes were assigned: (1) the selling price was fixed too low; and (2) funds for the purchase of supplies were not supplied in time to admit of extensive purchases in the cheaper market—consequently coast rice had to be purchased at sixteen seers the rupee, at a heavy loss.

14. For 1863-64 the selling price of grain was fixed at sixteen seers the Rupee—

		Rs.
Total expenditure on account of purchase of food, establishments, contingencies, &c.		1,98,346
Cash receipts by sale of food, at sixteen seers the Rupee		
Value stock in hand	Rs. 1,23,772	
Value stock supplied to works to be adjusted by transfer	„ 53,731	
	„ 6,000	1,83,503
Loss ...		14,143

Of this loss, Rs. 9,784 is the value of rice lost by inundation, leaving the net loss in the transactions of the year, from other than exceptional causes, Rs. 5,109 only.

15. Now, if we consider the vital necessity that exists for this food supply, that without it the important works on the river would be brought to a stand still; that at least no competent private agency has yet come forward to undertake the work, nor is likely to come forward, when the profits would be uncertain, or at best inconsiderable,—the results above stated may not be deemed very unsatisfactory, and, but for the unfortunate accident by flood, and the untimely supply of funds above alluded to, would be rather satisfactory than otherwise, and the Chief Commissioner trusts it will so appear to His Excellency the Governor-General in Council.

16. Then for the current year, and judging from the transactions as far as they have gone, with the selling price of rice still at sixteen seers the Rupee, it is estimated that the cost of the year's stock, inclusive of all charges for establishments, contingencies, &c., will be Rs. 1,82,400, whilst the receipts will be Rs. 1,92,000: profit Rs. 9,600.

17. The Estimate is based on the reasonable expectation of the larger proportion of the rice being purchased from the Bunjaras at twenty-seven seers the Rupee, and by the retail sale business being farmed to Contractors at a small premium, in kind, of one seer for every sixteen seers sold and paid for. If these expectations be realized, the success of the year's operations will, in part, cover the loss of the two previous years; and, it is hoped that, with care, and with the attention that is now turned to this branch of the operations, the whole previous loss will be more than covered in due time. Under these circumstances, I am to solicit the sanction of Government to the writing off the previous year's losses in the accounts.

18. Beyond the introduction of the contract element to the extent above mentioned, *i. e.*, the *retail sale* of supplies already purchased and stored by the Department, the Superintending Engineer has no hope of any further extension of the Contract system in the supply operations under consideration; and considering the extent of the transactions, the capital involved, the nature of the country along the river, the local experience and influence that would be necessary, the Chief Commissioner agrees with the Superintending Engineer in believing that the collection of supplies could not be safely entrusted to any private trader likely to offer to contract for the business, and that the provision of an unfailing and certain supply of good and cheap food to the work-people, who have come great distances from their homes, is, in the interest of the important works in progress, fully sufficient to justify the retention of the Supply Department,—as it would be, to bar any experiment with a private agency, in view to a possible or conjectural saving of a few thousand Rupees, at the risk of inflicting injury to the works, which it might take some time to recover.

19. I am now to proceed to explain the operations of the Transport Department.

These consist of the transport by water and land of all materials and stores in connection with the works, and food for the work-people.

	Tons.
The quantites carried during 1863-64, were, by river—	
Materials, almost wholly limestone, for 1st barrier	3,387
Public Works stores	404
Private baggage and goods...	50
Rice and provisions	904
Salt	222
Total ...	4,967
The quantities carried by land during the same period were ...	1,406
Total by land and water	6,373

which, reduced to an unit of tons carried one mile, would be equivalent to 304,787 tons moved one mile.

20. Now, the total expense of the whole Agency is given by the Superintending Engineer at Rs. 63,146 during the current year, inclusive, it is believed, of charges of all kinds, establishments, contingencies, repairs of vessels, &c., &c., but exclusive of Rs. 13,000 for permanent establishments not chargeable to the Transport Agency. Taking the amount of work done, and the charges incurred on that account, as afore-stated, the cost of carriage per ton per mile would fall at the rate of three and a quarter annas. This result may not at first sight appear altogether satisfactory; the rate of carriage per ton per mile by water and by land, but mainly by water, above-stated, is about the same as the cost of land carriage only. The ordinary water-carriage rate is at one anna per ton per mile, or even less. But there are several points to be considered before the actual results of the Transport Agency can be said to be unsatisfactory. First, the three steamers, "Trevelyan," "Rose," and "May-flower," with crews maintained for some months, had no work to do on the Reaches of the river where they are situated, except one trip by the "Trevelyan," between the 1st and 2nd barriers; the cost of these steamers is, therefore, at present, a charge upon the works, for which there is no return. Again, it will be remembered that, steamers are employed as a means of communication between the places where work is in progress, and for the cost of which no credit is taken in the accounts; then, land carriage at the barriers has to be maintained, to some extent, during the rains, when the work done is less than the average, and a great part of the goods moved is carried only very short distances, such as three to ten miles; and lastly, most of the steamers are not fully efficient, and not fully equal to the amount of work required of them; they have been some years in use, and their machinery is a good deal strained and shaken by the high pressure to which, from their want of power, it has often been necessary to raise the steam. All these exceptional causes raise the rate of carriage unduly. The value of the Transport Agency cannot, therefore, be fairly measured by the actual freight rate resulting from last year's operation. The Agency is admitted to be essential to the works in progress; and making due allowance for the exceptional circumstances above-mentioned, it may be held to have done fairly well. The result might have been better had traffic offered to be carried by the down-trip, but none offered during the year. It would, perhaps, be well that no traffic did offer till the navigation works at the barriers were in a more advanced state: and till then the cost of the Agency must necessarily fall heavy upon the work, more particularly till the extension of the works to the 2nd barrier shall have brought the whole strength of the Transport Service into full play. The Superintending Engineer will, however, be called on to report specially what economies are practicable, in view to equalizing the Agency to the immediate wants of the engineering works in hand.

21. Regarding the steamers themselves, I am to extract below the Superintending Engineer's description of those now in employ. It is stated that not one of the steamers upon the river was built for this service:—

"The "Prince" was originally sent out for a Ferry at Baizwarrah on the Kistna; the "Trevelyan" for a Ferry at Rajahmundry; the "Shamrock," "Rose," and "May-flower" were built and sent out for the Coast Canal, a still-water navigation; the "Arthur Cotton" and "Queen" were built at Dowlaishwurum, chiefly for towing purposes in the anicut and Delta works; the "Hope" was also built there, and fitted with engines and boilers which had been sent out from England for other purposes. This steamer was only intended for the shoal navigation:—

Thus for the monsoon navigation of the river, we have not a single steamer built to suit its peculiar requirements. All that we have, have been considerably improved since we received them. They were originally placed upon th; Godavery, because no others were available; and we were content to take them, and by careful observation and improvement, to make the most of them e and, upon the whole, they have done good service, though ill-adapted to the river. Two or three are still capable of, and worth some, additional improvement; but one, the "Arthur Cotton," is pretty well used up; and another, the "Trevelyan," is, and, indeed, always has been, unserviceable from her low speed and size.

23

With the extension of the works up river to the 2nd and 3rd barriers, there will necessarily be a considerable increase to the transport operations, while, instead of being in a position to meet such increased demands upon the present Flotilla, we find it insufficient even for existing requirements, and have difficulty in keeping it up even to its present state of efficiency.

It is essential, therefore, that additional steamers should be procured with as little delay as possible. I will bring forward some definite propositions with this view, after hearing from the makers in England the precise description of steamers they would recommend to fulfil all the conditions required.

Meantime I would propose that the steamer "Trevelyan" should be returned to the Madras Government. * * * * No use can be made of her on the upper river; but it is possible that she might be of service as a ferry boat at Rajamundry. * * * Her present value is estimated at Rs 30,000."

22. The Superintending Engineer will be requested to report further with reference to the future strength of the Flotilla, which he considers necessary on the extension of the works up-river to the 2nd and 3rd barriers.

23. The Madras Government will also be requested to take the "Trevelyan" at what she is now valued by Captain Haig.

24. In conclusion, and as containing Mr. Temple's views on the character and operations of the Transport Service, I am to annex the following paras. from his Report on the Godavery in 1863, which was forwarded with this Office letter No. 85 of the 20th January 1863:—

"126. In connection with the works, I should advert to the Transit Agency. At present there is a River Flotilla of vessels plying between the several reaches as given below:—

Transit Agency.

"On the first Reach (between the Sea and the 1st Barrier),
The "Prince."
The "Hope."

"On the second Reach (between the 1st and 2nd Barriers),
The "Sir Arthur Cotton."
The "Shamrock."

"On the third Reach (between the 2nd and 3rd Barriers),
The "Queen."
The "Rose."

"On the fourth Reach (between the 3rd Barrier and the falls of Wurdah),
The "May-flower."

These are serviceable vessels, though not always suitable as tugs; they draw from two to four feet of water. They carry officers and employés of the navigation works up and down the river; they convey stores of all kinds, and tow boats laden with materials, and perform a variety of service of this kind. In these respects, they have been most useful; and, as the works proceed, they will become vitally necessary. Indeed without them it would be almost impossible to carry on the works, as at present there are absolutely no other means of communication. But besides the above departmental work, the steamers have brought up a quantity of Commissariat stores and other articles belonging to Government. During the past season,—*i. e.*, the rainy season of 1862,—the navigation department established an agency, and undertook to carry mercantile goods, partly by water, and partly by land, across the barriers, for one anna (1½ *d.*) per ton per mile. This was done with a view to making a commencement in opening the route to commerce; and to testing the tendency, or otherwise, of trade in this direction. It was calculated that, if the Agency received 5,000 tons down-river, and 2,000 up, the transit operations would be carried on at a profit to the State. During this year, 1862, though the steamers plied regularly, the land carriage at the barriers was quite incomplete. Still the Agency, during the season, conveyed 1,200 tons of goods, and 2,000 passengers. The greater part of the tonnage, however, consisted of Government stores. The only articles of importance, in the way of private merchandise, was a consignment of about 700 bales of cotton, belonging to Mr. Stanbrough, a gentleman who had received an advance of Rs. 20,000 from Government in order to embark in the undertaking.

127. The question then arises as to whether the Transit Agency shall be maintained during the next and subsequent year?—In my opinion it should be maintained *for Government work alone*, and should *not* undertake, by advertisement or otherwise, to convey general merchandise. For the work of the

Should be maintained for Government work alone.

navigation department, the Transit Agency will be indispensable; for carrying various consignments of Government stores, it will be useful. The above work will, I believe, furnish it with ample occupation. It has no room nor scope for the conveyance of general merchandize. Our Officers have enough to do in attending to their own proper business. The cares and responsibilities of a general Transit business, which does not regularly pertain to them, only distracts them from their official work, and it can hardly be expected that they would perform such extra business with efficiency; nor do I perceive what particular advantage is to be gained by the arrangement. The route, partly by steamer and partly by land, is confessedly a temporary one, which it is not proposed to perpetuate. Why, therefore, should commercial experiments be made upon it? Why should an attempt be made to force traffic on the river before the navigation is open? The rate proposed, one anna (1½*d.*) per ton per mile is no doubt moderate, and *if* goods, partly by land and partly by water, could *really* be conveyed for that rate, with profit to the transit, no doubt the conclusion would be valuable. But it is very difficult to estimate actually *all the costs really incurred* in a *Government* Transit Agency, and the results arrived at might be partly real and partly apparent, and might not be a safe guide to private enterprise. If they were favourable, there would be doubt as to whether all those subsidiary charges (so difficult to estimate in Government undertakings of this sort) had been included. If they were adverse, it would be said that, after all, they proved nothing, as the route was avowedly incomplete. As a matter of fact, however, I do not believe that the present results show, what would be commercially considered, a profit to the transit. I learn that the receipts, chiefly consisting of freight on Government stores, at one anna (1½*d.*) per ton per mile, were last season below the expenditure. This circumstance does certainly militate against the supposition that the Agency could profitably carry goods at the one anna (1½*d*) rate in the present imperfect state of the communication. I should doubt whether it could afford to do this. But this consideration does, in no wise, prejudice the navigation project. Nor does it affect the interests of Government; for, whether, the transit can, or cannot, carry the stores for one anna per ton per mile, it is at all events much cheaper than the ordinary land carriage. It may be said, in favour of having a General Transit Agency, that the operation affords valuable experience in the river, which will be of use when the navigation is open. To this it may be replied, however, that such experience is gained by working the Agency for Government purposes alone, without undertaking other business.

Without undertaking any commercial work.

128. On the other hand, there is some disadvantage in any commercial undertaking on part of the Government Transit Agency, inasmuch as its failure in this respect (which is more probable than its success) would be apt to create a prejudice in the minds of merchants against the Godavery project altogether. It were better far to wait till the navigation works are finished, and then the traffic will follow of itself. If it be really important to open the Godavery route, (and I believe it to be so) the works should be pushed on without delay. To force traffic by the river, whilst the works are under construction, would be to divert the attention of our Officers from their real duty, and to delay the completion of the works upon which all our energies should be concentrated.

129. For these reasons, I should recommend that the Transit Agency be maintained for the Government work alone, without undertaking anything else.

130. It may be added, in this place, that, when the navigation shall be open, there will be no difficulty in the building of boats in any number, at any point of the river. There is everywhere abundance of serviceable timber close at hand. The boats constructed by Government have cost Rs. 1,000 and 1,200 Rs. each; but it is believed that boats, sufficiently good for general purposes, could be built for Rs. 500 each."

No. 62, dated 17th November, 1864.

From—*Her Majesty's Secretary of State for India,*

To—*The Government of India.*

[No. 79.]

I have had under consideration in Council, your Excellency's despatches Nos. 48 and 59 of 2nd July and 4th August last, on the subject of the

Godavery Navigation Works. Among the papers which accompanied these despatches, are two letters from the Chief Commissioner of the Central Provinces, and three illustrative drawings, together constituting, as you say, the only Report which has ever been rendered to your Government of the state of the works. The Report is not very explanatory, but could scarcely be less satisfactory as far as it goes.

2. It appears that, during the year 1863-64, a sum of Rs. 4,23,591 was expended at the first barrier, yet that the progress made there was only 13 per cent. of the work remaining for execution at the beginning of the year. At this rate, the work at the first barrier alone will cost more than the amount originally stated by Captain Haig as the probable expense of opening 473 miles of navigation from Dowlaishwurum upwards, and more than the amount which, so lately as the 23rd January 1863, was mentioned by Mr. Temple as likely to suffice for rendering the river navigable to the foot of the third barrier. With such decisive proofs before you of the worthlessness of all past calculations, it would be highly improper to allow operations based upon them to be continued with the same absence of check or control as heretofore.

3. You have intimated to the Chief Commissioner of the Central Provinces that, unless the detailed plans and estimates, so repeatedly called for, are speedily submitted in a complete form, you may be under the necessity of stopping the works, and there can be no doubt that it will be incumbent upon you to do so rather than run any further risk of committing yourselves to an indefinite expenditure on account of them.

No. 1479, dated 26th July, 1864.

[No. 80.] *From*—Lieut.-Col. C. H. Dickens, R. A., *Secy. to Chief Commr. of Central Provinces, in the P. W. Dept.,*

To—*Secretary to Government of India, P. W. Dept.*

I am directed to acknowledge receipt of your letter No. $\frac{429 C}{277}$ of the 2nd instant, conveying observations and instructions by His Excellency the Governor General in Council, on the subject of the works on the Godavery; and to state that, while the Chief Commissioner has the satisfaction of finding that his views on this important matter are approved by the Government of India, he regrets to find that, on some points, the Supreme Government has remained without information for so long a period.

2. This is partly owing to the unfortunate losses of various papers in the Chief Engineer's and Public Works Secretary's Office, reported in my letter No. 910, dated 24th July 1864. And although the Government of India have thus, for some time past, been without information on these subjects, the Chief Commissioner trusts that the Reports recently submitted have fully supplied this want, and that now a fair amount of information is at last before the Supreme Government.

3. The following is a list of the various Reports, which have now been submitted to the Supreme Government from this Office, regarding the Godavery, in addition to Mr. Temple's general printed Report:—

No. 1066 of 15th October 1863, forwarding the 1st barrier project, delayed, as before explained, and forwarded on 30th June 1864.

" 1209 of 5th December 1863, reporting on the size of steamers and locks for the Godavery, and forwarding Colonel Impey's Report on the Transport and Supply Department.—Duplicate sent on 24th June 1864.

" 125 of 31st January 1863, on the question of obtaining, by private enterprise, the necessary means of conveyance on the Godavery.—Duplicate sent on the 26th July 1864.

" 528 of 5th May 1864, on road-feeders to the Godavery Navigation.

" 909 of 24th June 1864, forwarding Captain Haig's further views on the modification of the 1st barrier project.

" 996A of 4th July 1864, submitting the plans and estimates of the 2nd barrier project.

No. 1075, dated 7th July 1864, reporting the actual progress at the 1st barrier, up to June 1864.

" $\frac{1242}{20}$ of 15th July 1864, forwarding proposals for carrying on the works on the 2nd barrier, and asking for a grant of two lakhs of rupees for this purpose.

" 1398, dated 21st July 1864, reporting on the state of the question regarding the Godavery Establishments and the organization of the Executive Divisions. To these may be add,—

" 920, dated 10th September 1863, on the Kanan Reservoir Project, as a means of adding to the water-supply of the Wurdah; and

" 975, dated 2nd July 1864, regarding the project of the Pench Reservoir for adding to the water-supply of the Godavery.

4. On the above despatches, the orders of Government have not yet been received. In this category, the No. 1239 of the 17th December 1863, reporting on general questions relating to the river, has not been included, as that has been replied to by your letter now under acknowledgment.

5. I am now to advert to those points in your letter under acknowledgment, and which remain to be noticed by the Chief Commissioner. These points appear to be contained in your para. 17, and the subsequent paragraphs.

6. In your para. 17, you observe that the formation of executive charges for the river works remains to be reported on. This has been done by this Office letter No. 1398, dated 21st July 1864.

7. In your para. 18, it is prescribed that the Subordinate Establishments require further consideration, with the view to economy, and that this matter should receive the Chief Commissioner's early attention. This subject has been reported on in the communication just cited.

8. Your para. 19 contains observations regarding the non-submission of estimates, to which observations the Chief Commissioner's best attention has been given. Still, while admitting that there has been delay in some respects, he must still submit that since the works in this river came under the control of this Administration, our very first care has been to secure the preparation of these important documents. The first open season under this Administration was that of 1862-63. During that season the plans and estimates for the 1st barrier were prepared. These embraced, not only the anicut on the river, and the canal to be taken therefrom, but also the various buildings required for the public establishments at the station of Doomagoodium. In the Autumn following they were submitted to the Supreme Government. It is true that, owing to an unfortunate occurrence, they were stolen, but subsequently recovered. The second open season under this Administration was that of 1863-64. During that season, the plans and estimates for the 2nd barrier were prepared. These have now been submitted to the Supreme Government. The third open season under this Administration will be that of 1864-65. If the Supreme Government shall be able to supply the requisite professional establishments, Mr. Temple is confident that, at the end of that season, plans at least, and, perhaps, estimates, shall be furnished for the 3rd barrier and for the river Wurdah above it. These observations apply to the river itself, or its main branches. But, in addition to these plans and estimates, there have been made during the season of 1862-63, and 1863-64, extensive enquiries regarding the means of augmenting the water supply of the navigable channel of the Godavery. The general results of these enquiries have also been submitted to the Supreme Government. The Chief Commissioner hopes that this brief retrospect will satisfy the Supreme Government, that the matter of plans and estimates had at least received the constant care of this Administration.

9. In your para. 20, it is remarked that information had not been received regarding the Transport Service on the Godavery. Upon this subject two Reports were prepared in this Office, one in January 1863, and one in December 1863. In order to make sure of their receipt, duplicates have been submitted; and it is hoped that these will furnish the information required.

10. In your para. 21, it is observed that the active prosecution of works, for which plans and estimates have not been approved, cannot be permitted. The Supreme Government may rely on the Chief Commissioner's bearing this fully in mind. But now that these have been submitted for the first two barriers, he hopes that such an amount of professional assistance, and of financial means, may be afforded, as may ensure the works at those barriers being completed during the next two working seasons,—that is to say, by June 1866. He believes that the supply of competent officers will be a greater difficulty than even the supply of funds.

11. In your para. 22, it is prescribed that our aim should be to produce, in the first instance, and in the shortest time possible, a perfectly definite scheme on which the Government of India should be able to pronounce a final judgment; and to see, with approximate truth, the actual expenditure that will be involved in carrying out the works to completion Here, again, the Chief Commissioner can assure the Supreme Government that he is fully impressed with the importance of the above observation. But the plans and estimates now furnished do only provide for the first two barriers. And it will be in the recollection of Government that, for the reasons explained in Mr. Temple's printed Report, these works, though valuable, as far as they go, do not provide for the entire object of rendering the Godavery navigable. There will still remain the 3rd barrier, the river above it, and the projects for the storage of the water for the additional supply. In order, therefore, to fulfil the behest of the Supreme Government, as conveyed in your para. under explanation, it will be necessary to have plans and estimates made for the following works :—

1st.—Anicut at the 3rd barrier and canal.

2nd.—The minor anicuts on the Wurdah.

3rd.—The road from Chanda to the 3rd barrier.

4th.—The storage reservoirs of the rivers debouching from the hills north of Nagpoor.

If, then, the Supreme Government is to be furnished with the information prescribed in your paragraph under consideration, it will be necessary that the above several matters should be investigated. And, if the requisite professional establishment can be made available, Mr. Temple believes that he can get all this done in a year and a half. To effect this, with the punctuality demanded by Government, the Chief Commissioner would require one Engineer of some experience at the 3rd barrier; another Officer for the Wurdah; one officer (already applied for) for the road; and two Assistants, placed under the orders of Mr. Hanna, the Executive Engineer of the Irrigation Department of these Provinces. In all, three Executive Engineers or Special Assistants, and Assistant Engineers, in addition to whatever establishments may be allowed for the 1st and 2nd barriers, and for the Transport Service. Should there be any difficulty in deputing so many Officers, and if the Supreme Government would be pleased to sanction the establishment as above sketched, the Chief Commissioner would endeavour, by searching, to find qualified Officers who would be willing to undertake work in this part of the country.

12. In your para. 23, it is stated that if, in order to get the works properly planned and estimated, further assistance should be necessary, a reference to you should be made by the Chief Commissioner; and that the Supreme Government are willing that this great project should be promptly carried out, and that, in fact, everything in a reasonable way for this object has hitherto been done by Government. While thankfully acknowledging the many sanctions which have already been received for these works, Mr. Temple has been encouraged by the above observations to make the proposals contained in the foregoing paragraphs for additional Officers.

13. In our 24th para. attention is drawn to the despatch of the Right Hon'ble the Secretary of State, on the subject of the Godavery; and it is observed, that it will be the first duty of this Administration to keep the Government supplied with information upon this subject. Mr. Temple trusts that this despatch, together with the other despatches to which it refers, will be found to supply at least much of the information required. If upon any specified point further information be needed, every effort will be made to supply it.

14. To conclude, the general object of this despatch is explanatory, with a view to convey a comprehensive notion of all that has been done, or proposed, up to date. The only specific proposition which Mr. Temple has at this moment to make, is as follows :—

To obtain sanction to the following appointments :—

One Executive Engineer, or Special Assistant, to prepare the estimate for the 3rd barrier.

One Executive Engineer or special Assistant to examine, in detail, the valley of the Wurdah, with a view to planning small anicuts at various points.

One Executive Engineer, or Special Assistant, (already applied for) to make estimates for the road from Chanda to the foot of the 3rd barrier.

Two Assistant Engineers, to assist Mr. Hanna in making plans and estimates for storage reservoirs.

The detailed Tabular Statements will follow, for consideration in the Financial Department, on a general approval being intimated to what is now prepared.

Nos. 930—3 C, dated 13th September, 1865.

[No. 81.] *RESOLUTION,—By the Government of India, P. W. Dept.*

Read again—

Resolution No. 5088—90A of 29th December 1862, on the subject of the transfer of the Godavery Works to the Central Provinces. [*Proceedings, Communications, December* 1862, *No.* 57.]

Letter to the Chief Commissioner of the Central Provinces, No. 1388 of 14th July 1863, approving of the suggestion in Mr. Temple's Report on the Godavery. [*Governor General's Proceedings, Communications, July* 1863, *No.* 5.]

Letter to the Chief Commissioner of the Central Provinces, No. 422C of 22nd July 1864. Re-affirming that decision. [*Proceedings, Communications, July* 1864, *No.* 18.]

Read also the following papers :—

Connected with the 1st Barrier Works.

Secretary to the Chief Commissioner of the Central Provinces, No. 1066 of 15th October 1863, forwarding plans and estimates for the 1st barrier works (received 21st June 1864).

Secretary to the Chief Commissioner of the Central Provinces, No. 1736 of 4th August 1864, fowarding duplicate copy of Captain Haig's No. 333 of 1st September 1863, on the subject of the 1st barrier project.

Secretary to the Chief Commissioner of the Central Provinces, No. 909 of 24th June 1864, forwarding Captain Haig's No. 1236 of 26th April 1864, proposing a modification of the 1st barrier project.

Secretary to the Chief Commissioner of the Central Provinces, No. 1514 of 27th July 1864, forwarding a communication from Captain Haig, supplying certain information regarding the Godavery River.

Secretary to the Chief Commissioner of the Central Provinces, No. 3168 of 26th September 1864, forwards certain particulars regarding the flood levels of the Godavery.

Secretary to the Chief Commissioner of the Central Provinces, No. 1209, dated 5th December 1863, regarding size of locks on the Godavery (received 1st July 1864).

Secretary to the Chief Commissioner of the Central Provinces, No. 7538-2684, dated 10th March 1865, reporting sanction to the prosecution of the locks on the 1st barrier canal.

Public Works Department Telegram No. 44, dated 20th March 1865, sanctioning above.

Secretary to the Chief Commissioner of the Central Provinces, No. 442 of 20th May 1865, submitting revised project for works at the 1st barrier.

Connected with the 2nd Barrier Works.

Secretary to the Chief Commissioner of the Central Provinces, No. 996A of 4th July 1864, forwarding plans and estimates for the works at the 2nd barrier.

Letter from Secretary to the Chief Commissioner of the Central Provinces, No. $\frac{1242}{90}$, dated 15th July 1864, submitting proposals for the prosecution of the work on the 2nd barrier.

Secretary to the Chief Commissioner of the Central Provinces, No. 1935 of 12th August 1864, forwarding copy of Captain Haig's No. 467 of 22nd October 1865, reporting on the works proposed for the 2nd barrier.

Secretary to the Chief Commissioner of the Central Provinces, No. 2860—701 of 15th September 1864, fowarding proposal by Captain Haig for procuring steamers machinery, and plant from England for the 2nd barrier.

Secretary to the Chief Commissioner of the Central Provinces, No. 5094A, dated 6th December 1864, with accompaniments, submitting estimate for works supplementary to the project for the 2nd barrier. [Received on 1st June 1865, with Memorandum No. 523, dated 26th May 1865.]

Connected with the extension of the communication to the North-West, the question of Establishment, &c.

Secretary to the Chief Commissioner of the Central Provinces, No. 1398—155, dated 21st July 1864, regarding the Upper Godavery Circle Establishment.

Secretary to the Chief Commissioner of the Central Provinces, No. 3699-1040, dated 14th October 1864, on the same subject.

Secretary to the Chief Commissioner of the Central Provinces, No. 7791A of 18th March 1865, reporting on the Transport and Supply Department.

Despatch from Her Majesty's Secretary of State, No. 62 of 17th November 1864, remarking on the Progress Report of the 1st barrier works.

Secretary to the Chief Commissioner of the Central Provinces, No. 1479, dated 26th July 1864, on the further prosecution of the enquiries in regard to the Godavery Project.

Secretary to Chief Commissioner of Central Provinces, No. $\frac{47}{1865}$, dated 6th January 1865, reporting arrangements made for the survey of the road from Chanda to the foot of the 3rd barrier. [*Establishment, Proceedings, February* 1865, *No.* 41, *Part B.*]

Public Works Department to Chief Commissioner of the Central Provinces, No. 165E. dated 28th January 1865, approving of the steps taken. [*Establishment, Proceedings, February* 1865, *No.* 42—*Part B.*]

OBSERVATIONS.—The control of the works for opening out the navigation of the Upper Godavery, was transferred from the Madras Government to the Chief Commissioner of the Central Provinces, from 1st May 1863. In the Resolution of the 29th December 1862, in which, with the approval of the Secretary of State for India, this transfer was ordered, the Government of India approved of the suggestion made by Mr. Temple (Officiating Chief Commissioner), to confine the works for the present to the opening out of the 1st and 2nd barriers, and carrying the navigation up to the foot of the 3rd barrier.

2. On receipt of Mr. Temple's more detailed Report on the Godavery, the Government of India* reaffirmed this decision, and at the same time agreed in the necessity for constructing a road from the foot of the 3rd barrier to Chanda, to complete the connexion of the navigation with the road system of the Central Provinces, and open the communication with the cotton-bearing districts south of Nagpoor.

* No. 1388, dated 14th July 1863.

3. It was at the same time laid down that, the navigation works were not expected to be open for more than four or five months of the year (during the rainy season), owing to the deficiency of the natural water-supply of the river; and that, for the present, agreeably with Mr. Temple's suggestions, the Government of India was not disposed to prosecute any works for increasing the natural supply of the dry season.

4. The works which it was proposed to undertake were at that time roughly estimated to cost the following sums:—

	£
First Barrier Works	120,000
Second ditto	70,000
Works below foot of 3rd Barrier	65,000
Road to Chanda	45,000
Total	£300,000

5. The opinion of Captain Haig, R. E., the Superintending Engineer, and original projector of the works, was, however, invited on the subject of limiting the project, and after receipt of his Report, with Mr. Temple's remarks thereon, the above determination of the Government of India was again affirmed in a letter No. 422 C, dated 22nd July 1864. The approval of the Secretary of State had, in the mean time, been given to the same decision.

6. In all these communications on the subject of the Godavery Works, the Government of India strongly urged the necessity for the early submission of definite and complete designs and estimates; and although the works commenced in 1861 on the 1st barrier were allowed to go on, pending the revision of the first estimate, no other work was to be commenced until after the submission of detailed and definite projects.

7. On the 26th July 1864, the Chief Commissioner forwarded an explanation of the delays which had occurred in the preparation and submission of the projects, and furnished other information called for, and explained the steps which had been taken, and were recommended for the completion of the information required by the Government of India.

8. About the same time the detailed projects for the 1st and 2nd barriers were received, and a further revised project for the 1st barrier has since been submitted as promised.

9. The receipt of the detailed estimates for these projects now enables the Government of India to revise the general estimate of the entire cost of the works as contemplated for early construction. And it may be added that, in regard to the cost of the road, recent experience shows that in the Central Provinces a road which must be available for heavy traffic, especially in the rainy season while the river is to be open, cannot be constructed under £1,000 per mile, and it may be safer to estimate its cost at £1,200. Further, it seems necessary to carry the communication to the Civil Station of Seroncha, which is some miles lower down the Godavery, than the foot of the 3rd barrier. On the whole, the cost of the scheme of works now contemplated, is likely to be as follows:—

	£
1st Barrier Works	105,000
2nd ditto	130,000
Works between 2nd and 3rd barriers ...	65,000
Road 125 miles, at £1,200	150,000
Total ...	£450,000
Of this, work has been done to the extent of about	60,000
Leaving still to be carried out ...	£390,000

10. But to this the charge of establishments must be added, which, on these works, must include a medical establishment, and the establishment for working the steamers and supplying provisions. Also, provision must be made, both in additional pay and additional numbers, for the prevalence of sickness. Thus the establishment altogether will come to about 25 per cent. of the entire outlay, or, which is the same thing, to 33⅓ per cent. on the cost of the works as estimated, exclusive of establishment.

	£
Thus, to	390,000
Add 33⅓ per cent.	130,000
And the result gives the total sum still to be spent, as	£520,000

11. In part of this sum an assignment of £55,000 has been made in the Public Works Budget-Estimate of the Central Provinces for 1865-66, and the balance of £465,000 has still to be provided in future years.

12. Before proceeding to contemplate the provision of the outlay for the future, it will be well first to review the expenditure already incurred.

13. An account received from the Madras Government gives the expenditure prior to 1st May 1863, as follows:—

		£
1855-56-57	...	13,347
1859-60-61	...	7,926
1861-62	...	36,179
1862-63	...	56,697
Captain Haig's supplemental account	...	37,403
Total	...	£151,562

The account from the Central Provinces for the succeeding two years, is—

		£
1863-64	...	55,662
1864-65	...	78,951
Total	...	£134,513
Making the entire expenditure up to May 1865		...£286,075

14. The record of the expenditure is so far defective as not to admit of a satisfactory analysis. But as far as can be made out, the following are the main heads of charge:—

		£
Tramways	...	52,335
Improvements in river bed	...	6,001
1st barrier Works.		
Before 1st May 1863	...	£41,156
Since ditto	...	£44,711
		85,867
2nd barrier, preliminary charges	...	9,878
Establishment charges assumed as one-fourth of the entire expenditure	...	71,519
Balance apparently representing steamer block,* materials, and advances outstanding	...	59,875
Total	...	£286,075

15. The charge for tramways is due to the first intention of the Madras Government, on commencing the works in 1861, to construct tramways round the barriers before the navigation works were completed, so as to secure a temporary communication at an early date. This plan was given up after Mr. Temple's visit to the works in August 1863. It is further to be remarked that the work done on the 1st barrier, prior to May 1863, is exclusive of that included in the late revised project, which only includes work remaining to be done on that date. How much of the old work is utilized in the new project has not been distinctly reported.

16. The Chief Commissioner of the Central Provinces has been requested † to have the accounts more completely analysed, and to submit a fresh abstract account showing distinctly the charges,—(A), for abandoned work in the tramways and in the 1st barrier; (B) for work which is to form part of the final project now in course of execution at that barrier; (C), for establishment exclusive of all other charges; (D), for the block of the steamers and cargo-boats, and for machinery and tools; (E), for materials available for use on the works, and (F), for advances and materials which cannot be worked off, and are therefore contingent charges on the works. It is believed that the defect in the accounts is not in the original record, but only in the abstracts submitted to the Government of India.

17. As the account stands, however, it is clear that, on the whole, the expenditure which has already taken place is all but the full sum originally contemplated by Mr. Temple as sufficient to complete the series of works to the extent recommended by him. And yet not more than half the work required at the 1st barrier, according to the latest returns, is yet done; and none of the other works have as yet been touched.

18. This is no doubt due in part to the changes of plan already alluded to. The tramway at the 1st barrier has been useful. That at the 2nd barrier has been very little used, and the wood work of many bridges having been destroyed by jungle fires, the whole has been dismantled. Some of the materials, it is believed, will come into use in the navigation works.

19. This result of past expenditure is not encouraging. The work was hurried forward, in order to meet the interest felt by the English public, before the designs and estimates were fully matured or sufficiently considered. And the consequence, no doubt, is that, to a great extent, the money hitherto spent upon the project has produced no adequate result. Thus, this instance is added to the many others which have come before the Government of India, of the necessity for insisting on the complete maturity, and careful scrutiny of all projects of magnitude before the work is allowed to be put in hand.

20. The expenditure incurred has already amounted to £286,000 with as yet a comparatively small result; and to complete the works to the extent contemplated, it is necessary to look forward to an outlay of at least £520,000 more. In all, the cost of the works will doubtless not be under £800,000, or four-fifths of a million sterling. It may come up to one million, or even to a million and a quarter, if unexpected difficulties are met with, and if prices continue to rise. And this is to afford, not the entire scheme for a permanent navigation all the year round, as was contemplated by the original projectors, but a river navigation of 309 miles from the Sea, for four or five months of the year, supplemented by a road of 125 miles to Chanda, to connect the navigation with the roads of the Central Provinces, and bring it into contact with the Great Indian Peninsula Railway at about 60 miles from Chanda. The whole distance from the Port of Coconada to the Great Indian Peninsula Railway, will thus be 459 miles. The entire line of navigation which will be opened out by the works now contemplated from Ganapawaram at the foot of the 1st barrier, to Dewalmurree at the foot of the 3rd barrier, is 186 miles; and the road to Chanda, 75 miles more, makes the line from end to end 261 miles; adding the 50 miles of road between Dewalmurree and Sironcha, the entire length of communication embraced in this project becomes 311 miles. The cost to the State will thus not be under £2,572 per mile; or looking to the additional sum now to be spent only (£520,000), it is £1,672 per mile. Or if it be thought more fair to calculate the cost upon the whole distance of the naviga-

* The flotilla now employed consists of 8 steamers and 32 cargo-boats. The reported value of the 8 steamers is £12,594.—See Reports from the Central Provinces, No. 7791 A, dated 18th March 1865.

† Letter No. 74 A, dated 17th August 1865.

tion from the Sea to Dewalmurree (309 miles), the whole communication by navigation and road will come to 434 miles, and the cost from first to last, as estimated, will not be under £1,843 per mile, or the prospective outlay only not less than £1,198 per mile.

21. It thus appears that, on any calculation, the cost of the communication by the Godavery (even only the prospective cost), will exceed that of a metalled road for the entire distance estimated, according to the usual cost in the Central Provinces. But in this case, in order to make the comparison fair, it is necessary to take in the cost of the establishment to be employed in constructing the road, and to add something on account of the difficulty of the country. Taking the cost of the works only at £1,200 per mile as before, and adding as before one-third for the cost of establishment, the charge would come up to £1,600 per mile. Thus making the cost of the road more than the prospective outlay, according to the calculation of the last paragraph; but still not so much as in the calculation based on the distance actually to be opened out. Navigation is no doubt a superior mode of communication in many respects; but its superiority can hardly be considered so great as to make a navigation open for four or five months in the year, better than a metalled road open during the entire 12 months.

22. If the calculation be made to take in the expenditure from the first, it is clear that the difference is very greatly against the navigation project; and had the cost of the whole project originally been understood to be as it now appears, it is probable that the work would never have been undertaken. Possibly it would never have been recommended by the projectors.

23. But taking the prospective outlay only, the probable cost on the lowest estimate is not above £1,200 a mile on the entire distance from the sea, and possibly the cost of a road might have been as high in such a locality. Certainly, with the cost of establishment added, it would exceed that sum—mounting up to £1,600 probably.

24. In this view, then, considering only the amount of the prospective outlay, the line of communication by the Godavery may not be thought so costly as to render it advisable to abandon the work. Although there is little apparent result from the large expenditure heretofore incurred, knowledge and experience have been gained, which may now be turned to account on the works. To abandon the works now would be to throw all this away, and to loose a considerable sum which may now be actually turned to account by completing the works. Thus it appears to the Governor General in Council possible that, upon the whole, Her Majesty's Government in England may deem that it will be best to prosecute the works to completion, on the scale recommended by Mr. Temple.

25. To carry out such a determination, there are two modes of procedure open to the Government. One is to go on with the 1st barrier works until they are completed; and then, after that, to begin with the 2nd barrier, and from thence with the road, until the communication at last shall be open from the sea to Chanda. But this mode of proceeding, though it would unquestionably be the safest, and would have other advantages, would be very slow. The expenditure already incurred, and that to be incurred for several years to come, would remain unfruitful for a long period. Moreover, although the country is thinly-peopled and poor, and great difficulties are experienced in getting labour, still the sites of the works are so far apart, the efforts to obtain labour would not greatly interfere with each other. The works

in fact, for the 1st barrier 2nd barrier, and Chanda road would, to some extent, draw upon separate labour markets for their supplies of workmen.

26. The Government of India will not in this place do more than record the circumstances, so far as now known, upon which an opinion may be based, as to whether the works shall be proceeded with or not, or whether, if carried on, they shall be carried on over the whole line, or confined for the present to completing the 1st barrier works. The final decision on this point must rest with the Secretary of State, who will be addressed on the subject. And to aid in the decision, it seems desirable to obtain a report from Engineers of reputation and experience, after an inspection of the work done, and of the site of the intended works. The Governments of Madras and Bombay will be asked to furnish officers to take part in this enquiry. But, meanwhile, it seems desirable to lay down the course of procedure that it may be advisable to adopt in case the ultimate determination should be to proceed with the works simultaneously to the full extent of Mr. Temple's proposals.

Grant of Funds for the Work.

27. In case it should be determined to proceed with the works, therefore, it is desirable to consider what would be the provision of funds necessary, in order to prosecute the works on the whole line of communication simultaneously. To do this with reasonable vigour, a larger annual grant than five and a half lakhs (£55,000) should, for the future, be devoted to this object. Funds have to be provided to the extent, in all, of £465,000. Less than £90,000 per annum will not suffice to complete the works with the degree of rapidity that is reasonably requisite to bring into use the capital to be sunk in the construction. Perhaps more could not easily be spent with advantage in a poor and thinly-peopled country.

28. The grant for Civil Works in the Central Provinces was reduced with those for other Administrations in the Budget-Estimate for 1864-65, in order to allow of increased expenditure on providing improved accommodation for the troops throughout India; and it appears that the grant for Civil Works cannot be further cut down to provide more money for the Godavery Works. It will be necessary, therefore, to provide an extra grant of three and a half lakhs (£35,000) for the Central Provinces for 1866-67, in order to the vigorous prosecution of the Godavery Works, in case the Secretary of State for India should be disposed to sanction the prosecution of the works on the whole line, as here indicated.

This sum should provide for the steamers and plant required from England for the 2nd barrier, as well as for commencing the works at site.

Establishments.

29. In regard to the projects and proposals now before the Government of India, it is to be observed that there is no estimate yet for the works between the 2nd and 3rd barriers which form part of the proposed series of works; nor is any estimate yet ready for the road to Chanda. The Chief Commissioner reported last January that the surveys for the latter work had been put in hand, and it is presumed that some progress has been made with them, and that, therefore, there would be no difficulty in speedily submitting matured projects for one or two sections of the road on which work might be begun at once, while the project for the remainder is being completed. The establishment under the Executive Engineer appointed to the road works must,

therefore, include the means of carrying on the survey, as well as work of actual construction. And the establishment for the 2nd barrier must, in the same way, include what is necessary to complete the project for the works between the 2nd and 3rd barriers.

30. In considering, then, the letters from the Chief Commissioner, No. 1479, dated 26th July 1864, and No. 3699, dated 14th October 1864, the Governor General in Council thinks it best at once to lay down the scale of establishment which would be suitable for carrying on the works, if the above scale of operations in regard to them should receive the approval of the Secretary of State for India. As the subject has received much consideration, it seems desirable to record the results arrived at now, so that there may be no further need for discussion and delay when the time for action arrives.

31. The following table embodies the conclusions the Government of India have arrived at on this branch of the subject:—

Table of Establishment for carrying on the works of the Upper Godavery.

	Superintending Engineer.	Executive Engineers.	Assistant Engineers.	Upper Subordinates.	Lower Subordinates.	Accountants.	Office Clerks.	Draftsmen.	Office servants.	Cashiers and Store-Keepers and Moharrirs.	Marine Officers and Transport Agents.	Lascars and Ferry Officers.	Medical Officers.	Native Doctors and Dressers.	Hospital servants.	NOTES.
									Rs.							a. 1 on 150= 150 2 on 70= 153 4 on 60= 240 5 on 50= 250 6 on 40= 240 5 on 30= 150 23 = 1,170
Superintending Engineer ...	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
1st Barrier Division.	...	1	3	3	4	1	4	1	25	4	...	...	1	3	12	
2nd Barrier Division	...	1	3	3	4	1	5	1	20	3	...	...	1	2	9	
Road Division. ...	...	1	3	3	4	1	5	2	15	3	...	...	1	2	4	
Transport and Supply Agency	...	1	...	1	4	1	4	...	15	4	9	44				b. 1 on 80= 80 2 on 60= 120 3 on 50= 150 6 = 350
Total ...	1	4	9	10	12	4	23	6	90	14	9	44	2	7	25	
Approximate monthly cost.	1,500	2,800	3,000	1,500	600	400	170	350	90	560	1,260	700	1,100	285	220	c. 1 on 80= 80 1 on 60= 60 2 on 50= 100 2 on 40= 80 4 on 30= 120 4 on 25= 100 14 = 540
							d.	d.		d.	d.		f.	g.	h.	d. 2 on 250= 500 1 on 200= 200 2 on 150= 300 1 on 100= 100 2 on 80= 160 8 = 1,260
																e. 1 on 35= 35 9 on 25= 225 10 on 20= 200 24 on 10= 240 44 = 700
																f. 1 on 600= 600 1 on 500= 500 2 = 1,100
																g. 2 on 50= 100 2 on 40= 80 3 on 35= 105 7 = 285
																h. 2 on 24= 48 11 on 8= 88 12 on 7= 84 25 = 220

Total per mensem, Permanent Establishment	Rs.	16,175
Total per annum, Permanent Establishment		
Add for Temporary Establishment, including Treasure Guards and Postal Peons	"	1,94,100
Add for travelling allowance and contingencies, at 10 per cent. on Permanent Establishment	"	11,490
	"	19,410
Grand total per annum, being equal to 25 per cent. of an outlay of nine lakhs annually	Rs.	2,25,000

32. This establishment would be required for the entire conduct of the works, and would be inclusive of what is already employed on the 1st barrier works. The addition to the provincial establishment of the Central Provinces, on orders being given to proceed with the entire series of works, would, therefore, be the difference between what is now employed on the Godavery Works, and the scale above laid down.

33. The Superintending Engineer, whose services have lately been utilized for the general work of the Department in the Central Provinces, must, in case of the works of the Godavery being taken in hand on the scale above contemplated, be given up exclusively for the supervision of the works of the Godavery Circle; and other arrangements must be proposed for the works of the Nagpoor Circle where he is now employed.

34. The Transport and Supply Agency has hitherto been maintained as a separate charge, to provide for the carriage of materials, and for procuring and distributing the food for the work-people, which has to be obtained from a distance. From the Chief Commissioner's Report on this subject, No. 7791 A, dated the 18th March 1865, it seems clear that this agency must be kept up for the present, until it is certain that supplies will be procurable in the ordinary course of trade. The establishment should be reduced as far as is consistent with the work to be done, and any of the boats not likely to be of use, should be sold or otherwise brought into use. The losses on the transport and supply transactions must be borne by the rates of the estimates, and should be charged off to the works accordingly.

35. Proceeding now to the matters more immediately connected with the works, the 1st Barrier Revised Project is the first to be noticed.

1st Barrier Proj

36. The works at the 1st barrier were begun before the transfer of the projects to the Central Provinces Administration. The Madras Government intended at first to confine the operations to the tramways round all the barriers, having steamers to work between, and leaving the permanent works for after consideration. But on the suggestion of the Government of India in 1861,* the permanent works at the 1st barrier were allowed to go on, based on Captain Haig's first detailed estimate for an anicut and 25 miles of canal, amounting to Rs. 9,59,000, (£95,900), and they have been in progress ever since.

* Papers ordered by House of Commons to be printed, 18th February 1862, page 134, letter No. 2407, dated 5th July 1861.

37. In the course of the progress of the works and of the discussions which took place, it was found desirable to modify the project as regards the size of the locks and the site of the dam. It is not explained how much of the work first constructed has been thrown out of use. But the new project framed by Mr. Schmidt, the Executive Engineer under Captain Haig in 1863, does not include any of the works done prior to 1st May 1863. This project amounts to 35 lakhs (£350,000). It was submitted to the Chief Commissioner of the Central Provinces with Captain Haig's letter No. 333, dated 1st September 1863.

38. Captain Haig and Mr. Schmidt, however, differed in opinion as to the nature of the works required. The latter Officer wished to pass all the drainage under the canal, while Captain Haig considered that it might, with advantage and economy, be passed through it. Captain Haig therefore sent up with Mr. Schmidt's project, a rough estimate of the cost of carrying out his own views. The amount of this was Rs. 16,34,289 (£163,429). The Chief Commissioner in his letter

No. 1066, dated 15th October 1863, submitted these estimates to the Government of India, recommending sanction to bo accorded to Captain Haig's. This letter, however, miscarried, and it was not until June 1864 that the papers reached the Government of India. Further information was then found necessary, and was obtained; and in October 1864, the the matter was taken into consideration.

39. Captain Haig had meanwhile put in hand the preparation of a detailed estimate for his project, and the immediate submission of this was promised. It was, however, delayed, and Captain Haig having been obliged to proceed to England from ill-health, the estimate when prepared by Mr. Isaac, the Executive Engineer of the works, was submitted by Major Stoddard (Captain Haig's *locum tenens*). This estimate amounts to Rs. 17,08,963 (£170,896), and was received with the Chief Commissioner's letter No. 442, dated 20th May 1865. Mr. Isaac agrees with Mr. Schmidt that the plan of passing the drainage through the Canal is not advisable. Major Stoddard recommends certain alterations tending to reduce the cost of the works within Captain Haig's rough estimate of Rs. 16,34,287 (£163,429). These modifications are approved: but as some enhancement of rates is to be apprehended, the project will, in this Resolution, be treated as from Mr. Isaac's figures.

40. In the meantime, in a letter No. 616, dated 16th November 1863 (Public Works Proceedings, July 1864, No. 17), and subsequently in No. 1236, dated 26th April 1864, forwarded with the Chief Commissioner's No. 909, dated 24th June 1864, Captain Haig urged the advantage of postponing, for the present, the execution of the work on twenty-two miles of the canal, being satisfied to connect the water above the anicut with that below, by a short canal with barge locks at its tail, which he states would be sufficient to maintain the navigation for four months of the year for steamers, and for six or eight months for boats. The cost of the lock would not exceed Rs. 20,000 (£2,000), and of the blasting operations necessary to render navigable the main channel in the portion of the barrier below, would come to Rs. 15,000 (£1,500). Three times that sum would make the navigation in this lower part of the barrier practicable for steamers. The entire cost of the additional work required was not stated; and though urged by the Chief Commissioner to prepare a detailed design and estimate, Captain Haig had not done so.

41. This modification of the project, if the lock and connecting channel be made fit for the navigation of steamers, precisely suits the views of the Government of India of affording a communication by steamers for four or five months of the year; and the Chief Commissioner will accordingly be directed to cause a detailed design and estimate to be prepared, and the works to be put in hand accordingly as soon as it has been approved. All further works, on such parts of the canal which will not come into use under this arrangement, will at once be stopped.

42. It thus becomes unnecessary to discuss the doubtful points respecting drainage in the project for the lower canal. All other parts of the 1st barrier project are approved and sanctioned provisionally, subject to the decision of the Secretary of State as to proceeding with the works.

43. The financial effect of the sanction proposed cannot be precisely stated until the detailed estimate for the shorter canal is received; but it may be approximately estimated. And in order to state the more accurately the amount for which sanction is required, it will be necessary

to take into account the increase of rates on masonry works, which, from the last Half-yearly Progress Report, it appears is likely to come to as much as 30 per cent.

		Rs.	Rs.
Anicut—Masonry	... ...	2,02,013	
30 per cent.	... ...	60,604	
Other works	... ...	49,005	
			3,11,622
Scouring Sluices—Masonry	...	52,695	
30 per cent.	...	15,808	
Other works	...	15,737	
			84,240
Head Lock—Masonry	... ...	67,499	
30 per cent.	...	20,250	
Other works	...	25,553	
			1,13,302
Short Canal with its lock, say, including the blasting operation to open the channel below	... ...		2,50,000
Accommodation for Establishment and shelter for Stores	... ...		80,000
			8,39,164
Add Contingencies @ 5 per cent.	... ...		41,958
Add total cost of work done on Canal from 1st May 1863 to May 1865	...		1,63,245
Total cost of work to be sa[illegible]d	...		10,44,367

44. Of this amount, Rs. 4,47,108 has already been spent on work actually executed, and Rs. 5,97,259 remains to be spent. But there is a considerable stock of materials already laid in, so that, probably, the cash outlay yet required will not exceed four lakhs, exclusive of establishments. This latter may be reckoned at one and half lakhs more.

45. Thus it would seem that the money provided in the Budget for 1865-66 ought to complete the work at the 1st barrier, as now limited. But this is not probable. The difficulties in procuring labor, especially after the late lamentable outbreak of cholera will doubtless prolong the period for completing the works. A portion of the funds of 1855-56 may, therefore, be available for the purchase of the steamers and flats from England for the 2nd barrier works, as mentioned more in detail below.

46. The Chief Commissioner has already given sanction, as reported in his letter No. 2860, dated 15th [illegible]ember 1864 (para. 6), to blasting operations at a cost not exc[illegible] Rs. 10,000, between the 1st and 2nd barriers. This is approv[illegible] Government of India.

2nd Barrier

47. This has been received wi[illegible]hief Commissioner's letter No. 996 A, dated 4th July 1864. The pro[illegible]t consists simply of a dam of large blocks of rough stone across the river, with scouring sluices, and a series of locks on one side. There is no canal. The amount of the estimate is Rs. 11,34,139; but from experience of the 1st barrier works, there is every prospect that there will be a rise of the rates at the 2nd barrier also, so that the cost of the rubble and cut-stone

masonry will exceed the estimate by nearly 50 per cent. But this rise will probably not affect the main item of rough stone work, so that, on the whole, the estimate may not be largely exceeded.

The main items are—

	Rs.
Locks	1,78,021
Guard sluice and wing-walls	1,36,442
Total masonry works ...	3,14,463
Anicut or dam of rough stone ...	6,77,251
Navigable channel below	40,768
Shelter for Establishment and Stores ...	47,650
	10,80,132
Contingencies at 5 per cent.	54,007
Total ...	11,34,139

Allowing for the rise of rates above anticipated, the work is not likely to be completed for less than thirteen lakhs of Rupees.

48. It is observed that Captain Haig, after proposing and examining several projects, at length reverts to his original plan of a simple dam with locks. The general design of the works is approved as suitable and good. But possibly the dam itself may admit of some reduction in dimensions, while the wing and guard walls would, it appears be better if rendered, more lofty and massive, so as to be safer from injury and afford better protection from the floods. The dimensions of the locks must be made 900 × 30 feet. The inner lock walls may, perhaps, be dispensed with if the bank is hard and solid. There would appear to be a want of depth in the chamber of the lowest lock; and, it might be well to have valves to the lock gates as well as in the walls. The separate wing wall to the entrance of the upper lock may, perhaps, be omitted with advantage, joining the lock with a curve to the guard wall of the sluices. These are the only points in the design that seem to call for further consideration.

49. The supplementary estimate, amounting to Rs. 47,650, for shelter for establishments and stores, is sanctioned provisionally to cover the expenditure on the work which has taken place, in order to provide the shelter for the establishment required for preliminary operations. No further expenditure is to be incurred without orders.

50. In a letter No. 2860, dated 16th September 1864, the Chief Commissioner forwards certain proposals of Captain Haig's, connected with the progress of works of the 2nd barrier.

These are—

I.—To procure fr[illegible]gland—

450 Ton[illegible]n rails.
6 Tur[illegible].
10 Cra[illegible] chains.
3 Small Locomotive engines.
60 Sets of iron-works for trucks.
1 Portable engine.
4 Mortar mills.
4 Pug mills.
Corrugated-iron.
Patent Forge.

These will proba[illegible] £10,000.

II.—To order in England—

2 Steamers of iron, 150 × 25 feet.
2 Barges of ditto ditto.
2 Engines, 16 horse-power, to replace those worn out of one of the existing steamers.

The cost of these is set down at £15,500. But probably the cost, landed at Coconada, will come to £20,000.

III.—To procure from England the services of a practical Quarry Superintendent to be graded as a Sub-Engineer in the Public Works Department.

IV.—To obtain, from the Madras Government, the services of a Company of Sappers, and to build lines for them at the 2nd barrier works.

51. The first three of these proposals will be referred to the Secretary of State for favourable consideration and orders, with the remark that the rails should, perhaps, be lighter than 48 lbs. per yard; and that the steamers and barges should be built fully up to the size of locks, which has been fixed by the Government of India at 200 × 30 feet.

52. Some of the articles, and even the steamers, might, perhaps, be procured in Calcutta from the surplus Railway stores; but there would be difficulty in arranging to transport them to Coconada, and, after all, they might not be so suitable as they would be if procured under Captain Haig's own orders in England, and shipped direct to the mouth of the Godavery.

53. The charge for these things will [illegible]ably come to three lakhs, and must be met from the Budget grants for 1865-66 and 1866-67. It is understood that the cost of these things will, for the most part, be prepaid in the savings they will effect on the cost of the works, and that little or no extra charge will then be incurred beyond the 13 lakhs above stated.

Concluding Remarks.

54. Some concluding remarks are necessary on the manner in which these projects have been prepared. It was, as already stated in this Resolution, laid down by the Government of India that, the scheme to be adopted was one for a water communication to the foot of the 3rd barrier, with a road from thence to Chanda; the water communication was to be open only four or five months during the year, and the road to be such as to be open for traffic during the rainy season when the river could be made use of under this scheme.

55. In working up a project to carry out these instructions, it was naturally to be expected that these orders would have been referred to, and that the Engineer's Reports would have shewn that the works devised were such as were necessary, and no more than necessary, for carrying out the object the Government had in view. And, further, it was to be expected that if the entire project could not be submitted as a whole, that at least there would have been some account of the wanting parts, and some rough statement of their probable cost, so that it might be known how each partial project stood related to the whole. But nothing of this sort has been given.

56. In the 1st barrier project there is nothing to show that an anicut or dam was necessary at all for the duration of the navigation

contemplated by the Government of India; and it is clear that the length of canal, contained in the projects of October 1863 and May 1865, was not required, had the conditions specified by the Government of India been attended to, since it has now been proposed to suspend its construction, and to use a shorter canal which it is said will afford navigation for the period specified. If Captain Haig hoped to induce the Government of India to extend the project to a navigation for the entire season and estimated accordingly, he should at least have estimated *also* upon the general scheme which had been laid down for his guidance.

57. Again, in regard to the 2nd barrier project, it has been left for the Government of India to discover whether the works are meant to afford navigation for the entire year or for four or five months, and it is not quite clear that some less height of anicut might not suffice for the latter.

58. Further, no information is given of the state of the river below the 1st barrier, whether it gives now a sufficient depth of water for navigation to the extent contemplated by the Government of India, or whether any further clearances are necessary.

59. In regard to the river between the 1st and 2nd barriers, it is said that certain clearances, involving an expenditure of Rs. 10,000, are necessary to remove obstructions, and it is stated that the work contemplated will open the river for navigation for six months of the year. It should have been stated definitely that it is believed that no further work will be necessary to place the river in a completely satisfactory condition, or what further expenditure is expected to be required.

60. Above the 2nd barrier, again, to the foot of the 3rd, no information is given of the state of the river. If it is the case that time has not permitted any further investigation to be made, and that the sum set down in Mr. Temple's Report is still supposed to be a fair estimate of the expenditure to be incurred, this ought to have been stated. As it is, the Government of India are left to assume that this is the case.

61. Once more, no estimate or rough calculation of the cost of the road is given, and the Government of India is left to frame one for itself, without the assistance of the local knowledge of the Officers employed upon the works.

62. No doubt information on all these points, of more or less precise nature, and of more or less recent date, is to be found by searching through all the Reports that have been submitted on the subject of the Godavery navigation. But the opinions and information on these subjects have varied much since the works were first contemplated; and on the occasion of the submission of the partial projects now before the Government of India, it is clearly proper that a *resumé* should have been given [illegible]rly the state of the information available, and the last [illegible] on each point in question.

63. The Governor General in Council fully appreciates the zeal and ability with which Captain Haig has investigated the project for the navigation of the Godavery, and the difficulties and hardships he has encountered in this pursuit. All his letters show how much he has this object at heart, and how the interest he feels induces him to urge forward the prosecution of the works according to his latest views and opinions. Feeling thus, it is with regret that the Governor General in

Council finds it necessary to remark that the settlement of the question of proceeding with the works for navigation on the Upper Godavery has been rendered difficult, and much retarded, by the want of concise, definite and systematic information.

The provisional sanctions accorded in the above Resolution have been entered as Nos. 63-64 of 1865-66 in the Register of this Office.

ORDER.—Ordered, that a copy of the foregoing Observations be forwarded to the Chief Commissioner of the Central Provinces, for information and guidance.

Ordered also, that a copy of the foregoing Observations be forwarded to the Financial Department for information, with intimation that it is not necessarily implied that an extra grant for Public Works of improvement will be required for 1866-67 in order to carry on these works. It may be arranged within the present total sum allowed for India, but this will be considered with other wants in communication with the Financial Department on the subject of the general grant of funds for Public Works for 1866-67.

Ordered further, that a copy of the foregoing Observations be forwarded to the Governments of Madras and Bombay, with reference to para. 26, with a letter asking for the services of an experienced Officer for each Presidency to report on the subject.

Ordered finally, that the Secretary of State be addressed with the view of obtaining orders on the subject of [illegible]ntinuing the works, and if so decided, to authorize Captain Haig to r[illegible]he supplies from England accordingly.

No. 934 C, dated 13th September, 1865.

[No. 82.] *From*—LIEUT.-COL. C. H. DICKENS, R. A., *Secy. to Govt. of India, P. W. Dept.*,
To—*Secretary to Government of Madras, in the P. W. Dept.*

I am directed to forward a copy of a Resolution recorded by the Government of India upon the state of th[illegible]ress of, and expenditure on, the works on the Upper Godavery, from w[illegible] it will be perceived that the Governor General in Council attaches much importance to procuring a report by Engineers of reputation and experience in hydraulic works, upon what has been done, and what is proposed t[illegible]done.

2. I am directed to state, therefor[illegible] that the Governor General in Council will esteem it a favour if the Government of Madras would lend the services of Lieutenant-Colonel J. C. A[illegible]E., to accompany another Officer to the site of the works, about J[illegible]t, and to draw up a Report accordingly. But for the great importa[illegible] to this duty, the Government of India would not have named a[illegible]ose services can so ill be spared as those of Lieutenant-Colonel A[illegible]nder the circumstances explained, however, it is hoped that the [illegible]Madras in Council will not object to his undertaking the duty.

No. 935 C, dated 13th September, 1865.

[No. 83.] *From*—LIEUT.-COL. C. H. DICKENS, R. A., *Secy. to Govt. of India, P. W. Dept.*,
To—*Secretary to Government of Bombay, in the P. W. Dept.*

I am directed to forward a copy of a Resolution recorded by the Government of India, upon the state of the progress of, and expenditure

on, the works on the Upper Godavery, from which it will be perceived that the Governor General in Council attaches much importance to procuring a report by Engineers of reputation and experience in hydraulic works, upon what has been done and what is proposed to be done.

2. I am directed to state, therefore, that the Governor General in Council will esteem it a favour if the Government of Bombay would lend the services of Lieutenant-Colonel Fife, R. E., to accompany another Officer to the site of the works, about January next, and to draw up a Report accordingly. But for the great importance attached to this duty, the Government of India would not have named an Officer whose services can so ill be spared as those of Lieutenant-Colonel Fife. Under the circumstances explained, however, it is hoped that the Government of Bombay in Council will not object to his undertaking the duty.

No. 116, dated 13th September, 1865.

From—The Government of India,
To—Her Majesty's Secretary of State for India.

[No. 84.]

Referring to your despatch No. 62 of the 17th November last, we have now the honour to submit a Resolution reviewing the state of the expenditure and prospective measures to be adopted, if it be considered advisable, to carry on the works for the navigation of the Upper Godavery to the extent which was formerly recommended by us and approved by Her Majesty's Government.

2. It will be perceived that we have now before us definite and detailed plans and estimates for the works at the 1st and 2nd barriers. And although we have not yet received full details of information and estimates for other parts of the project, the estimates for these principal parts appear to be sufficient to enable us to lay the state of the case before you, so as to obtain orders upon the main point as to whether the works shall be proceeded with to completion, and whether simultaneously along the whole line, or by sections.

3. It will be remembered that the series of works which it was previously determined to undertake, was that embraced in the minor project recommended by Mr. Temple, *viz*:—

I.—The 1st barrier works;

II.—The 2nd barrier works;

III.—A road from the foot of the 3rd barrier to Chanda;

together with such works between the barriers as might suffice to render the navigation safe and easy for the four or five months during which the natural supply of water in [illegible]r would be sufficient for this purpose.

4. The works requi[illegible]ow the 1st, and between the 1st and 2nd barriers, are known to be c[illegible] cost, and the river is already navigable for steamers in these reach[illegible] works between the 2nd and 3rd barriers were estimated roughly to [illegible]khs of Rupees (£65,000), of which we have received no later or more pr[illegible]se estimate. The rough estimate, however, was made in contemplation of navigation for the entire year, while it is known that the river in this reach is already navigable for steamers for part of the year. Hence we do not apprehend any increase of the estimate for providing safe navigation for four or five months. It would have been more satisfactory to have had precise and definite plans and estimates for all these intermediate works. But the unhealthy climate, and wild and difficult nature of the country, must be considered in excuse of the want of these. We propose, therefore, to insist on obtaining these precise estimates before

the works are finally set in hand on [illegible] such should be your decision); but it [illegible] this account before laying the matter b[illegible]

5. In regard to the road to Char[illegible] gress in the survey was made last seasor[illegible] been prepared. A road, however, is a co[illegible] experience of the cost of roads in the [illegible] inces and reaching to Chanda, which [illegible] cost would be of continuing this spec[illegible] foot of the 3rd barrier, or onwards to S[illegible] cost per mile, derived from this experier[illegible] on which to base our calculations.

6. Before leaving this part of the [illegible] do not consider that the Administration o[illegible] in regard to the want of estimates. Duri[illegible] were under that Administration, a revise[illegible] was prepared. During the next season [illegible] barrier was prepared, and in the third [illegible] the survey necessary for the road p[illegible] discontinued because we considered it [illegible] establishments employed on the Godav[illegible] the scale on which they were to be carri[illegible]

7. Of the two detailed projects [illegible] remark that, that for the works at the [illegible] expenditure than might have been [illegible] attempting to provide more than four [illegible] fully attended to from the first. Bu[illegible] that we would not recommend any oth[illegible] greater part of the canal, and connec[illegible] the dam with that below it, by a shor[illegible] steamers, instead of completing the [illegible] fication is now recommended by Capt[illegible]

8. The project for the 2nd barr[illegible] with some trifling modifications of de[illegible]

9. In the case of both these es[illegible] caused calculations to be made of the [illegible] prices actually ascertained from th[illegible] Thus the estimates may be considered [illegible] usually are.

10. The entire expenditure up[illegible] up to £286,075; and the cost of the [illegible] scarcely be under £800,000; whil[illegible] in such cases, to outrun even the m[illegible] but state that we think it quite pos[illegible] end may come up to a million and

11. And further, when done [illegible] contemplated by the projectors of [illegible] for the entire year, but only for fo[illegible] to be contemplated the possibility [illegible] fect the work; and not only to ca[illegible] and up the Wurda, but also to st[illegible] the dry season, and to extend the [illegible] this, would, we think, not cost less [illegible] more than the scheme we formerly

scale of expenditure (if [illegible] sary to delay longer on [illegible] orders.

[illegible]s the same. Some pro[illegible] d estimates have not yet [illegible] simple work, and we have [illegible] n of the Central Prov[illegible] idge fairly of what the [illegible] lication thence to the [illegible] taking a high average [illegible] tolerably safe estimate

[illegible]ould remark that we [illegible] Provinces is to blame [illegible] season that the works [illegible] for the 1st barrier works [illegible] led project for the 2nd [illegible] at now just terminated) [illegible] ut in hand, and was only [illegible] reduce the cost of the [illegible] pending a decision as to

[illegible]een received, we would [illegible]en to embrace a greater [illegible] had our intention of not [illegible] as' navigation been care[illegible] as been so far carried out, [illegible] than the cutting off the [illegible] igation of the river above [illegible] ree miles, with a lock for [illegible] of 25 miles. This modi[illegible] itself.

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No

All communications should be addressed to the Secretary.

GOVE
PUBLIC WORK MENT.

Com ons

To, The Se e Govt of Madra
Public Works Depar

Madras, 9th May 188

Sir, In c uation of this Off
letter No. 876 7th April last,
I am directed to forward the accompa
ding marginally note
relating to the Upper Godave
Navigation Works, and to
request their return whe
done with.

I have the honor to
Sir,
Your most obed servant

G. F.

A

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Comms

Septr/65 No. 49/84.
April/66 " 2/4.
July/67 " 34/40.
April/67 " 1/16.
Septr/67 " 26/8.
Decr/67 " 7/10.
Decr/67 " 39/40.
May/68 " 4/8.
May/69 " 20/2.

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CIVIL WORKS.
Communications.

GODAVERY NAVIGATION WORKS.

Pros. (Civil Works Comms.) June 1865, No. 31.
" (") " " Nos. 2—5 Part B.
" (") Aug. " " 15—25 & 26—8.
" (") Sept. " " 49—84.

No. 11, dated 8th February, 1866.

From—*The Secretary of State for India,*
To—*The Government of India.*

[No. 2.]

The review of past, and the discussion as to future, procedure in the matter of the Godavery Navigation Works, contained in the papers transmitted with your Excellency's Despatches Nos. 90 and 116 of 9th August and 13th September last, have caused me again to consider the whole subject in Council, and I have taken advantage of Major Haig's presence in this country to confer with him on the project, with the details of which he has so long been personally connected.

2. There seem to me good grounds for believing that, if brought into navigable condition, the Godavery and its affluents will afford the cheapest possible means of transport for the whole territory through which they run; that the greater part of that territory is quite beyond the reach of any existing or projected Railways; and that even from those Districts of Nagpoor which may become accessible both by river and Railway, the latter will not suffice to carry down to the coast more than a portion of the cotton and other produce likely to be raised for exportation. Indeed, from information which has lately reached me, the requirements of traffic are already greater than can be met by a Railway up to the point which the one under construction has hitherto reached, although that point is still distant from those Districts of the Nagpoor Territory for whose staple produce a new outlet is most needful.

3. With respect to the limits to be set to the Godavery Project, the advantages which may be derived from it cannot be properly developed, unless the navigation be extended considerably beyond the limit at present in view. Between that barrier and Rajamundry, the country on both sides is represented as being for the most part uncultivated forest, and although the improvement of those tracts might doubtless be greatly accelerated by the opening of the river, still that result would at best be only a very inadequate, as well as very remote, return for the large expenditure demanded for the latter purpose. In order to secure those more important and more immediate advantages, with a view to which the project was originally undertaken, navigation must, in my opinion, be made to commence at the nearest practicable point to the great cotton fields of Nagpoor, and that point is represented to be Hinghinghat. It has been roughly estimated by Major Haig, that to establish a continuous line of water communication from Hinghinghat downwards, would require a total outlay of £800,000, or about £500,000 beyond what has already been spent, and although this sum is very considerable

exceeds the original estimate, it would still appear to be not too high a price to pay for between four and five hundred miles of river navigation, open during the greater part of the year.

4. With respect to the works at the first and second barriers, and, indeed, up to the foot of the third, I entirely concur in the conclusion at which you have arrived that, having proceeded so far, these works must be prosecuted to completion, and that the sooner they are finished the better. For the third barrier, however, no detailed plans or estimates have yet been prepared, and these must be got ready before any work is permitted to commence at that barrier, for past experience has shown too clearly the evil consequences of proceeding without those essential preliminaries to allow of their being again dispensed with.

5. Still higher up the stream, the portion between Chanda and Hinghinghat has not yet been properly examined, and careful surveys must be made before trustworthy plans or estimates of the operations there required can be framed. Those surveys should be set on foot without delay, and pushed forward vigorously, while the works at the lower barriers are in course of execution.

6. To complete the communication with the Nagpoor country, you have proposed the construction of a road, but, I am of opinion that water communication, if obtainable at a reasonable expense, would be far preferable, and if navigation can be extended as far as Hinghinghat, or even as Chanda, the proposed road from the latter place to the foot of the third barrier would apparently be superfluous. The cost of that road, exclusive of a bridge over the Wurdah, is roughly estimated at £75,000, but it is doubtful whether sufficient allowance has been made for difficulties of construction, and the real cost might, not improbably, be much greater. So large an outlay ought not to be incurred when there is a great probability of a more complete means of communication being made. The data for comparing the cost, and advantages of the alternative modes of transport, are not yet in your possession, and should be obtained as soon as possible, but, in the meantime, all operations on the proposed road, if any have been already begun, should, it appears to me, be suspended, and all sanctions given in connexion with it should be held in abeyance.

7. In accordance with the suggestion made in the 19th para. of your Despatch of 13th September last, Major Haig will be at once employed in procuring the steamer, plant, &c., required for the operations at the second barrier.

8. If it should be determined to construct a canal on the right bank of the river near the third barrier, I must not omit to draw your Excellency's attention to the necessity of obtaining from the Nizam the cession of that portion of territory through which the canal would be cut, and early arrangements should evidently be made for the purpose.

9. I do not wish to be understood as enjoining the construction of the works referred to above, but I desire that the arguments in their favour may be duly weighed by your Government, with whom will rest the responsibility of providing the requisite means for their execution. With the foregoing expression of my views, and with the Reports of those Engineers of reputation and hydraulic experience, whom, as the later of your Despatches under reply informs me, you were about to depute to examine the river, you will, I trust, have no difficulty in deciding on the course to be henceforward pursued with respect to the Godavery Works, so that no

further delay may occur in the prosecution of an undertaking which, if satisfactorily concluded, promises to prove highly conducive to the interests of this country as well as of India.

10. Major Haig has submitted to me a Memorandum on the Godavery Works generally, copy of which is forwarded herewith for your information.

No. 826, dated 24th March, 1866.

Endorsed by P. W. Dept.

Copy of the Despatch, with the enclosures in original, forwarded to the Chief Commissioner of the Central Provinces for report, in communication with the Committee appointed to report on the Godavery Navigation Works.

[No. 3.] *Memo. by* Major Haig, *on the Godavery Navigation Works.*

[See Appendix annexed.]

No. 365 C, dated 24th April, 1866.

[No. 4.] *From*—Lieut.-Col. C. H. Dickens, R. A., *Secy. to Govt. of India, P. W. Dept.*
To—*Secretary, P. W. D., at the India Office.*

With reference to Sir Charles Wood's Despatch No. 11, dated 8th February 1866, regarding the Godavery Navigation Works, I am directed to request that 30 copies of Major Haig's Report referred to in the concluding para. may, if available, be supplied overland for the use of this Department.

APPENDIX

TO

PUBLIC WORKS DEPT. PROCEEDINGS, APRIL 1866.

CIVIL WORKS.

Communications.

GODAVERY NAVIGATION WORKS.

[No. 3.] *Memo. by* MAJOR HALL, *on the Godavery Navigation Works.*

MEMORANDUM

ON THE

NAVIGATION

OF

THE RIVER GODAVERY.

BY

CAPTAIN F. T. HAIG,

ROYAL ENGINEERS.

LONDON:
PRINTED BY GEORGE EDWARD EYRE AND WILLIAM SPOTTISWOODE,
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FOR HER MAJESTY'S STATIONERY OFFICE.

1866.

7025.

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MEMORANDUM

ON THE

NAVIGATION OF THE RIVER GODAVERY.

1. The despatch of the Government of India to the Right Honourable the Secretary of State for India, under date 13th September 1865, having called in question the policy of proceeding with the works now in progress on the Godavery, it is desirable that the whole question should now be reviewed, with the aid of all the information upon the subject which has been obtained in the course of the last ten years.

In the following paper, therefore, the question will be considered with reference to the capabilities of the river for navigation; the probable cost of opening it up to a greater or less distance from the sea; the present condition in regard to population, trade, and revenue of its valley; and the probable effect of the opening of the river upon the country.

A brief sketch of the history of the project, and of the progress of the works up to the present time, will also be given. The evidence which will be brought forward upon such of the above points as do not involve questions of a purely engineering character will be derived chiefly from the published reports of the Chief Commissioner, Central Provinces, Statistical Reports to the Resident at Hydrabad, and other public documents, the source from whence the information is obtained being in each case noted in the margin. With regard to the engineering parts of the subject, the facts which may be adduced, and the opinions expressed will be supported by references to reports submitted to the Governments of Madras and of India.

2. Reference may first be made to the map which accompanies, and which has been prepared in such a manner as to convey, as far as possible, to the eye, correct ideas as to the general extent, territorial limits, and population of the part of Central India interested in the Godavery scheme.

This map comprises that portion of Central India which is situated between the parallels of 22° 9′ N. and 16° N., and bounded on the other two sides by the two seas. It is tinted with two colours only; red, representing British territory; and green, that of the Nizam; and the different shades of intensity given to these colours are intended to show different densities of population.

In the centre of each of such of the tracts thus indicated as have a special bearing upon the subject under discussion is noted its area in square miles, its population and principal productions.

3. It will be observed that the centre of the map, comprising the Valley of the Godavery, is occupied by that river and its numerous tributaries, which extend their ramifications throughout an area of 120,000 square miles (about three times the size of Ireland), and the broad blue line which, starting from a point a little to the south-west of Nagpore, runs in a south-easterly direction to the sea, is that part of the Godavery and its tributary the Wurda, which it is proposed to render navigable. The Mahanuddy is seen flowing to the north-east, to the Bay of Bengal, near Cuttack; the Tapty to the west, down the Valley of Berar; while on the south the Kistna, descending from the west, falls into the Bay of Bengal, near Masulipatam.

The principal mountain ranges are (1) the Western Ghauts, where the Godavery proper takes its rise; (2) the Eastern Ghauts, through which the Godavery passes, about sixty miles from the sea; (3) the Sautpoora Range, running east and west, the source of the two northern tributaries of the Godavery; and (4) the lower range of hills which bounds the Valley of Berar on the south.

In the upper centre of the map stands Nagpore, distant, by the railway now under construction, 528 miles from Bombay, and by road (to Hingenghat) and river, 515 miles from Cocanada, the port of the Godavery.

4. Directing our attention now to the Godavery, we notice, in the first place, that that part of the river which it is proposed to navigate forms the dividing line between the British and the Nizam's territories. *All the*

British possessions interested in the opening of the river lie exclusively on the north bank; those of the Nizam occupy the south[ern].

Turning first to the former, we find them represented in the map under the following divisions, distinguished according to relative density of population by different degrees of colour:

	Area: square miles.	Population.	
Valley of Nagpore - -	23,000 -	- 3,140,000	Mr. Temple's report of 23d January 1863.
Bustar territories - -	13,000 -	- 200,000	
* Godavery district -	3,900 -	- 54,300	

Bustar is a semi-independent State, a d[ependency of Nagpoor.]

The Godavery districts comprise the [narrow strip down the left bank of the] river which was ceded to us by the Niza[m in 1860, and must not be confounded] with the "Godavery district" on the coast.

To the north of Bustar again we ha[ve Chutteesghur, with a population of] 1,500,000, covering an area of 35,000 sq[uare miles. This province lies almost] wholly outside of the Godavery Valley [but will, nevertheless, as regards its] southern portion, at least, benefit consider[ably by the opening of the river.]

5. The statistics in regard to revenue[, productions, &c., of these four great] divisions are given as follows by Mr. Tem[ple:]

VALLEY OF NAGPOOR.†

Population, 3,140,000.
Revenue, 280,200*l.* (in 1863).
Well cultivated throughout.
Tank irrigation in southern part.

	EXPORTS.	Maunds.	Value.	IMPORTS.	Maunds.	Value.
			Rs.			Rs.
Trade with Bombay.	Cotton - - -	85,000	12,00,000	Salt - - -	200,000	10,00,000
	Linseed - - -	100,000	2,00,000	European piece goods -	- -	1,00,000
	Gingelly - - -	30,000	1,50,000	Bullion { Silver -	- -	5,00,000
	Ghee - - -	- -	- -	Gold -	- -	10,00,000
	Hides (Gentelly only) -	10,000	1,00,000	Silk - - -	1,200	1,60,000
	Ghee (Chutteesghur) -	3,000	30,000	European stores - -	7,000	2,00,000
	Red ochre - - -	- -	- -	Articles of hardware, brass and copper vessels -	5,000	1,00,000
	Coarse cloth - - -	- -	- -	Dyes - - -	1,000	20,000
				Miscellaneous - -	55,000	2,00,000
Trade with Chutteesghur.	Hides - - -	50,000	5,00,000	Bullion { Silver -	- -	5,00,000
				Gold -	20,000	2,50,000
				Sugar - - -	- -	- -
				Articles of hardware, brass and copper vessels, &c.	5,000	20,000
				Silk - - -	4,000	3,00,000
				European piece goods -	- -	4,00,000
				Miscellaneous - -	5,000	25,000
				Military stores, about 500 tons - - -	- -	30,000
				Tobacco and cloth -	- -	1,00,000
				Cocoanuts - - -	- -	- -
Trade with Madras and Coast.		- - Rs.	22,15,000	Total Imports -	- Rs.	58,75,000

* Mr. Temple gives the population of six out of eight districts, included in this tract, at seventeen to the square mile. That of the whole eight is here calculated at this rate.

† "Below the hills the valley is broad, generally cultivated, and often rich. On the right bank, opposite Nagpoor itself, the valley reaches to a breadth of some forty miles of unbroken cultivation, the valley of the Wyneganga becomes narrower; valley of the Wurda. Further down, southwards, tanks is abundant, but the climate in the neighbour- these lowlands are cultivated, and irrigation from the cultivation consists of wheat, maize, millet, and rhood is very insalubrious. In the upper portion of rice. oil-seeds; in the lower portion it consists mainly

"As regards the second of the two divisions, it is to be observed that the Wurda River debouches from the Sautpoora Range, to the north-west of Nag- poor. It is along the left bank of the river that is situated the great cotton field of Nagpoor. Immedi- ately below the range, the cultivation consists of a narrow strip of land along the foot of hills, [illegible] certer, near. Below this the country becomes [illegible] Chanda, again, it becomes contracted to a mere str[ip] limits of cultivation, that is to the eastward, there of light inferior soil, covered with low forest, and ge[ne] within the limits of cultivation, the ground is fully c[ul]tivated right up to the river. The soil is a black rich loam. The cultivation consists partly of cotton, and partly of wheat, millet, oil-seeds, and hemp.

Productions.

Cotton, wheat, maize, millet, oil-seeds, rice, hemp, &c.
Cotton is grown over a tract extending from the hills west of Nagpoor down 150 miles of the Wurda, to the third barrier. Crop estimated at 30,000,000 lbs.
The culturable area of this valley is stated to be for the most part occupied.

CHUTTEESGHUR DISTRICT.*

Population, 1,500,000.

Productions.

Cotton, lac, ghee (clarified butter), wheat, gram, rice, linseed, oil-seeds, and hemp. Cotton cultivation of recent date, and rapidly extending. Crop of 1863 estimated at 36,750,000 lbs.
Cultivated area, 3,200,000 acres.

BUSTAR STATE.†

Population roughly estimated at 200,000.
Revenue about 10,000*l.*
Thinly populated. Cultivation scanty. Mostly a forest country, containing some valuable timber, and producing the ordinary cereals.

* "This tract produces excellent rice and wheat, oil-seeds, and fibres. Of late years the culture of cotton has been commenced, and has increased so rapidly that already the crop is estimated at 36,750,000 lbs. per annum. It is generally anticipated that, as communications are opened, the culture of cotton will be indefinitely extended. Lac is obtained in quantities from the neighbouring jungle. So superabundant is agricultural produce beyond the demand of consumption on the spot, that prices of grain are often three times as cheap in Chutteesghur as elsewhere, and sometimes the disproportion has even been greater. The excessive cheapness of food has the usual effect on the character of the people, rendering them indolent and improvident; so that there is reason to hope that, if their energy were aroused by adequate inducements, a far greater quantity of produce might be raised by them than at present. And evidently this cheapness must afford an extraordinary inducement to exportation, if means or opportunities of exportation were presented.

	EXPORTS.	Maunds.	Value.	IMPORTS.	Maunds.	Value.
			Rs.			Rs.
Trade with Nagpore.	Wheat - - -	300,000	4,50,000	European piece goods -	- -	1,00,000
	Gram - - -	150,000	2,50,000	Bullion { Silver -	- -	4,00,000
	Rice - - -	12,000	15,000	Gold -	3,000	25,000
	Toor - - -	10,000	25,000			
	Linseed - - -	10,000	80,000			
	Oil - - -	5,000	15,000	Miscellaneous - -	-	-
	Gingelly - - -	2,000	6,000			
	Dyes - - -	4,000	1,60,000			
	Cocoanuts, bullock loads -	5,000	25,000			
	Miscellaneous -	-	-	Brass and copper vessels -	4,000	80,000
		20,000	80,000			
Trade with Mirzapore and Calcutta.	Wheat - - -	20,000	1,30,000	European piece goods -	- -	80,000
	Lac - - -	5,000	10,000		3,000	
	Hemp - - -	1,200	25,000	Miscellaneous -	-	-
	Ghee (clarified butter) -	- -	10,000			1,30,000
	Coarse cloth - -	- -	3,00,000		4,500	
	Cotton - - -	- -	-	Cocoanuts, bullock loads -		
Trade with Cuttack.	- - - -	- -	- -	Salt - - -	75,000	4,00,000
Trade with Ganjam.	- - - -	- -	- -			
	Total Exports - - Rs.		17,11,000	Total Imports -	- Rs.	11,95,000

† "It lies immediately to the north of the valley of the Godavery; its area is very great, and has been estimated at as high as 18,000 square miles. It is hilly, for the most part covered with forest and jungle, everywhere wild, and in some parts even barbarous. Its population and its cultivation are very scanty. The population is believed not to exceed 200,000 souls; its revenues may amount to a lac of rupees per annum. It has some valuable forests, which will be alluded to hereafter, and one route for traders from Chutteesghur, which has been already alluded to. It produces the ordinary cereals, and could, of course, produce much more. It will improve as its communications with Chutteesghur on the north, and the Godavery on the south, shall be opened. But some time must elapse before this territory could contribute any important quota to the general trade.

"The Ahiree teak forests have been already mentioned in paragraph 68. They are estimated to contain 15,000 serviceable logs. The other teak forests of the Godavery are situated chiefly in the

GODAVERY DISTRICTS.*

Extend along 250 miles of the river.
Population scanty, about seventeen per square mile. Total, 54,000.
Cultivated area, 60,000 acres.
Culturable area, 670,000 acres.
Highly improvable. Has numerous old tanks, bearing the traces of a formerly much more highly cultivated and prosperous condition.
Became British territory in 1860.

Productions.

Wheat, in small quantities; a crop first introduced about eight years ago, and now extending down fully 100 miles of the river on both banks.
Cotton in small quantities.
Millet, rice, oil seeds, pulses, plantains (bananas), limes, oranges.
Pasturage excellent and in unlimited abundance. These districts abound in cattle and sheep, exporting hides, wool, and ghee.
Forest products:—Teak and other timbers of small size; the Ahiree forests estimated to contain 15,000 serviceable logs of teak; wax, galls.

6. Turning next to the south side of the river, we find it wholly occupied by the Nizam's dominions, including the valley of Berar (distinguished by a deeper tint of green), which, however, is now assigned to the British Government, and under British management.

About half the valley of the Godavery lies on this side of the river. It includes, in fact, the drainage basin of the main Godavery. With the improvement and

Bustar territories beyond our regular civil jurisdiction. The principal are those of the Kotapilly subdivision, from which the timber is floated down the river Tal to the Godavery; and those of the Byjee and Soonkoom subdivisions; also the Mukanagiri subdivisions of Jeypoor, from all which the timber is floated down the Sibbree. These have been noble forests, but are now no longer so, owing to unchecked expenditure. These are the forests which the Native Government leased out to contractors, without any stipulation regarding conservancy, and from which the great cantonment of Secunderabad and buildings of all kinds at Hyderabad have been built for many years. As the teak logs float extremely well, the Godavery has always been largely made use of to convey them towards the coast. In 1860-61 no less than 25,000 logs were thus floated down, and this traffic still continues, though under better regulations than heretofore. A large portion of the timber cut in former years has consisted of undersized logs, obtained from trees felled before arriving at mature growth. This reckless destruction, for temporary advantage, of trees which, if spared might double in value, has seriously diminished the timber resources of the Godavery. Vigorous measures are now taken for conservation. Undersized logs, cut after a certain date, are stopped on the river; and the Bustar authorities are urged, for their own sake, as well as for the common weal, to co-operate in the conservancy. Thus these first-class forests may have a chance of reproducing themselves; and the next generation, enjoying the fruit of our present labours, may see a never-failing supply of first-rate teak timber floating down the great river. First-class teak forests were reported by Captain Steuart, the Superintendent of Forests, to exist in the higher hills near the Indrawutty. But it is doubtful whether this timber will be made available, on account of this distance from the Indrawutty, and of the difficult, if not impracticable, character of the river itself."—Mr. Temple's *Report*.

* "So far as extent of land is concerned, a fine field is open for agricultural enterprise, inasmuch as it will be seen that, while 60,608 acres, or about ninety-five square miles only, are as yet cultivated, there are estimated to be culturable and available 261,600 acres of the better sort, and 428,854 of the second sort; in all, 670,454 acres. If, in future times, the whole of this were to be cultivated, the agricultural production of the country would be increased by thirty or forty lacs per annum, the worth of produce by the lowest calculation. If only half were cultivated, there would still be an addition of fifteen or twenty lacs a year to the gross produce.

"The cultivated area, now so deficient, was at one period larger than at present, and the country more prosperous. In the jungle there are remains of the earthwork of tanks supposed to be a century or so old, and now quite overgrown with brushwood. There are, also, remains of tanks in many places which may now be improved.

"The present products are wheat (in places only); cotton in very small quantities; millet (jowaree) of fair quality; rice, good; oil seeds, inferior; castor oil; pulses; a few common vegetables; plantain trees, coarse; limes and oranges, small. In one village only is sugar-cane produced. Neither the cocoa-nut tree nor the date palm are to be found, but the palmyra, or toddy palm, and the mohwa tree are both in full abundance; they are both used for liquor, to which the people are much addicted. The sources which supply the food of the people are millet and rice. They do eat meat to a certain extent, such as mutton and poultry. The Gonds eat the flesh of the buffalo, and even of the cow, and many of them live on game. The buffaloes are large and fat; the cows, though good, are of a small breed; the bullocks are small, but hardy; the sheep are also small, but good; the goats are good also. The pasturage is everywhere excellent, and the cattle are in the best possible condition. As might be expected, ghee (clarified butter), hides, and wool, are abundant. All three articles are largely exported from Dowlaishweram and elsewhere by land as yet; wax and galls are produced, but lac is not (as might have been supposed) produced in those jungles."—Mr. Temple's Report.

utilization of this river we are not now concerned. Only a part, therefore, of its valley will contribute to the traffic of that part of the Godavery and Wurda whose improvement is now contemplated.

The probable limits of this tract are shown approximately by the heavy dotted line which, starting from the river where it passes through the Eastern Ghauts, runs first in a westerly direction a little to the north of Hydrabad, and then, turning to the north-west, crosses the main Godavery at the junction of the Munjera, and closes on the hills which bound the valley of Berar on the south.

7. The statistics of this part of the Nizam's dominions, covering as it does an area of 30,850 square miles, cannot be given in the same completeness, or with the same confidence as to their accuracy, as those for the British Possessions on the north bank.

It is, however, fairly populated. It includes the Warungul country, which, it is evident, from the astonishing number of tanks which cover it, was formerly highly cultivated and populous, but is now, through neglect and misgovernment, in much the same condition as the surrounding country. The population of the whole tract south of Berar may be taken approximately at fifty to the square mile; that of Berar, at seventy; which would give a total of 2,177,000. Its productions are various. In the upper part, viz., that to the north of the Godavery, cotton and wheat are extensively grown, and everywhere the other cereals, as pulses, millet, and rice, are to be met with, as well as hemp, and the other products mentioned as common in the British territories on the north bank. Woony and Jennagaum, on the right bank of the Wurda, the one a few miles above Chanda, and the other forty miles below it, are well known cotton marts, though not at all comparable in point of size and trade with such towns as Hingenghat on the other side of the river.*

8. To the north of the Nizam's provinces above described lies the valley of Berar, the great cotton field of Central India.

A line of navigation connecting it with the river may, undoubtedly, be carried into the heart of it, and this rich province may, and doubtless will ultimately, contribute to the river traffic. Its position in close proximity to the river, though outside† of the valley of the Wurda, may here be noted.

Its resources and importance are too well known to call for any particular description. The railway runs through its centre.

9. We have now taken a general survey of the whole of that part of the Godavery valley, both north and south of the part of the river which it is proposed to navigate, likely to benefit in a greater or less degree by the opening of this new communication.

It forms what may be termed the natural trade basin of the river, though, viewed in this aspect, its limits will not follow precisely those above laid down, but may be more or less expanded or contracted according to the degree of development given to the various feeding lines which must connect its remoter portions with the river.

Viewing it, then, as a whole, the following are seen to be its most prominent characteristics:—

1st. That the whole valley on the north of the river is British territory; all that to the south belong to the Nizam.‡

* The country round Nandair was spoken of by Colonel Davidson, the late Resident at Hydrabad, as a remarkably fine productive tract. He particularly directed my attention to it, as likely to be an important source of traffic. It lies, however, on the main Godavery, which, though navigable for some hundreds of miles, has a long series of rocky rapids between Nandair and the confluence of the Pranhita.

† This fact was particularly pointed out in my original report of May 1856. The watershed between the Wurda and Poorna is quite low, and has been examined by Sir A. Cotton. It presents no difficulties whatever to the construction of a canal.

‡ Population of British territory - - - - - 4,900,000
Ditto Nizam's, including Berar - - - - - 2,177,000
Total - - - - - 7,077,000

But from this about 1,000,000 might be deducted for the population of the most distant part of Chutteesghur, leaving 6,000,000 for the country whose trade would naturally take the Godavery route.

2d. That in respect of natural resources the whole valley possesses abundantly the elements of wealth, likely to develop, in British territory, into a high degree of prosperity, leading sooner or later to an extensive and flourishing trade, if only the means of cheap export and import are provided.

3d. That in respect of population and production, the upper part of the valley, viz., that lying above the third barrier, is much the most important, its population being half that of the whole of the rest of the valley.

4th. That, as a consequence, it is from this part of the valley that the most important and *immediate* traffic is to be expected, as well as the most immediate returns upon any outlay upon the river works.

10. Such being the geographical position and capabilities of the country traversed by the Godavery, let us next notice its present means of communication with the coast, and its condition in regard to trade and revenue.

These points have all been fully described in Mr. Temple's Report, and a brief statement based upon the facts which he reports will here be sufficient.

First, as to communications. There is no traffic by the river in its present unimproved state,* and the only outlets to the coast on the north bank have been mere cart tracks, or unmade roads, practicable only in the dry season for the most primitive description of country carts or pack-bullocks. There are three such roads; one leading westwards from Nagpore to Bombay; another northwards from the same point to the Ganges at Mirzapore; and a third southwards along the right bank of the Godavery, through the Nizam's country, to Masulipatam.

The Chutteesghur country has also two outlets, both bullock tracks: one to the east to Cuttack, and the other from Raipoor southwards to the Godavery, and thence to Masulipatam.

The cost of carriage by these rough and primitive modes of conveyance is so great as to be prohibitory of all trade except in articles of the very highest value, such as cotton, and in their case only in small quantities. As a consequence, the whole Godavery basin has been practically isolated from the commerce of the world. Its only markets have been within its own limits, and its people are engaged almost exclusively in raising their own food and clothing.

11. For the districts on the Nizam's side of the river no statistics exist, but it is certain that they are at least no better off than those in British territory, and the condition of by far the most flourishing of the latter, as revealed in Mr. Temple's reports, plainly indicates the state of poverty and depression of the whole. Thus we have for the valley of Nagpore, to which attention has been already directed as the most populous and best cultivated part of the whole valley, the following statistics:

Population, 3,140,000.
Revenue, 289,200*l.*
Exports, 291,500*l.*

With this we may compare the condition of the coast districts at the mouth of the same river, districts whose great staple is rice, a grain of low value, and which are not adapted to the growth of the rich and valuable products which, as cotton, linseed, &c., form the staples of so large a part of the Upper Provinces; districts, moreover, only partially improved, the irrigation of the land very incomplete, but possessing an unbounded demand for their produce, and access at an almost nominal charge to the port and to the markets of the world.

	Population.	Revenue.	Exports.
Nagpore -	3,140,000	289,200	291,500
Rajahmundry -	1,200,000	450,000	350,000

Reduced to the unit of each head of population, the comparison is as follows:

	Revenue per head.	Exports per head.
Nagpore -	2 shillings	2 shillings.
Rajahmundry -	7½ ,,	6 ,,

* Excepting timber, which is floated down in rafts from the Bustar country and Godavery districts, to the extent of, perhaps, 30,000 logs annually. Mr. Temple mentions 23,000 logs as having been exported, from one part of this tract only, in 1862.

But these figures do not show the whole truth of the case. As regards exports it should be stated that, while those of Rajahmundry consist mainly of rice and oil-seeds, worth only 5*l.* to 8*l.* per ton; half those of Nagpore consist of cotton, an article worth 36*l.* per ton on the spot. Unless, therefore, Nagpore had possessed this important staple, so valuable that it will bear the present excessive cost of transport, its exports would have been but a small part of what they are. Moreover, as regards the effect of this trade upon the people, it is important to notice that at present it is carried on under such formidable difficulties and risks that it is entirely in the hands of a few wealthy merchants who appropriate by far the greater part of the profits, so that that which falls to the share of the great mass of the people is far below two shillings a head.

As regards imports, we find salt imported to the extent of 7,400 tons* only for a population of over three millions, or at the rate of 5 lbs. per head, the retail price being† 8 lbs. to 12 lbs. per rupee, about three times that in the coast district, and the consumption not above one-third what there is good reason to believe it to be in those districts, or one-fourth of what it is known to be elsewhere.

We find, moreover, this valley, though exporting such a small amount of raw produce, and with a mere fraction of its population engaged in manufacturing pursuits, largely importing food from the surrounding district,‡ not even growing enough to meet the very limited wants of its own people. And yet there can be no question that it is the most prosperous part of the Godavery basin, possessing a soil and climate adapted to the growth of the most valuable products, with a firm and strong government, earnestly bent on improving its condition, with just and equal laws, securing to every one the fruits of his labour, and with a very light land tax. The districts on the Nizam's side of the river, while sharing, perhaps, to an equal extent, the natural capabilities of this valley, possess none of its other advantages, while the wants and disadvantages which they have in common with it are aggravated by the evils of unjust and oppressive government.

And it cannot be too strongly insisted upon, that such as this fine country is in its present depressed and impoverished condition, such it must remain, in spite of every improvement that may be introduced in the general administration of the government, in the tenure and assessment of the land, and in the education and enlightenment (if that be possible under such conditions) of the people, so long as the only stimulus to exertion is the necessity to support life, and the accumulation of wealth is rendered impossible by the absence of a market for anything beyond the requirements for home consumption.

In a purely agricultural country like India there is but one source of wealth, its surplus produce, and the only markets for this lie beyond the sea.

The first and fundamental necessity, therefore, to such a country, next to the establishment of order and maintenance of public security, is cheap communications with good ports on the coast, and, until this is provided for Nagpore, all else that may be done for it will be of no avail, the condition of its people cannot possibly be, in any material degree, bettered, or its revenue increased.

This leads me to consider in the next place,

12. What communications are now being constructed, or have been proposed, for the Godavery valley?

I trust that it will not be thought that in the remarks above made I have been wasting time in the repetition of mere truisms. I cannot think that the real condition of the Godavery country is rightly apprehended, or the fundamental necessity for really cheap transport clearly seen. Were it otherwise, I feel sure that an expenditure of even two or three millions (were such a sum at all necessary) upon a line of transit which should place six millions of people, the cultivators of a fairly

* "The average consumption of salt in the country of Nagpoor proper amounts to two lakhs of maunds per annum from Bombay."—Mr. Temple's Report.

† Mr. Temple gives the price at 16 lbs. per rupee, but, unless this is a clerical error, I can have no hesitation in saying that he must have been misinformed upon the subject. The monthly price lists published for every district in the Central Provinces show that the rates are as above given, *excepting in the Godavery districts*, where the price is given at 16 lbs. per rupee, the fact being that the salt is now largely imported *by the river* for the wor people, and sold, at the date mentioned, throughout that part of the country.

‡ "Nagpoor, though essentially a wheat icing district, has hitherto sent none of its cereal produce away. On the other hand, it import at and gram largely from the Nerbudda Valley, and more recently from Chutteesghur, in the east. Mr. Temple's Report.

productive soil, in communication with a good port, would not be thought too much, and that the idea of substituting a common road for such a line could never for a moment have been entertained; never at least until the fullest investigation had established the impracticability of opening the river. For the following simple and obvious calculation upon the subject at once presents itself. If a river communication with the coast would be likely to have such an effect upon the people of the Nagpore Valley *alone*, as to enable them to pay a revenue per head only *half* that *now* paid in Rajahmundry, the increase of revenue would be 250,000*l*., which alone is eight per cent. on 3,000,000*l*., independently of other sources of profit. I desire not to dogmatize, or to discuss questions not strictly pertinent to the subject under consideration; but I would respectfully submit that if the statistics above given of the Nagpore Province at all fairly represent the state of the case, the condition of the people of the Godavery Valley is one of depression and poverty, mainly arising from the want of incentive to exertion which access to good markets alone can supply. And if this be admitted, then I would further submit that no adequate measures have yet been taken to remedy this state of things.

With what object, I would venture to ask, are we now making roads in these provinces, the road from Nagpore to Raipore, for instance? Except for the carriage of military stores, the only use of that road will be to enable Chutteesghur to send food more cheaply to Nagpore, and to carry back the rupees received for it; but as both districts grow, or might grow, their own food, this process clearly cannot lead to any increase in the total production, *and without such increase the wealth of the country cannot be increased by a single rupee*; matters must remain just as they are now; there may not be the same inequalities of production, but the general level to which all will be brought must still be one of poverty; the population must still continue, as now, to be engaged almost exclusively in raising its own food. The same remarks apply to the road from Chanda to Nagpore, and in fact (I say it with reluctance, and in the earnest hope that if my error may be pointed out), to the greater part of the roads throughout Central and Southern India.

I turn, for instance, to the map of the Madras Presidency, and find it seamed all over with roads, some parts of it thickly so. I call to mind the large expenditure which has been incurred in the construction and maintenance of those roads in the last fifteen years, and yet, with the exception of the Deltas of the Godavery and Kistna, a small and insignificant part of Vizagapatam, and the districts at the extreme southern point of the Peninsula, where the distance between the two seas is so small, I look in vain for a single district which has cheap communication with a good port—the very first essential in such a country. Roads are, no doubt, of use in their proper place and time; but to cover the whole country with them, without giving it really cheap access to good ports, will have no material effect upon its condition.

And this result seems evident from the very small advance made by the very districts whose *internal* communications have thus been pushed forward without any facilities being given for their external trade.

It is reasonable to suppose that if the same expenditure had been applied to the opening of two or three great lines of transit leading from safe ports into the heart of the country, the effect upon the country and people would have been very much greater.

It is because we are now engaged in Nagpore in the construction of such roads, in applying to them the funds which, I humbly conceive, would be far better devoted to the opening of the river, and because the substitution of a road for the river, suggested by the Government of India, is a question for consideration, that I venture to offer these remarks upon the subject.

13. There are three lines of communication between the Godavery Valley and the coast, the claims and comparative value of which have to be considered—

The railway from Bombay to Nagpore.
The Godavery.
A road running generally parallel to the Godavery.
The first is in course of construction, and well advanced towards completion.
The second has been commenced; but the question has been raised whether it might not with advantage be abandoned in favour of the third.

1st. The Railway. The question for consideration in reference to it is, not whether it was advisable or not to make such a line—with that we have here nothing to do, the line is well nigh finished; nor is it whether the railway will be of benefit to the country through which its runs—that is foreign to the subject in hand. The question is this:—The most populous and productive part of the Gadavery basin is the Valley of Nagpore. The railway enters this in its upper part, from the west, and has its terminus at Nagpore. It has further been proposed to extend the railway to Raipore,* crossing the valley of the Wyne Gunga, and thus running through an important part of the river basin. To what extent is this line likely to affect the country? In what degree will it supply the wants of the Nagpore Valley? Is there a probability that it will so far meet its wants as to render the extension of the Godavery navigation (supposing that to be possible) into it a matter of little importance?

These questions seem to be distinctly raised. There may be not a few who would answer the last in the affirmative. The Chief Commissioner, Central Provinces, speaks of the railway as likely to be an "inestimable advantage" to the districts under notice, and the opinion is, doubtless, held by many. The question, however, has never been discussed, and some remarks upon it in this place will clearly be appropriate.

14. These are two questions in regard to the probable effects of a railway upon any given district. 1. Whether it can carry cheaply enough to attract traffic? And, 2. Whether it can carry off the traffic thus drawn to it?

The case is quite conceivable, and not uncommon, in which such a line of communication might satisfy the first condition, and yet be wholly unable to meet the second; for every railway clearly has a limit to its capacity for traffic.

On the other hand, the cost of transport by rail may be unsuited to the wants of the country, and the traffic on this account inconsiderable.

In the latter case the line is plainly of no value to the country.

(I speak now with reference to the *commercial* wants of the country, leaving out of consideration the use of the line as a military communication.)

In the former case, the value of the line though great, must be limited, and in comparison of the extent and resources of the country tranversed *may* be small, and to the most distant parts insignificant.

It is also clear that the further a railway advances into a country the less traffic will it attract at its extremity, the cost of carriage increasing with the distance from the port, till at last a point is reached beyond which it will cease to attract any export traffic whatever. Moreover, this limit may be determined by another cause. The capacity of the road for traffic may be exhausted before its extension in land has reached the distance at which export or import trade by it ceases to be profitable.

It is evident, therefore, that the assumption that a railway, simply because it is a railway, must benefit in an important degree every district it passes through, is erroneous. It *may* do so, under certain conditions, but it also may not. The cost of carriage by it for the distance at which the district in question is situated from the sea may be greater than articles of export will bear; or the traffic on the line before it reaches the particular district may be all that the line can accommodate. I speak of the *export* trade as deciding the question, because when there are no exports there clearly can be no imports, and the *local* traffic in a country with no external trade must be insignificant.

15. Now, which of these supposed causes is likely to apply to the Bombay and Nagpore Railway? It enters the Nagpore Valley at a distance of 500 miles† from Bombay, and the questions that arise are,—1. Will the cost of carriage by it be such as to give rise to such an increase of production as we have reason to believe that valley is capable of? What amount of traffic is such increase likely to cause? Can the railway accommodate such traffic, either as a single or a double line?

In answer to the first question, it may safely be said that in no country in the world, in conditions at all similar to India, does a railway entering a particular tract at a distance of 500 miles from the sea, produce any but the most insigni-

* *See* Mr. Temple's Report upon the subject. Raipore is the principal town of Chutteesghur.
† In round numbers.

ficant effect upon it. In fact there is but one country in the world at all like India, a purely agricultural country, whose wealth consists simply in the raw produce it exports, and that is America, where such a line is to be met with, and there the result is as described. There there may be two or three such, and they have a local traffic, and a small *through* traffic, but the exports by them from distances of 500 miles are insignificant; these go in every case by water, even though that be available for only eight months of the year, and the prosperity of such inland tracts is entirely owing to the facilities they thus possess for cheap export. Such lines have a value in a country like America, already provided with the finest system of internal navigation in the world; but the *wealth of the country* is made by the water lines, and is wholly dependent upon them. Thus we find the auditor of the New York State Canals speaking thus in 1860: "The conflict of political "partizanship has not been the least evil encountered during the last thirty-five "years of intense struggle which has been going on while our public works were "moving to an enlargement and completion. The canals have forced themselves "into public confidence, and we have the gratifying spectacle of seeing that the "commercial tonnage borne upon their imperial waters in 1860 was a little more "than *seventy* per cent. of the whole import and export tonnage of the United "States."

This, be it remembered, is said of a country where there has been the keenest and most reckless competition between the different carrying lines, and where there is a larger extent of railroad than in any other in the world; for where once a country possesses the essential elements of wealth in a fertile soil, a free people, just laws, *and water transit*, railways will follow, and both feed upon and increase the wealth thus created.

This case of America is, in respect of this question, parallel to that of India, and is the only one that is so. No similar case is to be found in a manufacturing country like Europe, where goods of high value have to be moved, and where the distances are not above a tenth of those in India, while at the same time *water carriage is everywhere available*.

No data for determining this question are to be had from India, because there the railway lines are but recently made, and it may be thought that they have not yet had time so to develop their traffic as to render present results a safe guide as to what may yet be expected of them. What we need to furnish a really parallel case to that of the Bombay and Nagpore railroad, is a purely agricultural country, with little or no manufactures, and *without water communication*.

The last is an important condition: for where the wealth of a country has already been largely developed by means of cheap water carriage, railways may follow and find considerable traffic in the articles which a *wealthy* people require. Unfortunately, such a strictly analogous instance is not to be found; the most similar case is that, as above said, of America, where we have large productive tracts at a great distance from the sea-board, and so far in condition similar to the inland provinces of India, but differing in this respect, that before the introduction of railroads they possessed a magnificent system of internal navigation by river and lake, which had been largely improved and extended by means of canals. They were not, therefore, isolated tracts like those of Central India, shut out altogether from the general commerce of the world, but, having already ample means of export for their produce, were rapidly accumulating wealth, and were, therefore, prepared to receive, and to give employment to, the new and more expensive mode of transport suited to the requirements of a higher civilization.

16. Let us, however, select for comparison those States which are in circumstances most nearly resembling those of Central India, viz., the Western States, lying around the southern and western margin of the lakes.

A great part of their produce is exported eastward by the lakes, and by the lines of canal and railroad which connect the lakes, at Buffalo and Dunkirk, with New York. There are three such lines,* 1, the Erie Canal and Hudson River; 2, the New York Central Railroad and Hudson River; 3, the Erie Railroad, connecting Dunkirk with New York. By these three routes the Western States

* Lengths: Canal - - - - 360 miles.
Hudson River - - - - 150 "
New York Central Railroad - - 325 "
New York and Erie Railroad - - 445 "

exported in 1862 to New York 3,950,000 tons of produce (which, it may be remarked, had, before being shipped to these lines, been carried 500 to 1,000 miles by the lakes), to New York, and* of this quantity 3,150,000 tons, or eighty per cent., went to the canal.

Now, to comprehend the full significance of this fact (and if space permitted it might be greatly strengthened by similar comparisons for other parts of America) it is necessary to observe—

1st. The two railroads are both double lines.
2d. They are in direct competition with one another and the canal.
3d. They are, of course, open all the year round.
4th. The canal is closed on an average for four and one-third months of the year, and was closed for three and two-third months in the year in question.
5th. The canal is as yet without steam power, though this has lately been introduced in most of the English canals with great diminution of expense.†

A part of these exports are for the consumption of the manufacturing States in the Atlantic; and of the remainder, which are sent to Europe, an increasing proportion goes by steamers making the passage in ten to twelve days.

Time, therefore, is in this case already an important element. Shipments of produce at Buffalo are constantly ordered by telegraph from New York.

In spite of every disadvantage the canal thus carries eighty per cent. of the whole tonnage. Why? Clearly because it carries more cheaply than the railroads. It carries more slowly, and for only two-thirds of the time; but being the cheapest route it nearly monopolises the traffic.

Let me here again explain that I am not now discussing the question of water *versus* rail. The case would have been just the same had it been road instead of canal against railway, supposing it to carry as cheaply. The object is to show that in America the railways do not carry more than a fraction of the great traffic of the inland States, and that if those States have a large export trade, or rather the largest in the world, it is *because they have water carriage*.

17. If we now apply this illustration to the case of the Bombay line, we find that the adverse conclusions above drawn as to the effect of railways in America are greatly strengthened in its case, for, (1) the cost of the line is greater; (2) the working expenses are, probably, greater, owing to the greater cheapness of fuel in America; and (3) the profits on the passenger traffic must be but a fraction of those on the American lines, where the charge is 1*d.* to 1½*d.* per head per mile, against ⅜*d.* to ½*d.* in India; (4) the sea passage from India to Europe, occupying three *months*, instead of only twelve *days* from America, speed in the transport of goods from the interior to the coast is a matter of far less importance than even in America, where we find, that in spite of the superiority of the rail in this respect, the great mass of the exports move by water.

* This was in spite of the keenest competition on the part of the two railroads, a competition which only a great superiority in *cheap* carrying power in the canals can withstand, for were the rival routes at all on equal terms in this respect, the Railway Companies being carriers and from their immense capital able to make large sacrifices, if necessary, to crush opposition, would inevitably win in a contest where their opponents are a number of private carriers of small means, dependent on their earnings for the means of maintaining their trade. That the Railway Companies do thus frequently carry at a temporary loss in order to put down opposition is well known, and in this particular instance the following extract from the Report of the State Engineer of New York for 1863 shows that the two lines in competition with the canal have not scrupled to sacrifice earnings in order to secure a larger share of the traffic:—

"It will also be noticed that, in 1861, the averages on the New York Central Railroad have run down from 3·13 cents in 1857, to 1·96 cents a ton a mile—a reduction of 1·17 cents a ton a mile; that the averages on the New York and Erie have run down from 2·48 cents a ton per mile in 1856 to 1·78 cents in 1861—a reduction of three-fourths of a cent or 7·5 mills, which is equal to a *loss* of 1,885,125·19 dollars on freight. This road received in 1861 194,336 dollars *less* in freight than in 1856, on an *increased* carriage of 67,892,081 tons carried one mile. It will be found on examining the tables that the New York and Erie Railroad carried, in 1861, 310,203 tons *more* than in 1856 of through and way freight, but the aggregate earnings were 194,336 dollars *less*."

That the canal prospered in spite of such competition is shown by the fact that although in the next year 1862 the tolls were raised to a higher figure than they had stood at for ten years, the total movement in the canal increased from 863,623,507 tons one mile in 1861 to 1,123,548,430 tons one mile in 1862.

† "The cost of haulage by horses is one halfpenny per ton per mile; that by steam tugs a little under a farthing per ton per mile (about ¼*d.*). These are the rates charged to traders on the Ashby-de-la-Zouch Canal."—Thames Navigation Improvement Report, para. 517.

18. But it is further to be considered that while the railway can certainly carry no cheaper than in America, the need of cheap carriage in India is even greater than in that country, for these reasons: (1) that the value of the exports is less, and (2) that the cost of the ocean transport to the markets of Europe is greater.

Let us take the article of cotton, for instance, the most valuable product of Central India, and let us suppose that by the railway it is carried to the coast for one anna per ton per mile, or thirty-three rupees a ton. The total freight on it from Nagpore to Liverpool would then be,—

Carriage to the port - - -	33 rupees.
Freight by sea - - - -	25 ,,
Total - - -	58 ,,

On the American article the corresponding charges would be,—

Carriage to the port (1,000 miles) -	12 rupees.
Freight by sea - - - -	12 ,,
Total - - -	24 ,,

Thus, the cost of bringing the inferior Indian cotton to market would be two and half times that of the American cotton, which is at least twice as valuable. The Indian cotton, which from its lower value can least bear the cost of carriage, would thus be burdened with a charge two and a half times as heavy as the American, or, in proportion to its value, five times as heavy.

This is equivalent to an enormous protective duty in favour of the American producer.

The comparison with other cotton-producing countries, Egypt for instance, would be equally unfavourable. India competes with them all at a great disadvantage. Its cotton is of inferior quality, and it is much further from market. Clearly, therefore, if India is to compete successfully in the European markets it is essential that the *only* charge upon its cotton capable of reduction, that for transport to the port, should be cut down to the lowest possible amount.

The railway will, undoubtedly, effect an important saving in this respect, and so lead to a certain increase of production, but to nothing like what would follow a reduction of the cost to American rates, if that be possible. The amount of relief which it will afford to the Indian grower will be comparatively small, and much below what is required, and what will be shown to be practicable.

The excessive prices of the last four years have rendered cotton-growing such an extremely profitable pursuit that every country in the world has attempted it, and several which, previous to the American war, had no trade in this article, now find that they are quite capable of producing it of good quality at a remunerative rate. Fresh competitors are thus introduced into the market, and the margin of profit to the grower must become less and less. No country, therefore, and certainly India least of all, can afford to neglect any means of reducing to the utmost the cost of bringing the article to market.

19. The case is equally strong as regards the less valuable products, as oil-seed, wheat, rice, &c. The range of climate and soil adapted to their growth is less restricted than in the case of cotton; the area of production is, consequently, wider, and competition freer. The grower of Central India, therefore, needs all the help he can get from the cheapest means of export, to enable him to utilize to the full such advantages as he possesses. Agricultural produce of this class varies from 70 to 120 rupees value per ton in America, and is delivered at the port for four and five rupees a ton. In Central India it is worth forty to eighty rupees, and the freight by sea to the European market is at least double that from America. It is, then, of the greatest importance that the cost of bringing it down to the coast should be kept down to the lowest possible amount. But the railway charge (at an anna per ton) would be thirty-two rupees; six times what it is in America on an article of higher value. That cannot be thought a suitable mode of transport which thus discriminates against the Indian grower in favour of his American rival; nor can we expect in Central India, under such conditions, any such development of its capabilities or expansion of its trade as we witness in the case

of the American States, situated at a distance three and four times further from the coast.

20. But again, the necessity for cheap carriage in a case of this kind is not limited simply to the export requirements of a country. It is equally needed to supply in sufficient abundance, and at the lowest rates, those articles of low value which constitute what may be called the raw materials of agriculture, and which are amongst the first requirements of an agricultural community, such as manure, lime, fire, timber, and building materials. Wherever agriculture is in a healthy and flourishing condition, articles of this class circulate in enormous quantities, and from their bulk and low value are always left to the water lines for conveyance. A cheap and abundant supply of these is as essential to the profitable production of such expensive articles as cotton, as to that of the less valuable products. It is only where these are available at low rates that any improvements in agriculture are possible. The Indian ryot now uses as fuel the manure which he would apply to his land, were any cheap substitute to be had. He grows wheat and millet where he might grow cotton, if he could get his food as cheaply from elsewhere. He pays for salt what ought to be laid out on other articles. Cheap coal, cheap minerals, and cheap food are necessary to cheap manufactures; and precisely similar conditions are essential to cheap cultivation. Even if a railway could carry off the cotton at a sufficiently low rate, it could not supply the grower with all the other essentials to good husbandry, such as are required to improve the staple and value of the article, and to extend to the utmost its production.

21. To the above considerations may be added the great disadvantage at which Central India, provided only with a railway, must compete with the coast districts, with Rajahmundry, for instance, where articles of all descriptions, cheap or valuable, are carried at such very low rates. Such districts must, of course, retain a certain superiority inseparable from their position; but this should not, and need not be such as is involved in a difference of forty and fifty rupees a ton in the cost of export.

This investigation of the question can lead to one conclusion only, that the railway now approaching completion does not possess such capabilities of cheap transport as are needed by a country in the condition of Central India; and that the inference to be drawn from the experience of other countries similarly situated is greatly strengthened in this particular instance.

22. But there is yet another question to be considered. Could the railway, supposing it to carry at rates low enough to attract the traffic of Nagpore, accommodate it? Could it convey to the coast, and *vice versâ*, all the traffic that would flow to it? And the first point to be settled is this: supposing that country provided with really cheap means of carriage, what is its trade likely to be?

Here again India as yet furnishes no data for comparison, though some of the more improved districts afford some useful facts.

To find a case similar to that supposed we must again resort to America, where we find not only the special advantages in regard to communication now supposed, but all those other inducements to exertion, such as secure land tenures, and proprietary right in the soil, which, if they as yet exist but in part, it is the aim of the Government to afford to the people of India.

And we may form some idea of what the trade of an agricultural country, under such circumstances, like that of Central India, is likely to be from the instance above given of the Western States of America. We have seen that they export by the eastern route 4,000,000 tons of produce annually. The population which contribute this traffic is about 6,000,000 souls. This gives for the export trade alone about two-third ton per head. If the proportion were anything like this in India (and it is not necessary now to pause to inquire whether it might be more or less), there would be an export tonnage from the Nagpore Valley of 2,000,000 tons per annum.

Could the railroad carry this, or what portion of it could it carry?

The trade basin of the railway between the Western Ghauts and the Wurda, exclusive of the main line beyond the junction of the Nagpore line, covers an

area of 29,790 square miles, containing a population of about two and a half millions.*

The railway will, of course, receive the traffic of this tract before it can carry away any from Nagpore; and we may form some idea of what this may be, and of the capability of the railway to carry it off, from the fact that two double lines of railway (worked almost to their utmost capacity) running through the principal part of a population of three millions in the State of New York, *derive two-thirds of their tonnage from it alone*, besides all that the Erie Canal and the Hudson River carry off.

It is quite plain, therefore, that the Bombay Railway, even if a double line, which at present it is not, cannot possibly carry more than a fraction of the traffic which must flow to it, from its own trade basin west of the Wurda, if its rates are sufficiently low.

But not only has it to carry the traffic of its own trade basin, it must also carry off that which the main line passing through Central India, above Bhosawul, will bring down, and this will pass through a population of some millions more. Evidently, then, it would require several lines of railway to accommodate the traffic of the country to the west of the Godavery Valley alone. How hopeless then to expect that the railway can possibly afford vent for the trade of that valley or of any part of it?†

23. It may be thought that these illustrations, drawn from America, are inapplicable; that the two cases are too dissimilar for comparison. There are, of course, some points of difference in respect of the character of the two peoples, the extent of land available for cultivation, and the ease and security with which possession may be obtained and held. It is not meant to say that India, as it is now, is a fit subject for comparison with America as it will be; but that India, improved to the extent at which the Government now aims, fertilized, and its produce increased and secured by the application of water to the soil, and provided with such cheap means of transport as America now enjoys, must furnish results not inferior to what we now witness there. For it has a soil capable of yielding much higher returns to agriculture than that of America now does. Land watered in India yields from thirty to sixty bushels to the acre, while the average of that of the American States above cited is only twelve. Its productions also are much more valuable, combining those of the Southern American States with those of the

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* A dotted line in the map shows the limits of the tract whose trade would naturally flow to the railway. Its area is as above stated. Its probable population is thus deduced from returns of that of three large districts which it includes:

	Area.	Population.	Population. per square mile.
Candeish - -	9,311	778,000	83
Ahmednuggur - -	9,931	996,000	103
Dowlutabad - -	2,900	194,707	67

The return for Dowlutabad applies to the year 1849, when the population was stated to be only recovering from the effects of various causes which had operated greatly to diminish its numbers. The mean of the above, or eighty-four to the square mile, has been taken for the average population of the whole tract.

† The calculation, if worked out according to the American data, would stond thus,—

	Tons.
Traffic of trade basin of Railway from Bombay to Nagpore, at $\frac{2}{3}$ ton per head of population - - - - - -	1,666,000
Ditto of basin of main line above junction of Nagpore line at Bhorawul, for, say 3,000,000 of population - - - - -	2,000,000
Total traffic of trade basin west of the Godavery Valley - -	3,666,000

The total capacity for traffic of a *double* railway of similar length is reckoned, by Mr. M'Alpin, State Engineer of New York, at 1,500,000 tons per annum, and neither of the two busiest lines in the States, those in competition with the Erie Canal, have yet exceeded 1,250,000 tons. The above traffic would, therefore, be more than sufficient for two double railways, even if there were no such special difficulties as the inclined planes at the Ghauts must present to the working of such a heavy traffic. Then, *in addition* to the above, the exports from the Nagpore Valley alone would be 2,000,000 tons. If such a traffic be compared with the capabilities of the present railroad, partly single and partly double line, the utter inadequacy of this route to the requirements of the country will be strikingly apparent.

North, and its population, that, at least of Central India, is from forty to ninety to the square mile, that of the Western States of America being twenty-two. In these respects, and in the essential particular of both countries being exclusively agricultural, and dependent upon foreign markets for the sale of their produce, there is at least such a degree of similarity as to justify the comparisons above made. The results so obtained are, moreover, confirmed by what we now witness in the case of those few districts in India where similar improvements have been carried out. In Rajahmundry, with a soil only partially irrigated, and without that confidence which a permanent assessment of the land tax gives, but with cheap water carriage to a good port, already some hundreds of thousands of tons of produce and imports pass through its canals, though the benefits of these improvements are not fully enjoyed by the whole of its population. The traffic in the main canals leading to the port must be now somewhere about one-third of a ton per head of the population, against two-thirds of a ton in the Western States of America. It is important, also, to note that the trade of the district has reached this degree of expansion within fourteen or fifteen years from the time when the benefit of the improvements first began to be felt, showing how mistaken is the idea that the effect of such trials is only to be looked for in a distant future. In America, as is well known, the emigrant begins to export the first year that he breaks up the soil.

24. From such instances as these, and from such only, as it appears to me, can correct ideas be formed as to the probable effects of improved and *cheap* communication in India.

Nothing can be more fallacious than to argue from existing trade as to what it is likely to be under such totally dissimilar conditions, and no assumption more unfounded than that speculation upon the subject is useless. Unless we can form some definite idea as to the probable value of any particular line of communication, it will be impossible to decide whether it may be worth while to spend 100,000*l.* or 1,000,000*l.*, or 2,000,000*l.* upon it. I trust, therefore, I shall be excused for devoting so large a space to the discussion of this question.

25. With regard, then, to the Bombay and Nagpore railroad, the obvious inference from the above investigation is that neither in respect of cheap carrying power, nor of capacity for traffic, can it at all meet the requirements of the Godavery Valley. If this be not admitted, then we must take our choice of one or other of the two following conclusions:—

Either, 1st, if the railway rates of carriage are such as to produce any important effects upon the production of the country it traverses, the amount of traffic which must flow to it long before it reaches the confines of the Godavery Valley will be such as no single or double line of railroad can possibly convey, such, indeed, as it would require several lines to carry off. In this case the railway can manifestly be of no use to the Nagpore Province.

Or, 2d, if from inability to carry at such rates as will thus benefit its own trade basin, its traffic should prove to be such a fractional part of that above supposed as it can accommodate, the defect which will thus so greatly diminish its value to the districts nearer the coast must tell with far greater effect in the case of those more remote. If the rail cannot carry cheaply enough for its own trade basin, *à fortiori* will it fail to do so for the Godavery Valley.

Whichever of these alternatives we may adopt, the conclusion is the same, that the Godavery Valley requires for its improvement a distinct line of communication with the coast altogether.

This must be by the river, if practicable; but, before passing on to this part of our subject, a brief notice must first be taken of the suggestion that a road, which would cost no more, might, perhaps, be advantageously substituted for the water line.

26. This suggestion is made* on the supposition, which I shall presently show to be mistaken, that the river would be open for use during only four or five months of the year. Were the Government of India satisfied that a more

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* By the Government of India, in their Proceedings of 13th September 1855.

lengthened period of navigation were practicable, doubtless the idea of a road as an alternative would be at once abandoned.

It will be sufficient, therefore, briefly to direct attention to two considerations:—

1st. The high cost and difficulty of forming such a road, and the special objections in regard to the jurisdiction of the country which it must pass through.

2d. The high cost of transport by such a road, such that it could afford no relief to the greater part of the country it would traverse.

With regard to the first point, the cost is estimated at 1,600*l.* per mile, that being (establishment included) about the cost of roads in the Central Provinces.

But it is quite evident that, if this road is to be carried through British territory only, that is, down the north bank of the river, it must be specially and abnormally expensive, for (1) it will have to cross not only three great rivers, each fully half a mile in width, but the whole of the drainage of a tract 16,000 square miles in extent; and (2) when it reaches the Eastern Ghauts it must be carried right up over them and down again into the low country beyond, there being no pass on that side of the Godavery, and the passage along the bank of the river being perfectly impracticable, owing to the precipitous character of the hill sides, which could only be rendered practicable for a road at an enormous expense. It is evident that the ordinary cost of roads in a country like Central India, where there are no special difficulties, can be no guide as to the expense of a road constructed under such conditions.

Moreover, all the peculiar difficulties which the climate and paucity of population along the Godavery present to the construction of the river works, where labour has to be concentrated at one or two points only, where proper shelter and supplies of food can be provided, must be greatly increased in a case where the working parties would be scattered along a line of 250 miles in length.

If, to avoid these difficulties, the road be taken along the line of the existing cart track, on the right bank, it must then pass for 250 miles through the Nizam's country, where there could be no security for the traffic against plunderers, and where the conflict of jurisdictions would continually lead to difficulties and embroilments with the Native Government.

27. As regards the cost of transport by such a road, it is evident that in this essential point such a communication must altogether fail to exercise any important beneficial effects upon the inland districts. Even if we take the rate per mile at two annas (Mr. Temple states it to be three annas in the Central Provinces), the cost for 450 miles would be fifty-six rupees (5*l.* 12*s.*) per ton, many times what would be necessary so to raise the value of produce in the interior as to give any great impulse to production, and six times the cost by the river. Even with a four or five months' navigation (and I shall presently show that this is far less than what may be had), the river would be a much more valuable communication than the road. For the cost by water would be only nine rupees a ton, or forty-five rupees less than by road, while the average value of the great bulk of the produce being only fifty to sixty rupees a ton, the interest at even twenty per cent., for the six months of interrupted navigation during which produce would have to wait for export, would be only six rupees a ton, leaving a clear gain of thirty-nine rupees a ton in favour of the river. It is not too much to say that the river, even if available for four or five months only, would be of the highest value to the country (on which point the Government of India have already expressed a most decided opinion), while the road would be such an expensive mode of conveyance that the money expended upon it could benefit the country in a very small degree.

I pass on to notice the only remaining alternative mode of communication with the coast, the Godavery.

THE GODAVERY.

28. The line of least descent in the valley of the Godavery is that which, commencing at the Wurda near Hingenghat, follows the course of that river and of the Godavery to the sea. The total distance between Hingenghat and the port of Cocanada is 445 miles. The whole of this length of river would be navigable were

it not for the obstructions caused by rocks in the bed at three points. To these three rocky reaches the name of barriers has been given, and they are situated as follows:

	Length.	Distant from Sea.
First Barrier	8 miles	142 miles.
Second Barrier	14 „	220 „
Third Barrier	36 „	309 „

The first and second of these rocky reaches may be passed by steamers at certain times during the flood season, when the river is full enough to submerge the rocks. The third can hardly be said to be navigable at any time, though a steamer has been taken over it. The open reaches of river between these barriers have a gentle slope well adapted to navigation. They are in length as follows,—

Sea to First Barrier	142 miles.
First Barrier to Second Barrier	70 „
Second Barrier to Third Barrier	75 „
Third Barrier to Hingenghat	100 „

There are thus 387 miles adapted to navigation, and 58 which are not so.

The river, deriving its supply solely from the monsoon rains, partakes of the character of the seasons, and has an abundant supply of water, with occasional heavy floods, during a portion of the year, and during the remainder a much smaller, and, as the hot season advances, gradually decreasing stream.

Such navigation as it is capable of is thus naturally divided into two parts,—

First—Monsoon Navigation - from July to November inclusive.
Second—Dry Weather Navigation „ December to June „

29. A survey of the river was made by order of the Madras Government in 1855, with the view of determining the cost of opening the river for navigation, for periods of greater or less duration in each year.

The result was the submission of a scheme for works, estimated to cost as follows,—

	£
1st. For removing all the existing obstructions caused by rock, including the works required at the three barriers -	300,000
2d. For regulating and replenishing the flow of the stream so as to make it navigable during the dry season*	360,000

It was calculated that the first part of the scheme, if carried out, would render navigation practicable for eight or nine months of the year. The Madras Government declined to take up the second part, considering that the first possessed an important value of its own, and might, after completion, be supplemented by the second if necessary.†

30. Two distinct projects were thus placed before the Government,—

	Estimated to cost.
1. The Monsoon Navigation Project	300,000
2. The dry weather	360,000

On the strong recommendation of the Government of Madras, the Court of Directors ordered the first to be carried into execution, so soon as there should be funds available for the purpose.

No constructive operations, in furtherance of this project, were undertaken before 1*st January* 1861.

* Viz.: Stonework in the bed for confining the stream within proper limits - £160,000
Storing water - - - - - - - 200,000
Total - - - £360,000

† Neither estimate had much pretension to accuracy, the second was merely a rough approximation. The total cost of rendering the river navigable all the year round was thus estimated at 660,000*l.*

In the interim the following expenditure had been incurred,—

	£
In 1855–56–57 - - - - - -	13,347
In 1859–60, to 31st December - - - - -	2,436
Total - -	£15,783

		£
Viz., in 1855.	For survey of river - - -	6,000
	*Blasting and removing rock in the two lower barriers - - - - -	5,700
1857.†	Construction of two temporary locks in first barrier	914
„	† Temporary improvement of shoals - - -	720
„	Construction and repairs of steamers and boats -	1,000
„	Establishments - - - - -	1,449
	Total - -	£15,783

31. In the latter part of 1860, sanction was given by the Government of India for an expenditure of two lacs, in the official year 1860–61, on the works proposed, in the Monsoon Navigation Project, for the First Barrier.

Operations were commenced in the beginning of 1861, and at the close of the official year 5,490*l.* had been expended, on works chiefly of a preparatory nature.

32. In April or May of that year an important proposition was brought forward. It was urged (1) that the Budget allotment for the following year being only 20,000*l.*, the prosecution of the works on annual grants of this amount must be a tedious operation, the conclusion of which could only be looked forward to at the end of ten or fifteen years; (2) the open parts of the river between the barriers being navigable, the substitution of portages, as a temporary measure, at the barriers, for the locks and canals of the Monsoon Navigation Project, would render navigation practicable from the Nagpore country to the coast; (3) that the works required for such portages, viz., roads or tramroads, might be made of simple and cheap construction, in the course of a year or two, for a small part of what the permanent works in the river bed would cost; and (4) that the application of the available funds to this purpose, in lieu of that for which they were originally intended, would yield immediate results, would bring the river into immediate use, and so, it might be hoped, commence a traffic which, by the time the permanent works should have been completed, might be expected to have become important and remunerative; (5) that the river having thus been brought into operation, the locks and canals at the three barriers might be proceeded with, and prosecuted as rapidly as the available funds might permit.

This proposition received the approval of the Madras Government. A light tramway was ordered to be constructed with the least possible delay round each of the barriers, and two steamers (there being in all about six available) were placed in each of the navigable reaches of the year. It was intended that as soon as these preparations should be completed, the line should be opened for use, a special agency being organized for managing the transport of goods and passengers, which would then be effected by means of steamers in the navigable reaches of the river, and by tramways at the barriers.

* This work was proposed, and estimated for, by Colonel F. C. Cotton, in 1854. The object was to facilitate the passage of steamers over the barriers in the monsoon. It was carried out in 1855, but without effecting any material improvement in the navigation. It formed no part of the Monsoon Navigation Project which was subsequently brought forward.

† In 1857 no funds being available for the Monsoon Navigation Scheme, an attempt was made to render the First Barrier passable for boats, by means of locks constructed in the river bed. The locks were built, but, no further operations having taken place during the two following years, they remained unused, and some blasting and cleaning away of rock, which was required to render them effective, was never executed.

‡ In 1860, a small sum was granted by the Madras Government for the purpose of keeping open navigable channels through the shoals in the river below the First Barrier, with a view of facilitating the working of the steamers which were then engaged in carrying up military stores for the troops at Nagpore. The means used were groins of a temporary construction, called "bandals," made of bamboos and grass, and their operation was very successful. Up to the 5th February, or the beginning of the eighth month of navigation, a minimum depth of three feet was maintained in all the shoals between the Sebbry and Dowlaiswaram Annicut.

33. In June 1861, the navigation works which had been commenced at the first barrier were ordered to be stopped, and the allotment for the year to be devoted to the construction of the tramroads.

34. By the close of the year, 30th April 1862, the progress made was as follows:

At the First Barrier, the tramway, nineteen miles in length, was about half finished.

At the Second Barrier, the earthwork and ballasting of the line, eighteen miles in length, was nearly completed, and the greater part of the rails and sleepers laid.

At the Third Barrier, three-fourths of the earthwork and a portion of the ballasting, of a line thirty-three miles in length, was done.

At all three points temporary sheds for the reception of goods were erected, and the arrangements generally were in such a state of forwardness that in May 1862 the Madras Government ordered the line to be opened for traffic. The transport at the three barriers was to be effected by means of common carts, pending the completion of the tramroads. Public notice was given accordingly in the various district Gazettes, and in June navigation was commenced. The transhipments at the barriers were only effected with extreme difficulty, owing to the badness of the roads over which the goods had to be carried. The steamers also were ill adapted to the navigation, being mostly of small size, originally intended for still water canal navigation. Nevertheless, 1,290 tons of goods and 3,000 passengers were carried during the season, including about 1,000 bales of cotton from Chanda (the chief town in the southern part of the cotton country) to Cocanada. The result, considering the difficulties under which the transit was accomplished, was highly satisfactory, and justified fully the expectation that, with better steamers and properly equipped roads at the barriers, a safe and remunerative traffic of considerable amount might be obtained.

35. On 1st May 1863, the whole of the works of the Godavery were placed under the Central Provinces Administration. The expenditure, under all heads, up to this date, from 1st May 1861, viz., in the previous two years, was 92,876*l.*, or from date of the commencement of operations in January 1861, 98,366*l.* In addition to this there was a sum of 37,403*l.*, being the amount of unadjusted advances for labour and materials, and of sums expended in the purchase and repairs of steamers, boats, machinery, tools, &c., which had not, up to the close of the year, been exhibited in the accounts, under the several heads of work to which it was chargeable. A supplemental account for this was submitted, making the total expenditure, from the commencement of operations in 1861, 135,769*l.*

	£
Viz., in 1861 to 30th April - -	5,490
1861–62 - - - -	36,179
1862–63 - - - -	56,697
Supplemental Account - -	37,403
Total	£135,769

Of this amount the principal items were,—

	£
Expenditure on Annicut and canal at First Barrier -	39,342
Ditto, on tramroads - - - - -	37,570
Ditto, purchase of plant - - - - -	31,611
Ditto, improvements in river bed between First Barrier and the coast* - - - - - -	5,259
Ditto, establishments - - - - -	17,490

* It has been mentioned above that the operations undertaken in 1860, for deepening the channels through the shoals, had proved successful. In 1861 improvements of a more permanent character were effected. A good deal of rock which obstructed the stream at certain points was removed, and three groins of stone for confining the stream to a channel of proper width were commenced. One only of these, 600 yards in length, at the confluence of the Sebbry, was completed, though not to the full length required. Its operation has been most satisfactory. There was a shoal at this point which was, without exception, the worst known on the river. Little or no success had attended the use of the "bandals," and it proved the most formidable obstruction to the dry weather navigation between the First Barrier and the coast. Since the construction of the groin this shoal has almost entirely disappeared, and only the extension of the groin to its proper length is required for the complete extirpation of this serious obstruction.

The successful operation of this work is, in fact, the most important result of all since the commencement of the navigation works, from the direct proof which it affords of the possibility of so removing the natural defects of the *sandy* bed of the river as to allow of navigation by steamers of good draught during the dry months.

36. This statement shows that up to May 1863 not half the expenditure that had taken place was incurred on account of First Barrier works. These works, forming part of the Monsoon Navigation Project, had received much less attention than the tramroads. The prosecution of the original scheme (the Monsoon Navigation Project) had in fact, up to that time, been subordinated to that of the *altogether distinct and independent* scheme for opening immediate navigation by means of land transport at the barriers. The larger and more important scheme was, indeed, for a time suspended altogether, and throughout was only carried on in subordination to the lesser, the completion of which was made, by the orders of the Madras Government, the primary object of the engineers. It is important to notice this point, because it shows that much of the disappointment which has been felt at the small progress made with the navigation works, in comparison with the expenditure incurred, is groundless. The Government of India is evidently under a misapprehension upon the subject, owing to want of information, attributable, I think, chiefly to the repeated changes which have taken place in the jurisdiction under which the works have been conducted, and in the *personnel* of the different administrations through whose hands the correspondence has passed.* The facts are,

1st. The project for the Monsoon Navigation Works was submitted to Government in 1856.

2d. No operations in furtherance of it were commenced until January 1861.

3d. During the next two and a half years the works were in great part kept in abeyance, the principal operations being those for a separate and independent scheme.

4th. The expenditure in labour, materials, &c., during this period, including all preparatory works for the clearance of jungle, housing of workpeople and establishments, and erection of workshops, stores, and hospital buildings, was only 39,342*l.*

37. On the transfer of the works to the Central Provinces, the tramroad scheme was abandoned, the Chief Commissioner disapproving of it, and the Government of India endorsing his views. The work already done at the Second and Third Barriers was, therefore, left incomplete, and the money expended upon it must be regarded as in great part lost. The tramroad at the First Barrier, being of use for the transport of stores, materials, and food, from point to point of the line of canal under execution, was completed, and has been of much use.

From that date, viz., 1st May 1863 to the present time, the constructive operations have been chiefly confined to the Monsoon Navigation Works at the First Barrier, and the expenditure in the two following years (to 1st May 1865) has been 134,513*l.*

38. During the period above passed under review, a further expenditure took place on minor works, as noted in the margin.†

	£
Exploring Expedition of 1861–62	693
Survey of the Wurda in 1863	71
Drainage and clearing of station at First Barrier	331
Preparatory works, as surveys, clearing, &c., at Second Barrier	745

* Those changes have been great since 1st January 1861. The works commenced under Sir Charles Trevelyan continued under Sir H. Ward, then under Sir W. Denison, and finally were transferred to the Central Provinces under the administration of Mr. Temple, and a few months past of Mr. Campbell. During the same short period there have been three Governors General, Lord Canning, Lord Elgin, and Sir J. Lawrence. In the office of Deputy Chief Engineer, Chief Engineer, and Secretary to Government, the following succession of officers took place during the period referred to: at Madras, Colonels Boileau, Rundall, Ludlow, Horsley, Birdwood; at Nagpore, Colonels Impey, Dickens, Maxwell; at Calcutta, Colonels Dickens, Strachey, Dickens. Considerable diversities of opinion in the controlling authorities, and changes of plans in the direction of the works, could not but result from such changes, while it could scarcely have been possible for each incumbent to transmit to his successor a clear idea of the history, nature, and condition of the works. Add to this, that the engineers and their office establishments had to conduct their duties amid interruptions arising from frequent attacks of fever, to which not a few of the natives and some of the Europeans finally succumbed; and that in the transfer of the works to the Central Provinces a total change in the system of accounts and in the organization of the establishments took place, and it can scarcely be surprising that the officer who finally took up the long and tangled thread of correspondence in 1865 should find himself in ignorance of some points connected with the subject, or that the officer who had continued from the first in immediate charge of the works should fail fully to appreciate, as it was desirable that he should do, the need of information felt by his superior at Calcutta.

† These operations were as follows:—(1). Previous to 1861, no steamer had ever ascended the river further than the Second Barrier. In this year two steamers were taken over that barrier, and placed in the reach above it; and a third was taken over the Third Barrier in a flood, an operation of great difficulty and danger, very ably performed by Mr. de Grousilier, Assistant Engineer, and Mr. Farley, (2). The Wurda, from the Third Barrier to Hingenghat, was surveyed and mapped, and the levels of its bed accurately ascertained. (3). The clearing of jungle and drainage of the station of Dumagudiem, at the First Barrier was partly effected. (4). The surveys and levels required for the preparation of the estimates for the Second Barrier works were completed, and the ground for a station partly cleared.

39. As I have not now the means of analyzing the expenditure of the last two years, I here give the total expenditure under all heads on the Godavery, from 1855 up to 1st May 1865, as stated by the Government of India, viz., 286,075*l.* Of this sum the amount debitable to the works embraced in the estimates for the Monsoon Navigation Project is 201,295*l.**

Viz:—	£
First Barrier works	85,867
Second Barrier works	9,878
Improvements in river bed	6,001
Establishments	40,055
Stock, steamers, boats, and machinery, materials and unadjusted advances	59,494
Total	£201,295

40. A brief description must now be given of the works originally proposed for each of the three barriers. These were,—at the First Barrier, a weir, with lateral canal, twenty-four miles long, and locks to complete the communication; at the Second Barrier, a weir, with locks in the river bed; at the third barrier, a weir, with thirty-two miles of canal, and locks.

41. It will be understood from what has already been said that work has only been commenced at two of the barriers,—the First and Second. At the latter, however, the operations have been trifling, and merely of a preparatory nature, such as the cleaning of station, building houses, and purchase of machinery.

42. At the First Barrier, a considerable expenditure has already taken place. The works at this point have been carried out hitherto on the original design, with the exception of some unimportant modifications introduced to diminish expense. It is estimated by the Government of India that 40,000*l.* more, which has already been provided for in the current year's Budget, will be required to complete the works so far as to open navigation past that barrier for four or five months in the year; and the expenditure of perhaps 2,000*l.* more, in still further clearing and deepening the channel through the rocky part of the bed below the barrier, will extend this period to at least six or seven months for steamers, and to the whole year for boats.*

43. Estimates have been submitted, and generally approved of by the Government of India, for the works required for the Second Barrier. The amount is 113,413*l.*, but the Government of India think it better to allow for a probable expenditure of 130,000*l.* The completion of these works would open the navigation to the foot of the Third Barrier, or to a distance of 309 miles from the sea.

(5). The surveys and levels required for the preparation of the estimates for the Second Barrier works were completed, and the ground for a station partly cleared.

* This estimate did not include the cost of the survey of the river which preceded it (6,000*l.*), nor of the work done in 1855 on a previous estimate of Colonel F. Cotton's, with which it had no connexion (5,700*l.*). 11,700*l.* is therefore deducted on these accounts; 3,300*l.* on account of the other works noted in para. 30, which also were not included in the Monsoon Navigation Project; and 69,780*l.* (including establishments) for the tramroads.

† The works here referred to are the Head Works (Annicut and Entrance Lock) and two miles of canal, with locks to connect with the river below. The complete scheme, as estimated for in the original project, consists of the same Head Works, with twenty-four miles of canal and locks. In 1863 it was proposed to reduce the expenditure at the First Barrier as much as possible, and to apply the saving to the prosecution of the works at the Second and Third Barriers, which, up to that time, had not been commenced, from want of funds. For this purpose it was proposed to complete, in the first instance, only two miles of the canal, and to connect it with the river by an additional set of locks, and to postpone the completion of the remaining twenty-two miles until the works at the upper barriers should have been finished. The proposal was not favourably received by the Government at the time, but has now been approved.

I have not thought it necessary here to complicate the calculations by any addition to the estimate on account of the work thus postponed, because it may be found that the smaller scheme will afford as good navigation as may be required for several years. See, however, on this subject further on.

44. The probable cost, then, of *so much* of the Monsoon Navigation Scheme may now be stated with confidence; thus,—

		£
Already expended, as above		201,295
Estimated cost of Second Barrier works*		130,000
Amount required to complete First Barrier*	£40,000	
Add for extra clearance of rock to bed below Barrier	2,000	42,000
Establishments:*		
First Barrier	15,000	
Second Barrier	43,330	58,330
Total for works at First and Second Barriers, and for improvements already effected in river bed below First Barrier		431,625
Add for clearing a passage through rocks at two places in river bed between First Barrier and Second Barrier (rough estimate)		2,000
Total for all works required to open navigation to Third Barrier, 309 miles from the sea		£433,625

45. Of this amount, 201,295*l.* has already been expended, and 55,000*l.* has been provided for in this year's Budget. Thus the total amount yet to be provided from the public treasury will be 177,330*l.*

The result of this expenditure will be as follows:—

The Godavery and Pranhita will be rendered navigable to a distance from the sea of	309 miles.†
The main Godavery will also be available for navigation, above the confluence of the Pranhita, for a further distance of	80 miles.‡
Total length of navigation	389

The cost thereof will be $\frac{433,625}{389}$ or 1,115*l.* per mile.

As more than half the expenditure required for this purpose has been already incurred, and the estimate of the remainder is that of the Government of India, based on detailed estimates already submitted, including every item for contingencies and establishments, and with an addition of thirty per cent. to the estimate rates for work, there seems no reason to doubt that the cost of opening the above length of river will not exceed the amount stated.

46. In now estimating the probable cost of the remaining works required for carrying navigation up to Hingeughat, which was the extent contemplated in the original scheme, it must be premised that we have no longer detailed estimates on which to base our calculations. But let it not, therefore, be supposed that we enter the region of mere speculation. The data we actually possess are sufficient to determine the essential points of the question; and for the estimates which I shall now give I venture to claim a higher title to confidence than is due to those of the Government of India for the road which has been projected as a substitute for the river, and which, as I have above shown, there are the strongest reasons to distrust. My estimates are based on surveys and levels actually made; those of the Government of India rest only upon the known average cost of a road in the Central Provinces, which I have shown cannot at all apply to such a purely

* As estimated by the Government of India.

† The distance by canal from Dowlaiswaram to Cocanada, thirty-two miles, is included in this, but, on the other hand, the calculation does not include twenty-seven miles of the Sebbry and about eight of the Indrawutty, which will also be rendered navigable. The Sebbry, for this distance, has been in use for some years, though as yet only for four months, some rock requiring to be cleared away a few miles above the mouth.

‡ The main Godavery is quite free from any obstruction to a distance of eighty miles (to Dermapoory) above the confluence of the Pranhita. I have myself ascended it, in a steamer drawing two feet, to a distance of fifty miles, in the middle of October.

exceptional case as that of a road down the Godavery, the very line of which is undetermined, and for which not a single level has been taken, or even a *reconnaissance* made. If, then, the question has been argued by the Government of India on such an assumption as this, I trust that due weight will be allowed to my arguments on the other side, since they proceed on much more satisfactory data. Let me also add that all that I ask for upon this subject is investigation, that the case may not be prejudged. I do not for a moment wish to commit the Government to any scheme which has not been fully investigated, and its practicability and cost determined. But I would respectfully submit that this question about the alternative routes, river or road, above the Third Barrier, has been prejudged. The road proposed by Mr. Temple has been surveyed, and estimated for, and would actually have been commenced before now, had there been funds available, while no survey whatever has been made for the river scheme, which has, indeed, been set aside without examination, and without any discussion or reply to the arguments which I adduced in 1863 to show that it was at least worthy of full investigation, and that, if practicable, it would be of far greater value than a road, a point about which I suppose there could be no doubt. It is necessary to premise this much, though I do so with reluctance, in order to secure an attentive and unbiassed consideration of what I have now to bring forward.

47. We have now followed the river up to the foot of the Third Barrier, a distance of 309 miles from the sea. The barrier itself is a mass of rock, thirty-six miles in length, with a fall which renders it unnavigable. Above it the Wurda, for a length of 100 miles, has a slope and width far better adapted for navigation than that of any part of the Pranhita or Godavery below. At the head of the barrier the width between the banks is 400 yards, and this gradually diminishes towards the source, being only 250 yards near Chanda, and about 150 near Hingenghat. These dimensions may be compared with those of the rivers below, where the width varies from half a mile to two miles. At the First Barrier the weir is a mile in length; at the Second it will be 1,300 yards; at the Third one of 400 yards would suffice.

48. In regard to the slope of its bed, this part of the river possesses a superiority still more marked, the average for forty miles above the barrier being six inches per mile, and for 100 miles one foot. The slope of the river below varies from one to two feet. There can be no question, therefore, that this reach of river is the most favourably adapted to navigation of the whole.

49. At foot of it lies, as above stated, the rocky reach called the Third Barrier. Some passage round this must first be made if the river above is to be used. The plan proposed for this is to construct a weir across the river at the head of the barrier, and from the pool above it to lead off a canal, which would be carried across the neck of the bend in which the barrier lies, to clear the water below, with which it would be connected by locks in the same manner as at the First Barrier.

50. There is nothing impracticable in this scheme. It is true no detailed survey has yet been made with reference to it; but the levels taken for the tramway, partly constructed in 1862, and which follows closely what would be the line for the canal, are conclusive as to the fact that there are no difficulties whatever in the way of forming a canal. There is not a single hill to be crossed, nor a stream of the slightest importance. The country is very level, gently undulating, and with such an abundant fall (144 feet in thirty-three miles), that it will offer special facilities for adapting the level of the bed of the canal to the inequalities of the surface. I have been over it myself repeatedly, and had an officer and working parties stationed there for months, so that we are thoroughly acquainted with the levels.

There can, therefore, be no question whatever as to the practicability of making a canal. To determine its cost, detailed levels and surveys will, of course, be necessary, but from the levels already in our possession, and from my own knowledge of the ground, I estimated, in 1863, the cost of a *boat* canal (with locks large enough to pass cargo boats, or small stern wheel steamers only) at 131,000*l.*, exclusive of establishments; and my belief is, not only that this amount will be found sufficient, but that, by the substitution of the new system of inclined planes

worked by steam,* for locks, the cost may even be less. An abstract is given at foot.† It should be stated that this estimate was made *after* the completion of those for the two lower barriers which have now received the sanction of the Government of India, and with full knowledge of the actual cost of the work in the Godavery, derived from some years' experience. I submit it in its present form for criticism, and in the absence of any other shall assume that it is approximately correct.

51. The effect of these works may be described in one sentence. They would make a deep still-water navigation, extending from the foot of the Third Barrier to Bullarpoor, six miles from Chanda, a distance of seventy-three miles. This length of river and canal would be *navigable at all times of the year*. The canal would, of course, be so, and the forty miles of river above its head, having a fall of only twenty feet, would become a still-water pool also, by the construction of a weir of that height at that point.

52. Now, it is for this length of navigation, estimated to cost 131,900*l.*, that it has been proposed to substitute a common road, estimated to cost 75,000*l.* And the relative value of the two routes, and the effect upon the whole line of navigation of the one to which the preference has been given—the road—is shown by the original proposer thus:—

Cost of carriage from Chanda to Cocanada, by river, at 4 pice per ton per mile, 384 miles - - - 8 rupees
Ditto from Chanda to foot of Third Barrier, by road, 75 miles, at 3 an., and thence by river to Cocanada, 309 miles, at 4 pice - - - - 24½ ,,

In other words, the substitution of this one piece of road for the river would increase the cost of export, by this route, *threefold*.

If this simple calculation, which, I repeat, is not mine, is not sufficient to condemn the whole scheme of a road, I know not what argument I could use that would be more effectual. I will, therefore, transfer to foot notes‡ some of the

* This system has been in use on the Monklands Canal, in Scotland, for some years. The boat floats in a caisson resting upon a truck, which is drawn up, or lowered down, an inclined plane by steam power. The height of the inclined plane is ninety six feet. The levels of the canal at the Third Barrier may, very probably, be so arranged that the difference of level to be overcome, 160 feet, might be divided between two such inclines, one of 60 feet, and one of 100 feet. The saving in labour on the spot would be very great, as most of the work would be prepared in England and sent out ready to put up.

† Annicut and Head Lock Canal, Earthwork - - - - - - £20,100
Locks - - - - - £64,000
Sundries and Contingencies - - - - 32,000
96,000
- - - - 15,800
Total - - - £131,900

‡ Now if Moyellee* be made the head of navigation, only a corner of the important tract of country thus indicated will be effected by the improvement, or derive any benefit from it. In this case the cost of the land transport will be such an enormous addition to that of the water line that, as the Chief Commissioner shows, the river will attract no traffic from any point further north than Hingenghat. In other words, the limits of the trade basin in that direction may be described from Moyellee as a centre with a radius of 115 miles, instead of with one of 230 miles, were Hingenghat the terminus, or with one of nearly 300 miles if a little canal communication were opened northwards in connexion with the river. It needs but a cursory examination of the map to show what an immense extent of some of the most valuable and productive country in Central India will thus be lost to the river, contributing nothing to its traffic, and being itself deprived of the benefits of the communication. The trade basin north of the Third Barrier would in fact be only one-fourth or one-fifth in this case what it would be in the other, and thus by far the greater part of the very country which of all others it should be our object to reach, would be shut out altogether from the river and its port.

"But let us glance for a moment at the extent to which the proposed curtailment of the original project is likely to affect even the limited portion of the Wurdah and Wyne Gunga valleys which it would reach.

"The Chief Commissioner shows that the cost of carriage to Cocanada from Hingenghat by water alone might be Rs. 6. 15. 3 per ton, while from the same point to the Third Barrier by land and thence to Cocanada by river, the cost would be Rs. 26. 6. 3. This is to say, that the intervention of this one piece of land carriage would increase the cost of transport *fourfold*. To what extent is that likely to operate upon the traffic? Take any line of transit in India, or the world, and increase the rates of

* Moyellee is at the foot of the Third Barrier.

arguments I advanced in my Report of 16th November 1863, and merely observe here that, if the effect of the introduction of this road, as a link in the communication, is to be so disastrous, the counter scheme, which is estimated to cost so little more, and which would afford seventy-three miles of the best and cheapest navigation upon the whole line, is, at least, worthy of examination. If it is worth while to expend 1,115*l.* per mile on the river below, to bring the navigation up to the foot of the Third Barrier, surely it is worth while to spend 1,718*l.* per mile on the next seventy-three miles which would extend the navigation into the most populous and wealthy part of the Godavery Valley, rather than make a road at 1,000*l.* per mile, the extra cost of carriage by which would be equivalent to the imposition of a frontier duty of twenty rupees a ton on the export and import trade of that part of the Valley which, while from its natural advantages likely to have the greatest traffic with the coast, can, in consequence of its distance from the sea, least bear a high cost of transit.

I cannot think it can be necessary to say more upon this question. I shall be satisfied if what has been advanced shall be held to show the necessity for a thorough examination of the project for the Third Barrier.

53. But we have hitherto considered the effect of the proposed weir at the head of the Third Barrier upon the first forty miles only of the river above. We have seen that this much of the river, viz., from Ballarpoor, the port of Chanda, downwards, will be *navigable at all times of the year;* it will, in fact, be "canalised." We have now to consider the use that may be made of the river above, sixty miles in length, up to the neighbourhood of Hingenghat, the principal cotton mart of Nagpore. This piece of the river has a fall of 1·4 foot per mile, and is eminently adapted for navigation, if a sufficient depth can be maintained. It is in this

transport in this proportion, and the effect would be, in most cases, the annihilation of the traffic, or *decrease* them in the same ratio, and the increase may be not four, or five, or tenfold, but twentyfold."

"But the injurious effect of such a restriction of the scheme will be more apparent if we notice more in detail its effect on one or two of the commonest articles of trade. Let us take, for instance, salt, in which there is every prospect of there being a highly important traffic.

"The cost of carriage to Hingenghat by the two routes would be—

	Rs.	A.	P.	
By water only - - - -	11	9	5	per ton.*
By land and river - - - -	29	9	9	,,
Difference per ton - -	18	0	0	

"Now Rs. 13 per ton is Rs. 0. 10. 8 per maund. Thus the increased cost of carriage would be equivalent to an extra import duty of Rs. 0. 10. 8 per maund. Either this would operate as a most serious check upon consumption, and so upon the revenue from salt, or if this be not admitted, a river toll of this amount might be levied upon all salt imported by the river without checking consumption, supposing navigation to be practicable to Hingenghat, and as the Chief Commissioner is of opinion that with the river so improved, Nagpore Proper would derive the whole of its present supply of salt, 200,000 maunds, by the river from the Eastern Coast, the revenue from this toll alone would amount to 1½ lacs, representing a capital of 27 lacs, which therefore it would, on this ground alone, be worth while to spend on works above the Third Barrier.

"Or, let us take an export, such as oil-seeds, an article for which there is an ever increasing demand at Cocanada.

"The cost of carriage from Hingenghat by the two routes would be—

	Rs.	A.	P.	
By water only - - - - -	6	15	3†	
By water and land - - - - -	26	6	3	
Difference per ton - - -	19	7	0	

or Rs. 1. 8 per bag of two maunds."

"Now eight annas per bag is usually reckoned by the Cocanada merchants a fair profit upon this article, that is to say, that when they can clear this amount, the trade is sufficiently remunerative. Hence it appears that the above difference in the cost of carriage is *three times greater than what would suffice to stop the export of oil-seeds altogether*, and it must be remembered that in the production of this article, at least Nagpore has an important rival in the rich and highly irrigated tracts lying along the coast where almost every village has direct communication by canal with the port."

"It thus appears that, by carrying the navigation no further inland than the Third Barrier, we should fail to relieve so important an article as salt of a tax which must tell seriously upon its consumption, and leave the cost of transport so high that comparatively trifling fluctuations in price at the port may completely stop the export of some of the commonest staples. Is this to be the state in which the opening of the Godavery is to leave Nagpore?"

* See the Chief Commissioner's Report.

† Vide Chief Commissioner's Report.

respect that it is defective in its natural c tion. For such steamers as we now have upon the river, drawing two feet o ater, there is sufficient depth in this river for navigation during three month ly, and even during that time there are occasional interruptions when this de is not maintained; that is to say, *so far as we yet know the river*. But here o formation is defective, and this is just another part of the case in which I vente o submit that much has been assumed as proved, adverse to the river scheme, v e really *more investigation* was needed to establish the facts. A steamer drawi ally two feet of water was placed upon the Wurda, and during the season of I , when the transit operations were in progress, plied between the Third Barr and Chanda. It was found, as above described, that for such a vessel navi on could not be maintained uninter- ruptedly for even three months, in that rt of the river; but that is much the broadest part of the river, and the she might well be more formidable there than some distance higher up. In 1862 ascended the river in the same steamer to near Hingenghat, in September, a returned without difficulty. Several points have, therefore, to be establishe efore the original proposal to use this part of the river for navigation can be a doned.

1st. It must be ascertained for what gth of time it is navigable by vessels of two feet draught in its natural condition

2d. Inasmuch as from its gentle f and narrow width, it is pre-eminently adapted to improvement, it should be rtained how far the natural period of navigation may be extended by means such works as wing dams, groins, and training walls, which have been used ith advantage on other rivers for the purpose of restraining the eccentricit f the stream, and confining it to a narrower channel at the shallows.

3d. It should be ascertained to what ex t boat navigation, by sail and tracking, is practicable. It certainly is so for a lo the narrowness of the channel renders it r time than a steamer could run, and tion, which is always as cheap as steam. ecially adapted to this kind of naviga- Hingenghat and Chanda, and can be ta boats can ply in this manner between part of the value of the river may be re in tow there by tug steamers, a great d.

4th. Steamers drawing only one foot water can now be constructed and put upon this river. I myself built one wi draught of one and a quarter foot, of wood, which is now running below the t Barrier. It should be ascertained how much longer vessels of such draught could ply than those of two feet draught, either in the natural state of the river, or with its channel rectified as above suggested.

5th. It may very possibly be found, on examination, that, with the aid of some improvement of the bed, as above suggested, vessels of this light draught might work for some months.

6th. It is certain that the quantity of water required to supplement the natural flow of the stream to a degree sufficient to afford navigation for such light-draught vessels would be very small, and might be stored in the hills, west of Nagpore. This part of the river is peculiarly adapted to this mode of improvement. It is not more than three times the width of the Ganges Canal, its slope is considerably less, and one-fourth of the depth in the canal would be sufficient. In point of fact, however, at the few shoals where increased depth is needed the width of the stream would not be *half* this amount, as the water would not be permitted to spread over the whole width of the bed. There can be no question, therefore, of the applicability of the reservoir system in this case, and there is strong probability that the quantity of water to be thus stored will be found to be very small.

54. Putting all these considerations together, it must, I think, be admitted that the Wurda from Chanda to Hingenghat is eminently capable of adaptation to the purpose of navigation, and that there is at least a probability that the works required for the purpose may be found to be far less expensive than those proposed for any part of the rivers below. Under such circumstance a thorough investigation of the case is plainly necessary, for if the navigation can thus be continued up to Hingenghat, sixty miles further into the Nagpore Valley than Chanda, a great diminution of the cost of export and import will be effected, and the benefits of the communication more widely extended.

55. I have already contrasted the cost of carriage from Chanda to Cocanada by water, with that by road and water. A similar comparison may be made for Hingenghat. The several cases would stand thus:—

From Chanda to Cocanada by road and river (as above)	24½ rupees.
From ditto to ditto, by river	8 "
From Hingenghat to Cocanada by road to Chanda, and thence by water, 58 miles at 3 annas, and 382 miles at 4 pice	19 "
From Hingenghat to Cocanada by river, 467 miles at 4 pice	10 "
From Hingenghat to Cocanada, by road to foot of Third Barrier, and thence by water	31½ "

Now, the great value of the river carriage consists in its *cheapness*, and the radical objection to these substitutions of road for river is that by their means this essential advantage is lost; the value of the river is immensely reduced. For what must be the effect on the traffic of any such enhancement of rates as the introduction of roads would cause? If the cost of export and import is thereby doubled only, the traffic must be diminished in a very much higher degree; probably it would sink to a tenth at most of what it would otherwise be, and the loss to the country would be incalculable, while, of course, there would be a proportionate diminution of the returns from tolls on the whole of the expenditure on the 309 miles of river below the Third Barrier. It seems, therefore, clear that in no account whatever should land carriage be substituted for water in any part of the line until a full inquiry has shown that the river cannot be made use of for navigation, or could only be so at an altogether disproportionate cost.

56. With regard, then, to the river generally above the Third Barrier, there can be no question that it may be used for navigation up to Hingenghat, and if for the sixty miles of it above Chanda it be admitted that at present we are not in a position to determine *precisely* what works should be undertaken for its improvement, it will probably be granted that a clear case exists for full inquiry into this question. With regard, however, to the river below Chanda, from the town to the foot of the Third Barrier, let it be distinctly noted that no such uncertainty exists. The practicability and effect of the works proposed for this part is unquestionable. The levels which have been repeatedly taken, and are now thoroughly established, leave not a doubt as to the effect of such works as above proposed. They would form *a continuous canal navigation for seventy-three miles*, available without interruption at all times of the year. As to their cost, I shall, for the present, assume the probable correctness of the approximate estimate above given, amounting to 131,900*l.*, or including establishments (at thirty-three per cent.) 175,860*l.*

57. We may now review the cost of the whole scheme, which will stand thus:—

	£
Cost of works below Third Barrier as already described	433,625
Cost of works at Third Barrier	175,860
Add for cost of original survey of 1855	6,000
Total for all works up to Chanda, 382 miles from the sea	£615,485
If the works required for sixty miles of the Wurda above Chanda cost 1,000*l.* per mile, we should then have for the whole cost of opening the river from the port to Hingenghat, 442 miles	675,485

The total length of river which would thus become available would be:—

Cocanada to Hingenghat	442 miles.
Other tributaries (deducting for length of Cocanada canal	80 "
Total	522

and the cost per mile would be 1,300*l.*

58. Of the total amount required, 256,295*l.* has already been expended, and 419,190*l.* would yet be required to complete the works.

59. Thus, in four or four and a half years, with an annual allotment of 100,000*l.* the whole line might be opened for traffic.*

DURATION OF ANNUAL PERIOD OF NAVIGATION.

60. Now, what would be the effect of this expenditure in regard to the *time* during which the river would be available for navigation? This is an important point, and has been reserved for special notice here.

61. In the first place, it must be admitted that the expectations originally held out upon this point have not been fully confirmed by subsequent experience. The actual navigation of the river towards the close of the monsoon season was not commenced until some years after the original survey was made, and was then confined only to the part below the First Barrier. It was not till 1861 and 1862 that steamers were placed on the upper parts of the river, and that the state of the navigation was ascertained by actual trial.

62. It will be well to state here precisely what is now known upon this subject, and for what time navigation has been found to be practicable by the steamers now on the river, during the past three or four years. All these steamers draw at least two feet of water. It would, perhaps, be more accurate to say two and a quarter feet, allowing for some "sagging" amidships. One or two draw as much as two and a half and three feet.

In the reach below the First Barrier, then, such steamers work for eight months, meeting occasionally during the latter part of that time with detentions at the shoals, which, however, are not more than three or four in number. Steamers have worked to a later period, but the obstructions at the shoals usually limit their effective use to about the time mentioned.

Between the First and Second Barriers the shoals have not been the cause which has limited the time of navigation, but some reefs of rock which lie about halfway between the Barriers, and which, though removeable at a trifling cost, have been suffered hitherto to prevent navigation for a part of the time during which it would otherwise be practicable. Usually the passage through these rocks has not been safe after the middle or end of October. Nevertheless, I myself ascended this part of the river in December 1863, forcing a passage through the rocks, and met with but one shoal in the whole distance which caused detention, and this lay immediately below, and was caused by a cluster of rocks at one of the places referred to. This was in the middle of the sixth month of navigation. I made a special report upon the subject at the time, deeming the fact thus practically ascertained, of there being perfectly good navigation for vessels of two and a quarter feet draught, in the sixth month, of great importance.

Above the Second Barrier two steamers of the above draught were stationed in 1861, and worked for about four months in 1862. The transit operations, however, having been stopped, these steamers were subsequently brought down to the First Barrier. My impression is, that between the Second and Third Barrier steamers drawing two feet would meet with great difficulties in the fifth month, and, with occasional detentions, in the fourth.

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* This closely agrees with the estimate given in my report of 16th November 1863, in which the plans proposed were essentially the same as those now advocated:—

"First Barrier Works (to complete) - - - 3 lacs.
Second ditto ditto - - - 10½ "
Third ditto ditto - - - 13 "
Reservoir - - - - - 2 "
Clearance of rocks - - - - - 1 "
Total - - - 29½ lacs.

"Now if ten lacs a year could be given for three years, the river might be opened to this extent (viz., to Hingenghat) in that time."

This estimate does not include establishments. That forms, in all cases, a separate head of charge, and, as a rule, is not included in the estimates. If the charge for this be added at 33 per cent., the total approximates closely to the amount above given. It is satisfactory to find that the views then advocated have now, in regard at least to all the works below the Third Barrier, the concurrence of the Government of India; but if want of information has prevented the Government coming to an earlier decision, I cannot but regret that my strongly urged request, in March 1864, for permission to proceed to Calcutta, and there give in person any further explanations that might be required, was not granted.

Above the Third Barrier, as I have already stated, steamers of this class can only ply between the Barrier and Chanda during three or three and a half months, and not continuously for that time, the stream occasionally falling too low for a passage at the shoals. I ascended the river in a steamer nearly to Hingenghat in September 1862, and returned without hindrance, but a fortnight before this might have been impracticable.

In all these reaches boats, worked by sail and pole, can of course ply longer than steamers of the same draught; it may safely be said, fully a month longer.

63. It may be said, then, that were the obstruction caused by a few rocks in the open reaches of the river removed, the river would be navigable by vessels of two feet draught.

From the sea to First Barrier for	- - -	8 months.
Between the First and Second Barrier for	- -	7 "
Between Second and Third Barrier for	- -	5 "
From Third Barrier to Chanda	- - -	12 "
From Chanda to Hingenghat	- - -	3 "

Occasional detentions at the shoals would be met with in the latter part of the season, but as the removal of the rocks which here and there obstruct the passage would, at the same time, in many instances remove the shoals, these detentions would not be so frequent as hitherto.

64. Such would be the capability of the river for navigation, by vessels of two feet draught, were the works at the barriers completed, and a few rocks removed in the reaches between.

Were the draught of the steamers reduced to eighteen inches, I believe that the navigation of the river for the periods above mentioned would be almost unobstructed, and practicable for a month longer in each case.*

65. But the most important point in connexion with this subject is that we are now no longer limited to a draught even of eighteen inches. During the eight or nine years past great advances have been made in all departments of manufacture connected with iron shipbuilding, and the blockade running of the late American war has especially directed attention to the subject of light draught steamers. Steel, or "steely iron," can now be used freely in the construction of such vessels, and steamers may now be placed on the Godavery with a draught of twelve and fifteen inches. I did, in fact, build one of fifteen inches draught, of wood, in 1861, which has proved most serviceable, though from one of the boilers having sustained an injury in the passage out from England, the full power of the engines has never been obtained, and the speed is limited to seven miles an hour. With my letter of 24th August 1864, I submitted a specification by Messrs. Blyth, of London, for an iron steamer of 120 I.H.P., with a draught of fourteen inches; and I now append a similar specification by Messrs. Maudslay, Field, and Sons, for a steamer of larger size, suited to the dimensions of the locks now under construction at the First Barrier, with 240 I.H.P., and a draught of twelve inches.

It is evident, therefore, that the facilities for the navigation of shallow rivers are now immensely increased. We are, in fact, now in a position to say, without hesitation, that *all*, and more than all, the expectations originally entertained as to the *time* during which the Godavery may be navigated, may now be realized. It was stated, in my first report of May 1856, that if the barriers were rendered passable the river would be navigable for eight or nine months. It is a satisfaction

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* In writing upon this subject hitherto, that is since 1861, when we first commenced the navigation of the upper parts of the river, I have been accustomed to speak of the river as navigable for four or five months, referring to the whole length of it below the Third Barrier. I had received no orders to lead me to suppose that any greater precision was necessary. The Government of India having, in their Proceedings of expressed, in the most decided terms, their conviction of the sufficiency of a four or five months navigation for all the wants of the country for many years to come (see page , further on), I had no idea that the shortness of the period of navigation would, afterwards, be urged as a reason for abandoning the scheme. I had reported, at considerable length, to the Madras Government on the shoal navigation, and especially with reference to the success of the work at the confluence of the Sebbry, above referred to, and had I supposed that the Government of India entertained doubts upon the subject), and needed more detailed information, I should have given the details above mentioned. I cannot but here again express my regret that I was not summoned to Calcutta in 1864, as I requested. Personal conferences upon such subjects remove many misconceptions.

I object to this project and to the estimate of its cost.

1st. I object to the project—

(1) Because it proposes to substitute seventy-five miles of road for seventy-three of river, navigable all the year round, involving, at a trifling saving in the cost of construction, an increase (two or three fold) in the cost of carriage, which would immensely diminish the value of the river as a communication.

(2) Because the project further includes another fifty miles of road parallel to the river from the Third Barrier to Sironcha, which will be altogether unnecessary. With the river navigable for the whole year, the construction of a road alongside would be a fruitless waste of money, and even were navigation practicable for five months only, the cost of a piece of road, which would not be in any way a link in the communication at any time of the year, cannot fairly be charged to the river scheme.

2d. I object to the estimate—

(1) Because it includes in the expenditure already incurred a sum of 84,780*l.*, which I have shown was not expended upon any works connected with the scheme but upon those of altogether distinct and independent schemes.

(2) Because the estimated amount for completing the First Barrier Works is set down at 105,000*l.*, for works, and 35,000*l.* more for establishments, though in para. 44 it is stated that 55,000*l.* will be sufficient, including establishments.

(3) I object to the addition of thirty per cent to the cost of masonry, in the face of the strongly expressed opinions of the Superintending Engineers, that the lower rate is sufficient, and, with proper management on the part of the Executive Engineers, ought not to be exceeded. I have, nevertheless, included this additional cost in my estimates.

(4) I further object to this estimate because, after bringing up the total to 800,000*l.*, inclusive of a past expenditure of 286,075*l.*, with rates raised thirty per cent., and establishments calculated at thirty-three per cent. on the cost of works (a rate which, I believe, they have never hitherto reached), it is further stated that the total may come to 1,000,000*l.*, or even to 1,250,000*l.*

Every possible contingency is first of all allowed for; the amount yet to be expended is thus calculated at (800,000*l.*—286,075*l.*) 513,925*l.*, which may very well be provided in five years, and then the uncertainties, possible difficulties, and contingencies, are stated to be so incapable of calculation that this estimate may be found to come short of the true amount by 450,000*l.* This is to say, that with full knowledge of the actual cost of work upon the river, and after allowing for every probable source of extra expense, the best estimate we can make of the probable cost of work to be done in the next five years may very possibly be found to be only fifty-four per cent. of the truth; that the difference may be so great as between 523,000*l.* and 963,925*l.*"

71. I altogether object to this mode of calculation, and submit that there is nothing whatever in the history of the works hitherto to justify it.

It is quite true that the calculations made before we had any experience whatever of the country where the operations have been carried on have fallen far short of the result. The first estimates for works of this magnitude have always been found very deficient in all parts of India and the world; and in the case of the Godavery, a country almost wholly unknown and scarcely ever traversed by an European until a few years before the works commenced, the difficulty of estimating was peculiarly great. But present circumstances are quite different. We now know so thoroughly the cost of work, and what work *ought* to cost, that the Superintending Engineer is able to say that the cost of masonry last year was much higher than it should have been. Is it wise to allow for such extra cost in future

* The calculation is as follows:

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Probable cost of the works, including establishments and allowing for an increase of prices 30 per cent.	800,000
Deduct amount already expended	286,075
Amount still to be expended	513,925
Add 30 per cent. for unknown contingencies	450,000
Amount that may possibly be required	963,925

7025.

estimates, and after adding all probable contingencies to state that the result may not improbably be found to fall fifty per cent. short of the truth?

72. Lastly, I object to the result of the expenditure being described as "a river navigation for four or five months of the year," when the estimate includes a sum of 65,000*l.* for works which it was stated would make the river navigable by vessels of two feet draught for six months.*

73. This method of dealing with the question is, if I may be permitted to use a common expression "burning the candle at both ends." On the one hand, the *value* of the scheme is enormously reduced by the substitution of road for river on the upper part of the line; its value in this modified form is still further depreciated by a misapprehension as to the extent of navigation it would afford; and, on the other hand, its *cost* is unduly increased (1st), by including the cost of a number of works which formed no part of it whatever; (2d), by an increase of rates to which I venture to object; and (3d) by increasing the sum total thus obtained (and with all possible contingencies included) *fifty-six per cent.* on the supposition that the work yet to be done in the next five years may exceed the most liberal estimate that can now be made by *ninety per cent.*

Thus by a series of substitutions of road for river, *without investigation as to the practicability or cost of the works proposed for the latter*, the original scheme for opening a line of navigation to a distance of 445 miles from the sea, approved by the Court of Directors and the Secretary of State, dwindles down into a river navigation of 300 miles, and a road of 125 miles, the introduction of the latter at once depriving the scheme of almost the whole of the advantage which it promised—*cheap carriage* to the part of the country most in need of it, and best prepared to benefit by it. So low at last does the scheme sink by this process, that it compares unfavourably, in the opinion of the Government of India, with a common road. As to *cost*, the most liberal estimate that can now be made is increased *ninety per cent.*, to obtain a rough approximation only to the amount which it may be necessary to expend in the next five years.

I submit that this method of dealing with the question can only lead to the most erroneous conclusions.

I may here, also, point out an error in the description of the general project in the letter of the Government of India of 19th September 1860, paras. 10, 11, 12.

"We think it quite possible that the cost of the works in the end may come up to a million and a quarter sterling. And further, when done, the work will not provide what has been contemplated by the projectors of the scheme, a navigation of the Godavery for the entire year, but only for four or five months. So that there is still to be contemplated the possibility of the Government being urged to perfect the work; and not only to carry the navigation up to the Wurda, but also to store up water to supply the works during the dry season, and to extend the navigation throughout the year. To do this would, we think, not cost less than a million, or a million and a half more than the scheme we formerly adopted with your approval. When originally proposed the entire series of works was estimated at 300,000*l.* to provide this complete navigation."

This is an entire misapprehension, and it is difficult to conceive how it can have arisen in the face of the explicit statements on the subject, both in my Report of 1856 and in the Orders of the Madras Government thereon. I have above shown that the estimate of 300,000*l.* was for the works at the three barriers only, and for clearing some rock in the reaches between, and that the *additional* works, required for extending the navigation to the whole year, was then roughly estimated at 200,000*l.* more.

VALUE AND IMPORTANCE OF THE GODAVERY NAVIGATION.

74. In considering, in the next place, the value and importance of this river communication, it will be proper again to revert briefly to what has already been said as to the present condition of the people of the Godavery Valley. Without a distinct understanding of what this really is, we should fail altogether to perceive

* Memorandum by Mr. Temple, 20th August 1859, par. 19.
Report by Captain Haig, No. 616, 10th November 1862, par. 29.

the true bearings and importance of the Godavery question. It is evident, both from Mr. Temple's reports and from the despatch of the Government of India, that the opening of this river is regarded quite as a secondary question, a scheme which, if carried out, would be beneficial to a certain extent to the lower part of the valley, but by no means a matter of vital importance, such as it has been represented to be by its promoters. Upon this point I venture to differ entirely with these high authorities, and beg to state my reasons for so doing.

75. What then is the present condition of the Godavery Valley?

In the first place, it is without a foreign market, and production is limited almost entirely to the requirements for home consumption. In other words, the people are engaged almost exclusively in growing their own food. The testimony of the Chief Commissioner, Central Provinces, upon this point is conclusive, and it must be remembered that it applies to by far the most prosperous part of the whole valley, the Nagpore Province:—

"It has possessed no natural outlets, like navigable rivers, and no artificial communications like roads. It has grown produce chiefly for its own consumption; it has no special manufactures of its own; nor has it imported largely the products of other places."

It should be added that its principal imports are food and salt, the latter at a rate of only 5 pounds per head, and at a price three times that of the same article in the coast districts.

76. In regard to revenue, the people of the Nagpore Province pay only two shillings a head; those of the poorer parts of the Valley very much less, and the greater part of this amount is a charge upon their food. Their income is simply the value of the grain which they produce for their own use; and the land-tax is as much a charge upon this as the cost of ploughing or sowing.

77. In regard to exports, those of the richest part of the valley, Nagpore, are two shillings a head, according to Mr. Temple's tables above given. But I venture to affirm that these tables are not correct, and a more superficial inspection of them will not give a correct idea of the true state of the case. The value of cotton, for instance, is set down at threepence per pound, a price which is certainly abnormal, and double what it was only a few years before. The values of other exports are also given at rates which, though they may have been the prevailing rates, convey a wrong impression. Thus, gingelly oil-seeds appear at a value of eighty-two rupees per ton, or six rupees per bag of two maunds. Now, six rupees per bag is considered a good price at the port of Cocanada, and the very highest price ever known there was 8½ rupees in 1863. The cost of carriage to Bombay being eighty to 120 rupees a ton, or six to eight rupees a bag, the total cost of the Nagpore oil-seeds, delivered at Bombay, would be twelve to fourteen rupees, a rate at which they would be absolutely unsaleable. In fact, if six rupees a bag were the ordinary price in Nagpore, there could be no export trade in the article whatever.

78. But the fact of these articles having been entered at these rates in tables prepared, as Mr. Temple states, by the sowcars, reveals a little more of the actual state of affairs. It would seem, at first sight, from the figures above given, that either the local price of the article in question is much lower than is here represented, or that there is, in truth, no export of it at all. But I believe both to be true; the lowest price is as stated, and there is a small export trade. The explanation is that all that is exported is supplied to the sowcars, or great merchants, in whose hand the whole trade, and, indeed, the whole country is, at a very much lower rate, perhaps at a third of what is here stated. The great mass of the agricultural population are notoriously in the power of these usurers, and the ryot is compelled, as a necessary concession, in order to obtain the advances of money on which he lives, to supply a fixed quantity of this or of any other article which may be in demand, at a rate which the money lender fixes. The ryot may not make a single rupee upon the transaction; the rate may barely pay, and perhaps not even pay, the mere expenses of cultivation; but he must live, he is dependent on the money lender for the means of cultivating, and the latter will lend only on these terms. Every one acquainted with India knows this to be quite a common case. In Central India it is the normal state of things. The ryot is *ordered* by the sowcar to grow a fixed quantity of a certain grain

every year; an advance is made for the purpose, and the ryot at harvest takes the article, whether grain, or oil-seeds, or cotton, to his own price. Throughout the part of the Godavery Valley where Telooguo is the language, there is a peculiar and expressive form for advances given in this manner. This is the state of matters in Nagpore also, and hence we see that the real value of the exports to the people at large is but a small part of what the tables represent, certainly not above half, if so much. In the former part of this paper I assumed these tables to be correct, because that supposition was sufficient for my purpose at the time, but it is necessary to point out here what is the real state of the case, because it shows two things, first, that the mass of the people are very much poorer than an export trade of even two shillings a head would make it appear; and, second, that their present small revenue of two shillings a head is in reality in great part a charge upon their food, as veritable a bread tax, as ever existed in England. And yet I have no doubt it is as low as anywhere in India, and certainly it has been assessed with the most liberal intentions.

79. Again, the true value of all export produce in Nagpore is at least 8*d.* per ton less than it is on the coast. That is the present cost of carriage to the coast, and, consequently, the value of all articles of export in the interior is diminished by so much. Now as 8*d.* per ton covers the value of almost all the exports at the port, including cereals of all kinds, oil-seeds, grass, &c., but excepting cotton and one or two such highly valuable articles, it follows that there is practically no export trade at present from the interior. If any such products are raised, it is only for home consumption, and, of course, in small quantities. In fact, excepting the bare necessaries of life, all other articles possess no value.

80. Again, the demand for home consumption being the limit of production, there is no margin between a sufficiency and a deficiency of food. An unfavourable season may at once cause scarcity, and any serious failure of the local rains, wide-spread famine, for which no relief can be obtained from without. Chattesghur, not, properly speaking, in the Godavery Valley, is, to a certain extent, an exception, being peculiarly and exceptionally favoured in respect of rain; but there over production, resulting from an unusually propitious season, causes at once a glut in the local markets, and produce becomes almost valueless. In fact, the people of the Godavery Valley, always poor, are perpetually in danger of famine, while those of Chutteesghur oscillate between scarcity and excess.

81. Further, this great population, thus growing their own food, have one import which, to them, is an article of vital necessity,—salt. They can, at present, only procure this at a price three times what it costs on the coast, and in quantities averaging only five pounds per head, while it is known that, where cheaply supplied, in the coast districts, the consumption averages fifteen to twenty pounds a head. The excessive cost of carriage is one great cause of the dearness of this essential article, but this is further enhanced by a local tax of one and a half rupees per maund, itself doubling the first cost of the article, a tax which, under the peculiar circumstances of the case, I cannot refer to without expressing my regret that such an addition to the burdens of the people should be thought necessary. But it is my duty here simply to state facts. In regard, then, to salt, the facts are that its consumption in the wealthiest part of the Godavery Valley is at the rate of five pounds a head, while in many other districts it is at times not procurable at any price; and the cost is three times as great as on the coast, and three times as great as the poorest labouring man in England can purchase it for without stint as to quantity.*

82. It needs but few words to sum up, from the foregoing, the case as regards the condition of the people of Central India. A population engaged almost exclusively in growing their own food, the price of that food enhanced even by the scanty tax they pay to the Government; the supply of it precarious, dependent on the vicissitudes of the season; with few exports and no foreign trade; without any one inducement to exertion beyond the bare necessity to support life; a population under such circumstances cannot be otherwise than poor, dejected, and debased. This may not appear so if the comparison be made with many other parts of India, but it is so in fact; the fundamental conditions of the case are such

* Thirty times as dear in proportion to his income.

as can lead to no other result; they have produced the same effects everywhere else, and the result must be the same here also.

83. It is essential that we should thus understand the true state of the case. It has never yet been plainly set forth in any other paper on the subject that I have seen, though all the main facts on which it rests are distinctly admitted in the reports I have quoted. Unless we see clearly the effects, we shall neither seek nor fully appreciate the importance of the cause. Some of the inferences I have drawn may be thought in excess of the truth; if so, they will, doubtless, meet with correction or refutation at the hands of others better qualified to judge, and more familiar than I am with such questions; but the principal facts of the case are undeniable, and certainly, establish, in the main, the views I have expressed.

84. Now, what is the remedy? In the first place, it is very evident that no readjustment of taxation can be of any avail; the land tax is already as low as anywhere in India. Justice is impartially administered, and life and property are secure. Local roads can, as I have already remarked, afford no relief, nor would irrigation under such circumstances have any important effect. Of what use would increased production be in a country which already grows what food it requires, and has no market for anything more? Municipal conservancy, sanitary improvements, must be popular to be successful; a people living from hand to mouth cannot be expected to take an interest in such matters. All these expedients are now in operation, and with what result? Not one of them touches the real evil, and to busy ourselves with them is only to blind ourselves to the true state of the case.

85. What the country needs is a market, a value, the true value in the open markets of the world, for its produce. The burden that now presses upon its industry must be removed. Cultivation must be rendered profitable, without limit to production. The people must have the means of growing more than they want at home, as much more as the land will yield, and so of accumulating wealth, and shaking off the incubus of debt which now presses them to the earth. The ryot must be delivered out of the hands of the money lender, and made to feel that cultivate to whatever extent he may, there will be an unbounded demand at remunerative prices for all that he can produce. He must have the means of devoting his land to that kind of cultivation best suited to it, and of stimulating to the utmost its capabilities by the application of the proper agents for the purpose. In other words, cheap communication with a port must penetrate every part of the country.

86. These ideas are not Utopian. Such a happier state of things must inevitably follow upon the adoption of the one simple and obvious remedy, and that at no distant date, of which we have abundant proofs in the results which have followed similar improvements elsewhere. We have only to give Central India the facilities for cheap exportation possessed by the agricultural states of America to witness the same prosperity.*

* I believe that this will be admitted in part, but with large limitation as at least two accounts—(1) that as regards the important staple of cotton, there must be a limit to the extension of the land specially suited to its growth, and (2) that any such results as above supposed can only be looked for in a distant future.

The first of these objections is thus stated by Mr. Temple,—"That such an enhancement of price would greatly stimulate production, cannot be doubted, but there must apparently be a limit beyond which the cultivation cannot increase. A considerable portion of the area fit for cotton is, nevertheless, not grown with cotton, being reserved for other staples necessary to provide food for the people and their cattle, such as wheat, millet, oil-seeds, and other articles. Some of these might be superseded by cotton; but the millet is almost indispensable, and cannot be obtained equally good from elsewhere." In regard to this objection, I would ask, is such limitation to production found in other countries provided with cheap communication? How was it in the Cotton States of America before the war? There was room there for the growth of the food of the slaves, but it is notorious that these were fed for the most part on corn imported, from distances of 1,000 and 1,500 miles, from the North-Western States. The planters having the means of procuring, by the rivers, food for their slaves, as cheap as they could grow it themselves, devoted their labour to the production of that article which paid best, being specially adapted to their soil. The slaves were employed in growing cotton, and the North-Western States in feeding the slaves. Why should it not be so in Central India? Why should the ryot grow his millet on land which would much more profitably be devoted to cotton, if he can get the millet cheap enough from elsewhere? His home-grown food is dear to him if it displaces a more profitable cultivation. And we know that there is abundance of room in all other parts of the valley

87. When we come then, at last, distinctly to this conclusion, that what this great country requires, in its present state, is cheap access to a good port. But *cheap* is a relative term, and we must first define precisely what its signification here is.

1st. That will not be a cheap mode of transport which will merely produce such internal traffic as may lessen the present occasional inequalities of production, without increasing the *total* production. It will be of no avail to enable Chutteesghur in a favourable season to send some of its surplus to Nagpore, or Nagpore, under the same circumstances, to Chanda. The *total* production of the country will not be increased by a single bushel after this has been done. The principle of mutual help is a valuable one to the poor; it enables them to struggle on the better through their poverty; but it makes them no richer. Central India being wholly an agricultural country, the markets for its surplus produce *must lie outside of it*; unless it is placed in communication with them nothing has been done. The simple consideration is decisive as to the question of spending money upon the roads now in progress in Central India. They are out of place at present, and can produce only the most insignificant results.

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for the production of this article of food, which grows everywhere, and is, in fact, the staple food of the people.

The Mauritius, too, is a case in point. If any country in the world were compelled to grow its own food, this island would be so, but, on the contrary, its rich soil is wholly occupied with sugar plantations, and the population are entirely dependent on foreign countries, chiefly India, 3,000 miles distant, for their food. Berar and Nagpore should unquestionably do the same, and not until their soil is wholly given up to the growth of that staple, for which it possesses advantages unknown in any other part of India, will its full capabilities be developed. But for this purpose it is necessary that food, as good and as *cheap* as is now grown there, should be imported from elsewhere.

In regard to the other objection, that the progress of the country towards such a high degree of prosperity must necessarily be slow, I would observe that, even if this were the case, it would not affect the question of the adoption of the proper remedy for existing evils, but we have an illustration before our eyes of what may follow upon any great enhancement of the value of agricultural products generally. It is only necessary to note what took place during the late war, when the value of Indian cotton was suddenly and so largely increased. The supply responded immediately to the demand. So great and so rapid was the increase of production that even the land required for the growth of food was trenched upon, and a partial scarcity was threatened. There was no delay about the result; effect followed cause immediately. As soon as ever the ryot found that his cotton was worth twice or thrice its former value, he at once extended largely his cultivation of it. And a similar increase of production would certainly follow upon any great enhancement of the value of other articles of export. In present circumstances, it is only under very exceptional conditions, as above explained, that any of the great export staples of India, cotton excepted, are grown in Nagpore for other than home use. The export of such articles, worth only 5*l.* to 10*l.* at the port, is impossible, so long as the cost of carriage to the port is 8*l.* per ton. But let that cost be reduced from 8*l.* to 1*l.* or ten shillings a ton, and the whole of the articles now excluded from foreign markets will at once be exportable; a fair value will at once be given to many of the great staples of the country which before were worthless. It is reasonable to suppose that the ryot who showed himself so ready to take advantage of the rise in the price of cotton, will just as rapidly extend his cultivation of any other products as soon as he finds them to be in good demand at a fair price. Whatever the burden may have been which has weighed down the springs of industry in India, it has ever been found that its removal has been attended with an immediate revival of energy and a rapid increase of production. It was so in those districts where a burden-some land tax was lightened at an anticipated temporary loss of revenue. No such loss followed, the immediate extension of cultivation at the lower rates of assessment at once more than made up for it. So, too, in Rajahmundry, as soon as ever the water reached the land there was an immense increase of cultivation, even in the case of land which had never been irrigated before, and where the application of water involved a total change in the mode of cultivation.

Mr. Temple observes,—"Regarding the country generally, it is to be observed, that although the "population may increase in numbers, though the same numbers may acquire a greater industry and "productive power, though production may thus increase, though the kind and quality of produce "may be highly improved, yet the area of land under cultivation will not apparently increase to any "great extent. The culturable area is, for the most part, occupied. And though there may be many "detached patches of reclaimable land, there is no great extent of valuable waste. A portion, of "course, is reserved in most villages for pasturage. This may be gradually encroached upon by the "plough, as the people learn to provide superior fodder for their cattle; but some grass ground must, "of course, always remain." On this subject I would remark that very similar anticipations were expressed regarding the effects of the Irrigation Works in Rajahmundry fifteen years ago, anticipations which have been wholly falsified by the result. There the grass lands have been so encroached upon by the plough that the cattle are driven to the narrow field banks for pasturage, and in some cases loss of cattle has resulted from this cause. The fact of the export of butter from the Nagpore Province shows that there must be a great extent of land available for culture as soon as the demand arises. Besides, there can be no doubt that the present yield of the land, under the slovenly management of a people whose only object is to grow food for themselves, must be far below what it is capable of. Let but the needful stimulus be given and the yield may increase manifold. It is a fact that while the actual area of land under culture in England at the present time is but the same that it was twenty years ago, in the days of protection, the production of the country under the stimulus of competition with foreign countries, has *doubled* in that time.

2d. That will not be a cheap communication which will admit only of the carriage of articles of export to the coast at a cost which would render them unsaleable when they arrived there. This is obvious, and it is decisive with regard to the road which the Government of India suggests as a substitute for the river.

The margin of profit to the grower, between the bare cost of production and a remunerative selling price, out of which the cost of carriage to market must be defrayed, cannot be more than 1*l.* to 1*l.* 10*s.* per ton on the great mass of the agricultural staples of India, which average 6*l.* to 8*l.* in value at the port. The cost of carriage by road in Central India is given by Mr. Temple at three annas; the cheapest rate I have ever known military stores carried from Masulipatam to Nagpore by the existing track, which is a fair enough road in the dry weather, is three and a half annas. On a really good road, however, such as that now supposed, the rate ought not to exceed two annas, or threepence. At this rate the cost of carriage 120 miles would swallow up the whole margin of profit on the great mass of the exports; in other words, export by road from a greater distance than 120 miles from the sea would be impossible. Even if the cost of carriage were reduced to one and a half anna, 150 miles from the coast would be the limits within which export would be possible. Upon what principle, then, I venture to ask, is it proposed to substitute a road for a river navigation 400 miles in length? Is the road intended as an outlet to the produce of Nagpore? If so, will that produce bear an export charge of 5*l.* or 6*l.* per ton? If not, of what use is the road to be? Now, I venture to put these questions, because it seems to me just as necessary that when a road is proposed inquiry should be made as to whether it will be of use, and whether it is likely to pay a fair per centage on the outlay upon it, as it is when a river improvement is proposed. For years the Godavery scheme has been assailed on all sides by inquiries of this nature, and it is well that it should be, because the truth will thus best be brought out. It is estimated to cost 1,350*l.* per mile. A road is now suggested, at an estimated cost of 1,600*l.* per mile. What traffic will there be on which to levy tolls, and what are the tolls likely to amount to? Export traffic there would be little or none; it would be confined solely to the poorer and least prosperous districts on the lower part of the river. All imports would have to pay four to six times the charge by river; they would, therefore, be small in quantity. Under such conditions what return can be hoped for on this outlay, and of what use to the country can the road be? There is but one answer; it would be an almost fruitless waste of money.

88. The Government of India observe, "Navigation is, no doubt, a superior "mode of communication in many respects, but its superiority can hardly be con-"sidered so great as to make a navigation open for four or five months in the "year, better than a metalled road open during the entire twelve months." I venture to assert not only that such a navigation would be superior to such a road, but that while the former would be of the very highest value, the latter would be almost useless. With regard to the road I have already given my reasons, the cost of carriage by it would be four or five times as great as most of the exports would bear. As to the river, I have already shown that the extra expense caused by the detention of produce for three to six months would be merely the interest on its value, and that if this be added to the river carriers' charge the total is still only a fraction of the cost by road. In what other part of India, in what other part of the world, does a road create any but the most insignificant export traffic from distances of 300 to 400 miles? There are rivers in America open only for four or five months; but the Americans would smile at the idea of abandoning them for a metalled road.

89. With regard, however, to the river, the Government of India has recorded the following emphatic opinion upon the subject (Proceedings, 14th July 1863):—

"This part of the project will be a thing complete in itself, and of certain utility even if the navigation is only open for four or five months in the year. It is an error to consider that such communications as these must be permanently open to be of substantial utility. The Baltic is closed for half the year, and still the trade with its ports is of great importance. The canals of all the colder parts of Europe and America are closed for several months in every year, and yet their

value is undisputed. For the transport of mere agricultural produce, a partial communication, such as the Godavery might supply, when its ordinary and natural stream shall have been made navigable by the proposed works, at the barriers and its bed, will probably be quite as much as the country through which it passes will really require for a long time to come. The crops come in but once a year, and the whole produce for export should easily be got rid of during the four or five months which it may be looked on as pretty certain that the navigation may, under any circumstances, be kept open."

If such be the value of the river, why substitute for it a road by which the export trade of the inland Provinces could *not* be effected? And how can the prosecution of a scheme calculated to produce such important results be spoken of thus (Letter of Government of India, 13th September 1865):—

"It may be said, to use a common phrase, there is no use throwing good money after bad, and that it will be best to abandon at once these works which have proved, and promise to prove, so expensive, and which, passing through an unhealthy wilderness, are not urgently required in comparison with others from which immediate results may be obtained. Admitting that there is much force in this line of argument, we are not disposed, on the whole, to abandon the works."*

90. But further, it is very desirable that a similar inquiry to the above should be made respecting the value and necessity for other roads now being constructed in Nagpore and Central India. Money is found for these roads, and their formation proceeds unquestioned, at a cost, it appears, of 1,300*l.* per mile.† And yet, if it be asked, what purpose do they fulfil, and is it commensurate with their cost, there can be but one answer, as I have above shown. They are mere local roads, and can produce no effect upon either revenue or people. If, then, the further prosecution of the river scheme, at a cost of 1,350*l.* per mile, by which "the whole produce for export could easily be got rid of in four or five months," be in the opinion of the Government of India "throwing good money after bad," on what principle are mere local roads, costing 1,300*l.* per mile, now being constructed, which, as admitted on all sides, can have no effect whatever upon the export or import trade of the Province? If the purposes fulfilled by these roads are worth an expenditure of 1,300*l.* per mile, is a route by which the whole export trade of the valley may be effected not worth 1,350*l.* per mile?

91. But to return to this proposed substitution of road for river, the road never can produce any export traffic. For this, the main object of such a line, as distinctly laid down by the Government of India, and the great desideratum for the Godavery Valley, it must be worthless. The river will effect this essential object.

92. This investigation of the conditions essential to such an export traffic as would result from any great increase of production in the Godavery Valley is equally unfavourable to the Bombay and Nagpore Railway. The great mass of exports cannot bear a charge of thirty rupees, or 3*l.* 6*s.* per ton, which is the least the railway could afford, even to that corner of the valley nearest to Bombay, The charge must be reduced to a fraction of this if any great increase of production and traffic is to be effected.

93. That description of transport can alone be considered *cheap* enough which will allow of the produce of the Godavery Valley being delivered at the port, at the current prices there, with profit to the producer. The only markets for the great mass of the produce are beyond sea. The cotton, hemp, oil-seeds, wheat, grain, &c., of this valley will find purchasers only in English and Continental markets. If they are to be exported in any considerable quantities the cost of carriage to the port must not exceed ten to twenty shillings a ton. The river alone can afford such cheap carriage as this. No mixture of river and road will do so; the cost of carriage on the seventy-five miles of road alone, which it has been proposed to substitute for the river above the Third Barrier, would be 1*l.* to 1*l.* 10*s.* per ton, thus increasing the total cost of export to twice or thrice what it should be. This is decisive in regard to any such modification of the river scheme. Its effects would be ruinous. The river communication must be carried into the heart of the country; it should be improved to the utmost that it is capable of, and connected by navigable feeders with every part of the valley. The river improved only to the extent contemplated in the project above sketched, and estimated to cost 721,000*l.*, will afford transport at the rate of four pice or a halfpenny per ton per mile,* or seventeen shillings a ton from Hingenghat to the port. This, and *this alone*, will meet the requirements of the case. It will render export possible and profitable. It will at once give a fair value to a large number of products which are now almost worthless, and it will afford the means of cheap import of salt and other necessaries.

94. The completion of the Godavery navigation scheme to the extent originally contemplated, viz., to Hingenghat, is, therefore, a matter of *fundamental necessity*, it lies at the very foundation of the whole question of improvement in Central India. All that is now being done in that country is of no importance in comparison to it. Whenever it may be determined that Central India shall be raised from its present condition of poverty to one of prosperity, somewhat resembling what we now witness in the Delta districts, the very first step to be taken will be the opening of the river. This is no exaggeration of the real importance of the question. It follows directly from the simple facts of the case as above set forth. The assertion that the completion of this navigation is not a work of urgent necessity is one that cannot for a moment be sustained, unless the facts of the case, as set forth on unimpeachable authority, are ignored. To suppose that the districts on the lower part of the river only are interested in the matter is an entire misapprehension; those further inland are in far greater need of this communication, and their present impoverished condition is mainly attributable to this cause.

95. While, therefore, the case is abundantly plain, that the completion of the river works up to Hingenghat is the first thing to be done, we must undoubtedly look forward, if the State is to derive the full benefit of the communication, to the extension of water carriage in connexion with the river throughout the whole of Central India, south of the Nerbudda, on some such scheme as that already sketched out by Sir A. Cotton, in his memorandum on the subject, viz., by connecting the Godavery with the Nerbudda, on the north by the Wyne Gunga; with the Taptee on the west; with Hydrabad, by a line of canal, on the south; and by opening out the main Godavery to the full extent it will admit of, that is for some hundreds of miles. The project which is now in course of execution will, when completed, thus form the trunk of a system of water communication which alone can meet the fundamental requirements of Central India. The discussion of such an extension of the scheme is, however, foreign to the present paper, but the system of river improvement by means of reservoirs, on which such an extension would mainly depend, demands a brief notice.

96. In my report of 16th of November 1863, I strongly urged that this mode of improvement should be applied in the first instance to the Wurda, which river is, as I have shown in a former part of this paper, from the gentle declivity of its bed, and from its narrow width, so especially adapted to it. I fully adhere here to all which I then stated. We have in the Wurda a river of only three times the width of the Ganges canal in its upper part, and of only half its slope, while the depth to be maintained will not be above a third of that in the canal. Surely this is about as simple and as favourable a case as the system could be applied to. And I have also strongly urged, in the report referred to, that the system should thus be tried *on a small scale* in the first instance, using a reservoir which might cost about

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* On this I would observe,—
(1.) The river works are not more expensive than common roads.
(2.) Their effect upon the country will be incomparably superior to that of any common road.
(3.) Do the roads now made, or being made, in Central India, yield immediate results, and what are those results as expressed in interest in capital?
(4.) The term "unhealthy wilderness" is not properly applicable to the whole country in the lower part of the river.
(5.) If it were so, the navigation certainly ought not to terminate in a wilderness. This would be an additional reason for carrying it past the wilderness at the Third Barrier into the populous country of Nagpore.

† Including establishments.—Provisional Government of India, 13th September, 1865, para. 9.

* This is a common rate on the Ganges, even with steam Companies dividing twenty per cent. per annum profits. It is considerably higher than in the American rivers, and higher than the rates in the Delta in mixed river and canal navigation with very small boats and short trips of twenty to fifty miles.

20,000*l.* or 30,000*l.* only. At all events, the question of the navigation of the Wurda, and of the practicability of this mode of improvement, is *worthy of investigation*, and this *it has not yet received*, the preference having been given to a road project, the adoption of which would be *fatal* to the success of the whole river scheme.

It should also be observed that the water so stored in the upper part of the valley cannot in any case be wasted. It is wanted *already* in the Delta, and Mr. Temple has shown that it might be applied profitably to the irrigation of the lands along the banks of the Wurda. The Delta alone will require a stream of at least 600,000 cubic yards* per hour throughout the hot season. If this is not supplied the full value of the works there cannot be realized. I believe I am correct in stating that for a few years past there has been *an annual loss of revenue* from the insufficiency of the river supply, although not above three-fifths of the land is yet irrigated. The need of an additional supply will now become every year more pressing. I would suggest, therefore, that the Madras Government should now be called upon to state—(1) whether there is not *now* an annual sacrifice of revenue from want of water, and (2) what quantity will be required to supply the wants of the cultivators during the dry months. Then let this quantity be stored without further loss of time in the Wurda, and subserve the double use of navigation and irrigation. This is all that I have ever urged upon this subject, and the necessity of such measures, as regards the Delta only, is now undeniable. A practicable test may thus be applied to the reservoir system without risk of loss.

97. I cannot pass from this part of my subject without respectfully remonstrating against the manner in which it, and, indeed, the whole river question in respect of *cost*, is treated by the Government of India. I have already objected to the manner in which an addition of ninety per cent. is made to the cost of the Monsoon Navigation Scheme in the estimate given by the Government of India, and I would now further point out the manner in which the completion of the scheme by means of reservoirs is referred to in their Letter of 13th September 1865, para. 11:—"To do this would, we think, not cost less than a million or a million and a half more." Thus in one single sentence this scheme, fraught with results of the highest importance, is set aside. Upon what grounds, I venture to ask, does this assertion rest? I know of none that could in any way warrant it, and I may claim to have more thoroughly investigated this question than any officer who has ever had anything to do with the Godavery scheme, excepting Sir A. Cotton. I venture to assert, and I have little doubt that Sir A. Cotton would entirely confirm my opinion, that the extra cost of rendering the river navigable all the year round, at rates cheaper than those on the Ganges, would not exceed the *fifth part* of the amount here stated.

But why thrust aside the question in this manner when the means are in our hands of applying to it, without risk of loss, such a practical test as would at once determine both the cost and the suitability of this mode of improvement?

REMUNERATIVE CHARACTER OF THE GODAVERY SCHEME.

98. With regard to the profits that may be expected from this undertaking, if I have at all succeeded in what has been the principal object of this paper—placing the question of the Godavery improvement upon its true grounds as a work of absolute and fundamental *necessity*—there can be little question as to its remunerative character. If once it be admitted to be a work of necessity, its prosecution would no more be delayed by questions as to direct returns, than is that of all the roads now under construction, upon which no profits whatever are anticipated. And upon this point the question is simply reduced to this: either this river improvement is a work of the highest value and most pressing necessity, or it is one of the most trifling importance. If this river will afford the means of export and

* This may be much less than will be required—1,200,000 acres have to be watered, and the supply allowed during the rains is one cubic yard per acre per hour. More than this is required for the same crops in the hot season, but, I believe, by limiting the cultivation to oil-seeds, or some kind of crop not requiring so much water, the ryots manage for the present with about half a cubic yard. The question can easily be decided by a reference to the Madras Government.

import to Central India, it will be difficult to assign any limits to its importance. If it will not, it may be placed in the same class as the roads above referred to (though, as above shown, even on this supposition it would be worth what they cost, 1,300*l.* a mile). Upon this point the whole question turns. The one great need of Central India is the means of cheap export. The position which I have maintained in reference to this is,—(1) the railway cannot supply this essential; (2) a road cannot; (3) the river can. If it can, then the value of the great mass of productions of Central India will be *doubled*; produce now worth 8*l.* to 10*l.* a ton will be relieved of almost the whole of the present export charge of 8*l.* to 9*l.* per ton. This will, in fact, be to give to a large number of commodities, now worthless, a fair value, and immensely to increase production. Wealth must follow, and with it the ability to pay a higher revenue, and to import more largely from foreign countries. And when we consider that taking the trade basin of the Godavery and Wurda alone, and without taking into consideration the ultimate results of the full development of the scheme, a population of 6,000,000, of whom 3,900,000 are British subjects, would benefit in this manner, there can be no question that both the direct and indirect profits upon the undertaking must be great.

99. Taking, however, the one article of salt, the present consumption of which does not, as we have seen, exceed five pounds per head in Nagpore, and perhaps does not amount to that in other parts of the country, there are good grounds to expect that, with the reduction in the cost of import from 8*l.* to 10*l.* per ton to 1*l.*, and with the improved ability in the people to purchase with their exports, the consumption would quickly rise to fifteen pounds. Ultimately it would no doubt rise to twenty pounds. At fifteen pounds per head, or ten pounds in excess of the present consumption, for the 6,000,000 of people directly dependent on the river for their supplies, the increased import would amount to 60,000,000 pounds. I am not certain what the actual profit of the Government is on the sale of salt, but suppose it is not less than a rupee per maund; if so, the profit on this increased sale would amount to 732,000 rupees, or 73,200*l.* per annum, which is 7·3 per cent. on 1,000,000*l.*, or ten per cent. on 730,000*l.*, which is more than the estimated cost of opening the river to Hingenghat.

100. Again, if a toll of $\frac{1}{8}$ penny per ton per mile were levied on the river traffic, or four shillings a ton for the whole distance between the Nagpore country and the sea, to pay ten per cent. on 1,000,000*l.* would require an annual traffic of 500,000 tons, or 350,000 tons down stream and 150,000 tons up.

Now I have shown above, in the case of America, what the trade of an agricultural country, provided with really cheap means of export, is likely to be. The average value of the 4,000,000 tons annually exported from the Western States is about sixty dollars, or 12*l.* per ton, and the cost of sending a ton of produce from Chicago (the great grain port of the Western States) to New York (1,500 miles) is seven dollars, or 1*l.* 8*s.*, or twelve per cent. only on the value of the article. The charge by the Godavery ought to be considerably lower than this, as the distance will be only 500 miles. Can any one believe that under such circumstances 500,000 tons per annum will be more than a fraction of the traffic which must arise?

101. Indirectly, also, there must be large gain to the revenue. If the value of produce generally is doubled, and production at the same time largely increased, the ability of the people to pay will be much more than doubled. The present revenue is at the rate of less than two shillings a head. With the means of cheap export, four shillings would be a much lighter burden, and would still be only two-thirds of what Rajahmundry *now* pays, with the works only in imperfect operation. Another rupee per head of revenue from the 4,000,000 of British subjects on the north bank would amount to 400,000*l.* per annum. To affect the whole of this population, however, the works would require extension up the Wyne Gunga, but fully 2,000,000 would benefit to the full, and the remainder partially, by the opening of the river to Hingenghat, and an increase of revenue to the extent of 200,000*l.* on this account should certainly follow.

All these calculations only bring out the more strongly the one grand point on which the whole question turns—whether the river will afford the means of really *cheap* export, such as America, such as England, such as France, possesses, or

not? If it can, which can only be if the original project of a continuous navigation, extending into the *centre of the country*, is carried out, *its* value *must be* immense.*

VALUE OF THE GODAVERY AS A MILITARY COMMUNICATION.

One word upon this very important aspect of the question. The map shows that for 400 miles the Godavery and Wurda form the dividing line between the British territories on the north bank, and those of the Nizam on the south. I have shown that with light-draught steamers the river, only partially improved, may be navigated for the whole year. It will thus afford the means of delivering a body of troops at any point, at any time, along the whole of this length of frontier. Hydrabad is now only accessible from the south, east, and west, and in each case by road only. On the north it is distant 400 miles from Nagpore. Over the whole of the intervening country there is at present no means of controlling the population, and insurrection might spread over a great extent of country, and assume formidable proportions, before any troops could reach the scene of action. One important line of communication, the track by which military stores are sent to Nagpore from the coast lies through this country, mostly along the right bank of the river, and in the troubled times of the mutinies a convoy of stores proceeding by this route for the Central India Force was plundered by Rohillas. Utter lawlessness is, indeed, the characteristic of the whole country. It is needless to descant on the value of the Godavery as a military route under such circumstances. Its practically *indestructible* character should be noticed. It will only have three vulnerable points, the three barriers. At the two lower the locks, the only works liable to injury, are on the British bank. At the Third Barrier an exchange of territory can easily be effected,† which will place the works there also under our control. Railways or canals may be seriously injured by a sudden *coup de main*, or by the treachery of a disaffected population; but this river route must always remain secure, and, from its connexion with the port of Cocanada, form the very basis of our military power in Central India.

* No mixture of road and river will do, such as the Government of India and Mr. Temple propose. Mr. Temple calculates that the substitution of road for river above the Third Barrier would increase the cost of export fourfold. Take, then, the above case of America by way of illustration. A ton of flour, worth 45 dollars, is sent from Chicago to New York, 1,500 miles, by water, for 7 dollars. Increase that charge fourfold, or to 28 dollars, and what becomes of the Western States, of their trade, the value of land, &c.? The trade would be annihilated, and the country sink at once to the level of Central India. What would be the effect of even *doubling* the charge? Let the Americans decide the question. Take the following illustration of the value which the most practical nation on earth sets on cheap transport. In 1835, the cost of carriage from the Lakes to tide water on the Hudson had been reduced by the Erie Canal to 6½ dollars per ton (1*l.* 5*s.*). They then reckoned that by enlarging the canal and locks, so as to admit larger boats, the cost of carriage might be reduced 50 per cent. "John B. Jervis went into a thorough investigation of the subject, and reduced it to a mathematical certainty." They set to work accordingly, the work was carried out in spite of great opposition and difficulties, and, in 1861, was opened for traffic. In 1862, we find the State Engineer and Surveyor congratulating the citizens on the successful attainment of their object, the cost of carriage having been reduced from 6½ dollars to 4½ dollars, more than 30 per cent. "To accomplish this important result, the State expended for the enlargement of the Erie Canal, including land damages and interest on loans, 43,639,268 dollars, or 8,727,850*l.* sterling." "This important result,"—the reduction of the cost of transport from 6½ to 4½ dollars, from 14 per cent. "to the value of a ton of flour to 9 per cent. The traffic at the same time increased from 753,000 tons delivered at tide water, to 3,402,000 tons. Yet in India a proposition to *increase* the cost of export *fourfold*, at a saving in cost of construction of 56,000*l.*, on a line on which 6,000,000 of people (a larger population than that which contributes the above export trade of 3,400,000 tons) are solely dependent for the means of export, is regarded as a decided improvement upon the original project so eulogistic an improvement, in fact, that it is at once adopted, and the original scheme, which would have provided the means of export at a rate as cheap, and *cheaper*, than the Americans have purchased at a cost of *millions*, is quietly put aside as really a matter of very little importance. Two things strike me in connexion with this subject: (1.) that the Americans do not consider calculations as to the cost of carriage, or the probable amount of traffic on a given line, "premature," or "wild," or "mere speculations," and (2.) that their estimate of the value of cheap transport is something totally different from ours.

† No particular difficulty was experienced in effecting the exchange by which the Godavery districts on the north bank became British territory in 1860. As I was instrumental in bringing about this transfer, I may be allowed to remark here that its results, as regards the people of those districts, and the security and quiet of the Bustar country to the north, are most gratifying. I have the best means of knowing the real feelings of the people, and am able to state that they are those of unmingled satisfaction at the change of rulers. The people are thoroughly contented, and frequently contrast the security and peace which they now enjoy with the former reign of lawlessness and anarchy.

SUMMARY.

To sum up; the following are the principal points which I have sought to establish:—

1. The one great want of Central India, with its population of, probably, 10,000,000, is the means of *cheap export*.

2. By cheap export is to be understood carriage to a port at 10*s.* to 1*l.* per ton.

3. Neither road nor railway will afford this. Export by the one would be eight times, and by the other three to four times as great as is required.

4. A road, if practicable, would be found a more expensive undertaking than the river.

5. A river navigation to the distance of 309 miles from the sea, with a road of 75 miles (to Chanda) or 125 miles (to Hingenghat) could not supply cheap enough carriage.

6. The Godavery will afford the cheapest possible means of export.

7. Its value will be out of all proportion to its cost.

8. The adoption of any combination of river and road will be destructive of the value of the communication, and fatal to its success financially.

9. The country above the Third Barrier is the one most in need of the communication, and best prepared to take immediate advantage of it, being the most populous and productive.

10. The population, British subjects, below the Third Barrier is only 250,000; that above it 3,500,000.

11. The physical conditions of 100 miles of the river above the Third Barrier are far more favourable for navigation than those of any part of the river below.

12. The practicability of a canal round the Third Barrier is undeniable. The effect of such a canal, in conjunction with the river at its head, would be to make a permanent still-water navigation extending to within a few miles of Chanda, and available at all times of the year.

13. The probable cost of opening the river for navigation for the whole year, by vessels of light draught, from the sea to Hingenghat, 442 miles, will not exceed 800,000*l.*, of which 538,000*l.* have yet to be provided.

The navigation so improved will be practicable for steamers of two and two and a half feet draught for six or eight months.

14. The cost per mile of river, including 80 miles of the Godavery proper, which will also be available, will be 1,530*l.*

15. The cost of common roads in Central India is reckoned at 1,300*l.* to 1,500*l.* per mile.*

16. A single line of railway would cost 15,000*l.* per mile, would carry at three times the cost by river, and not above a twentieth part of the quantity.

17. The river will be of immense value as a military communication.

18. Water for the irrigation of the Delta lands during the dry season must be stored on the upper river. The river supply is already deficient, and there have been losses of revenue in consequence. The water which it will be necessary to store for this purpose will be of great benefit to the navigation, and probably quite sufficient for all its requirements.

* Including establishments. Proceedings, Government of India, 13th September 1865, paras. 9, 21.

PLAN ON WHICH THE WORKS SHOULD BE PROSECUTED.

In conclusion, I have simply to recommend that the original project for a line of navigation from the sea to Hingenghat be prosecuted without further delay. For an expenditure of not above 800,000*l.* we may thus obtain almost all that was originally expected for 660,000*l.*, viz., a navigation for the whole year, though not for vessels of the full draught of two feet for the whole of that time. The works should be prosecuted as follows:—

(1) Those for the three Barriers should be put in hand at once and simultaneously, the usual detailed estimates and plans yet wanting for the Third Barrier being submitted and approved in the first instance.

For the completion of these works a further sum of 420,000*l.* will be required.

This will open the river to Chanda, 382 miles.

(2) Let the removal of isolated rocks in the open parts of the bed proceed by degrees, as required.

(3) Let a thorough examination be made of the Wurda above Chanda, and detailed estimates and plans be submitted for its improvement.

(4) Let the Madras Government be called upon to state (1) whether there is not now a deficient supply of water for the hot season cultivation in the Delta; and (2) what extra quantity will be required to prevent loss of revenue, and to secure the full value of the works already executed.

Let a portion of this quantity be at once stored for use on the Wurda, and its effect on the navigation practically tested.

(5) Let the stonework required for the improvement of the shoals proceed either *after* the other works are finished, or in small portions and by slow degrees, during their progress, as may be found necessary.

Lastly, I cannot close this paper without distinctly warning the Government of the consequences of the course which is now being pursued with regard to the Third Barrier. Against any such limitation of the scheme as would confine the benefit of the navigation to the country below that barrier, to a population of 200,000 souls, British subjects, scattered over an immense extent of forest country, instead of extending it to a population of 3,000,000 above the barrier, I distinctly protest, as the most ruinous measure that could possibly be adopted, and fatal to the success of the scheme in every point of view. The objections which I have urged against this modification of the original scheme have *never been answered.* Mr. Temple so far agreed with my views as to consent, and indeed to recommend, that the practicability and probable cost of extending the navigation to Hingenghat should be investigated, and there was even some correspondence respecting the appointment of officers for this purpose. But *nothing has been done*, while the alternative scheme of a road, whose claims rested solely upon the assumed impracticability, or excessive cost (of which not a shadow of proof was ever attempted) of the other, has not only been investigated and estimated for in detail, but has already, very probably, been commenced. Against such a mode of dealing with a great question, so closely affecting the interests of all Central India, I respectfully, but emphatically, protest; and now place on record my deliberate conviction that, if persisted in, it will be fatal to the success of the whole scheme.

F. T. Haig,
Major, Royal Engineers.

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REFERENCE TO FORMER CASES.

Pros. (Civil Works / Commns.) June 1865, No. 31.
" (") " " Nos. 2—5, Part B.
" (") Aug. " " 15—25 & 26—8
" (") Sept. " " 49—84.

REFERENCE TO LATER CASES.

TAKEEDS.	DATED.

GOVT. OF INDIA. } 1866. { P. W. DEPT.

CIVIL WORKS.

Communications.

April.

Nos. 2 TO 4.

Godavery Navigation Works.

LIST OF PAPERS.

No. 2. From Secretary of State, No. 11 of 8th February 1866. Communicating orders in regard to the carrying out of the Godavery Navigation Works, and enclosing copy of a Memorandum by Major Haig on the subject.

No. 3. The Memorandum referred to [Copies will be attached on receipt from Secretary of State].

Public Works Department docket No. 326 C of 24th March 1866. Forwards copy of above Despatch to Chief Commissioner, Central Provinces.

No. 4. To Secretary, India Office, No. 365 C of 24th April 1866. Asks for copies of Major Haig's Memorandum.

PUBLIC WORKS DEPT. PROCEEDINGS, JULY, 1867.

CIVIL WORKS.

Communications.

NAVIGATION OF THE KANHAN AND WYNEGUNGA RIVERS, AND INCREASE OF SUPPLY OF WATER FOR IRRIGATION IN THE GODAVERY DELTA.

Pros. (Civil Works / Commns.) April 1867, Nos. 1—16.

No. 151—1868, dated 5th April, 1867.

[No. 35.] *From*—MAJOR C. POLLARD, R. E., *Offg. Secy. to Chief Commr. of Central Provinces, in the P. W. Dept.,*

To—Secretary to Government of India, P. W. Dept.

It will be in your recollection, that together with this Office Despatch No. 267/3079 of the 19th October last, was submitted a copy of Mr. Temple's Minute on the River Wynegunga. In your letter No. 195 C of the 8th ultimo, it was stated, among other things, that the Wynegunga papers would be transmitted for the information of the Secretary of State.

2. In continuation of this correspondence, I am now directed to submit a Report by Major Haig, the Superintending Engineer of the Godavery Works. On that Officer's return from England in November last, he was requested by the Chief Commissioner to descend the river by boat, and to report the result of his observations. This he has done. The Report is submitted, in original, together with the map, because it contains several interesting bird's-eye sketches, evidently by Major Haig's own hand, to the vivid and life-like character of which Mr. Temple can testify, which cannot be detached from the rest, but which the Government of India may like to see. Hereafter, if it be desired, the Report can be printed together with this letter.

3. In reference to the navigable capabilities of the Rivers Wynegunga and Kanhan, Major Haig remarks (para. 96)—

"It will be satisfactory to the Chief Commissioner to find that his estimate of these two rivers, as set forth in his Minute on the subject, is quite confirmed by the more detailed examination of them which I have now made."

It is not therefore necessary to trouble the Government of India with lengthened remarks on the present occasion.

4. Mr. Temple held that the 2nd or lower barrier of the Wynegunga extended from the confluence of that river with the Pranheeta up to a point near Chamoorsee. Major Haig holds that it extends further on up to Gurchchooroolee, there being two difficult places between Chamoorsee and Gurchchooroolee. The Chief Commissioner would still suppose that these two difficulties might be overcome by blasting, and it is clear that the river bed between Chamoorsee and Gurchchooroolee is not so continuously or thoroughly a barrier, as the river-bed between the confluence and Chamoorsee. If, however, the overcoming of this, the first or great barrier, be seriously undertaken, the above point of difference would not be material.

5. For the overcoming of this barrier, Mr. Temple suggested two anicuts at intervals, relying partly on Colonel Fife's authority. Major Haig prefers doing this by a canal which he has described. At the present stage it is not necessary to discuss this at length; but Major Haig's suggestion seems to be a very valuable one.

6. Mr. Temple's Minute contemplated the Wynegunga, if improved at all, being rendered suitable for monsoon navigation, which of course includes the use of steamers. Major Haig observes that such navigation would not last beyond three or four months, and that the steamers would remain unemployed for a portion of the year. All this is very true. But they would not, *per se* constitute any objection to the project, for precisely the same conditions exist on the Godavery itself, and are now not held to outweigh the advantages of the scheme; or if steamers shall be available all the year round for the improved Godavery, they would equally be so for the improved Wynegunga.

7. Major Haig urges that the attempt first be made to improve the Wynegunga bed for dry-weather navigation, relying on a reservoir to be formed at the Pench for the additional supply of water which would be required. He strongly urges the formation of the Pench reservoir.

8. Without at all abandoning any of the views expressed in his Minute, Mr. Temple yet thinks there is much force in what Major Haig advances. Looking to the distant prospect

placed upon the river, very soon show what use may be made of it in its natural condition. What an amount of disappointment, doubt, and delay would have been saved, had such steamers been ordered when first I asked for them in 1861.

However in 1868, we may hope to see them running. They will tell us what can be done with the river without any increase to its summer volume from artificial sources.

But however satisfactory the results of this test may prove, they will only show the more strongly how vastly the value of the communication would be increased were it practicable to use vessels of greater draught. If the steamers now building drew 2 feet of water instead of 1 foot, their resistance would only be increased one-seventh, though their tonnage would be doubled, and the tonnage available for *power* much more than doubled.

Hence a large reduction in the cost of carriage, the fundamental consideration in the whole matter.

I am not, however, going to weary the Government with a discussion of this somewhat ominous topic, but what I wish to point out is this,—if it is true that the Godavery Delta is already in want of water for summer irrigation, about which the Collector's notification leaves no room for doubt, and if such want is already causing a loss of revenue, and likely to cause very much heavier loss, which is matter for enquiry, then we have in our hand the means of testing, without risk of loss, the efficacy or inefficacy of the reservoir system of river improvement. If there is a sacrifice of revenue from want of water, it must pay to store that water, and pour it into the river for use in the delta, and as it travels down to the delta, its effects upon the navigation can be ascertained. We shall then know beyond possibility of doubt the cost of storing a certain quantity of water, the benefit derived to the navigation from the use of such water, the total extra supply which the delta must have for its summer wants, whence we may infer the total probable amount of benefit the navigation will receive if the storage of water be limited only to the requirements of the delta lands, and can determine whether, considering that these improvements of the navigation will cost the State *nothing* (as the water-rates alone will pay the interest), it may not be worth while to pour a yet larger quantity into the river for the navigation sake only.

6. I beg to say again, I am not assuming anything as proved in this matter beyond this, that the present water-supply is insufficient for the delta irrigation.

But I submit that there is a strong *primâ facie* case for investigation, and that such investigation is fraught with such important consequences that it should be entered upon without delay. It may bring to light facts which will give an entirely new complexion in the minds of many to the whole Godavery question, and show that an experiment which will set at rest all doubts upon the subject, may be conducted without possibility of loss, nay, with the advantage of saving what *may* now be an annually recurring and increasing loss of revenue to the State.

I hoped that I had made this plain enough in my Report on the Wynegunga, and my disappointment at finding that the point has altogether failed to attract attention, and that the matter is likely to be shelved for another year at least, must be my excuse for again pointedly drawing attention to it. Its investigation will commit the Government to nothing. What is now wanted is simply to ascertain facts, and I would submit that the investigation may well be conducted, pending the reply of the Secretary of State to the questions now to be submitted to him.

7. I have already indicated the main heads of the enquiry which, as proposed in my Report, might be addressed to the Madras Government. I will add one more point. Sir W. Denison cherished a scheme for constructing a second anicut across the Godavery about 40 miles above the present one at Dowlaishwarum, and watering from it a large extent of country, partly delta land, above the level of the other.

If irrigation works should now be carried out on a large scale, this scheme might receive attention.

If so, what increase to the summer supply of the river, already insufficient for the delta lands, would it involve.

8. I would suggest that the Madras Government should be addressed upon the subject generally, and requested to furnish the information under some such heads as those above suggested, which may enable the Government to determine whether steps should be taken for the construction of one or more reservoirs in the Wurda or Wynegunga Valleys, the primary object of which should be the supply of the present or prospective water demands of the delta irrigation, and the secondary, but ultimately most important, the settlement of the *vexata quæstio* of the reservoir system.

No. 507 C, dated 11th July, 1867.

[No. 39] *From*—Colonel C. H. Dickens, R. A., *Secy. to Govt. of India, P. W. Dept.,*
To—*Chief Commissioner of Central Provinces.*

I am directed to acknowledge receipt of your Secretary's letters marginally noted, forwarding a report and a subsequent communication from Major Haig, on the subject of the navigation of the Kanhan and Wynegunga Rivers, and increasing the supply of water for irrigation in the Godavery Delta.

No. 151—1868, dated 5th April 1867.
„ 172—2462, „ 22nd May „

2. The Governor General in Council has carefully considered Major Haig's interesting Report, but is not disposed to entertain any projects for extensions of the Godavery Navigation Works till those now in progress are approaching completion. As it will however be useful to ascertain the real facts of the case as to the alleged insufficient supply of water for irrigation in the Delta, the Government of Madras has been requested to furnish information on this point under some such heads as those suggested by Major Haig.

No. 506 C, dated 11th July, 1867.

[No. 40.] *From*—Colonel C. H. Dickens, R. A., *Secy. to Govt. of India, P. W. Dept.,*
To—*Secretary to Government of Madras, in the P. W. Dept.*

I am directed by the Governor General in Council to forward copies of a report and letter by Major Haig on the navigation of the Kanhan and Wynegunga Rivers, and the question of increasing the supply of water for irrigation in the Godavery Delta.

Report, dated 14th December 1866.
Letter, „ 13th April 1867, No. 502.

2. The Government of India is not disposed to entertain any projects for extensions of the Godavery Navigation Works till those now in hand are approaching completion, but His Excellency in Council will be glad to be informed meanwhile of the real facts of the case as regards the alleged short supply of water for irrigation in the Delta. I am therefore to draw special attention to paras. 129 to 136 of the enclosed report, and to Major Haig's letter of 13th April, and to request that, with the permission of the Madras Government, information on this point may be supplied as early as practicable under some such heads as those suggested by Major Haig.

No. 107, dated 11th July, 1867.

[No. 41.] *From*—*The Government of India,*
To—*The Secretary of State for India.*

In continuation of our Despatch No. 36 of 1867, on the subject of the prosecution of the Godavery Navigation Works, we have the honour to forward, for the information of Her Majesty's Government, copies of the letters noted below from the Chief Commissioner of the Central Provinces, forwarding an interesting Report by Major Haig on the subject of the navigation of the Kanhan and Wynegunga Rivers, and increasing the supply of water for irrigation in the Godavery Delta.

2. We are not disposed at present to give any encouragement to projects for extensions of the Godavery Navigation Works till those already in progress are approaching completion, and have so informed the Chief Commissioner, but as it would be useful to ascertain the real facts of the case as regards the alleged insufficient supply of water for irrigation in the Delta, the Madras Government has been requested to furnish us with information on this point.

Documents accompanying.

1.—Letter from Central Provinces, No. 151—1868, dated 5th April 1867.
2.—Report by Major Haig, dated 14th December 1866.
3.—One map.
4.—Letter from Central Provinces, No. 172—2452, dated 22nd May 1867, and enclosure.
5.—Public Works Department No. 507 C, dated 11th July 1867, to the Chief Commissioner of the Central Provinces.
6.—Public Works Department No. 506 C, dated 11th July 1867, to the Government of Madras.

APPENDIX
TO
PUBLIC WORKS DEPT. PROCEEDINGS, JULY, 1867.

CIVIL WORKS.
Communications.

NAVIGATION OF THE KANHAN AND WYNEGUNGA RIVERS, AND INCREASE OF SUPPLY OF WATER FOR IRRIGATION IN THE GODAVERY DELTA.

Dated 14th December, 1866.

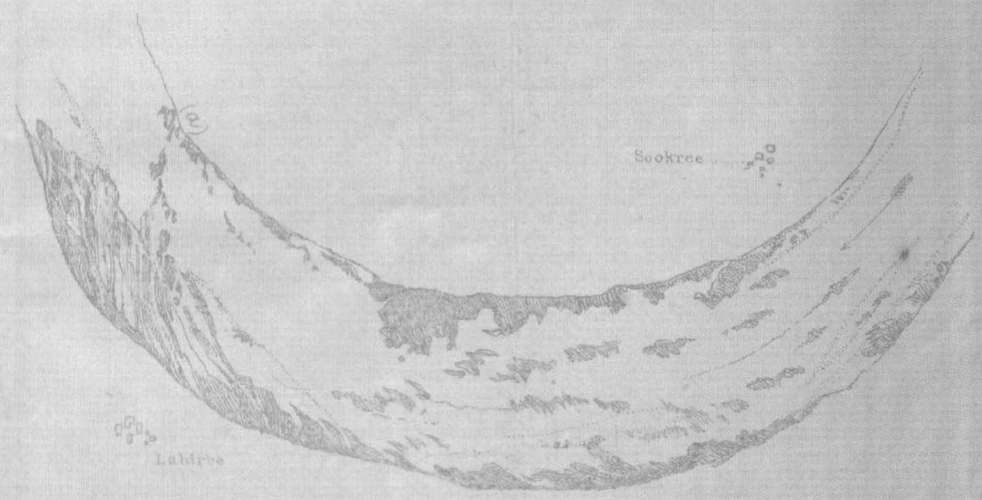
[No. 36.] *From*—Major F. T. Haig, R. E., *Supdg. Engr., Upper Godavery Circle,*
To—*Secretary to Chief Commissioner, Central Provinces, in the P. W. Dept.*

Having just arrived at this place, (Doomagoodium) I have the honour to submit some rough notes on the navigation of the Kanhan and Wynegunga Rivers, which route I took at the suggestion of the Chief Commissioner on my way down from Nagpoor in preference to that of the Wurda.

KANHAN.

2. The first obstacle to navigation in the Kanhan is met with at Lahiree (Reddie in map); and having been given to understand by Mr. Low, Deputy Commissioner, that no boat could get through the rocks at this spot, I dawked to Mohoda, and thence walked up to inspect the river at Lahiree. I found, however, that there would be no difficulty in descending from Jooler in a canoe, and accordingly had one sent up from Mohoda, and in it commenced my voyage down river on 14th November.

3. A rough plan of the river at Lahiree is shewn below. The bed



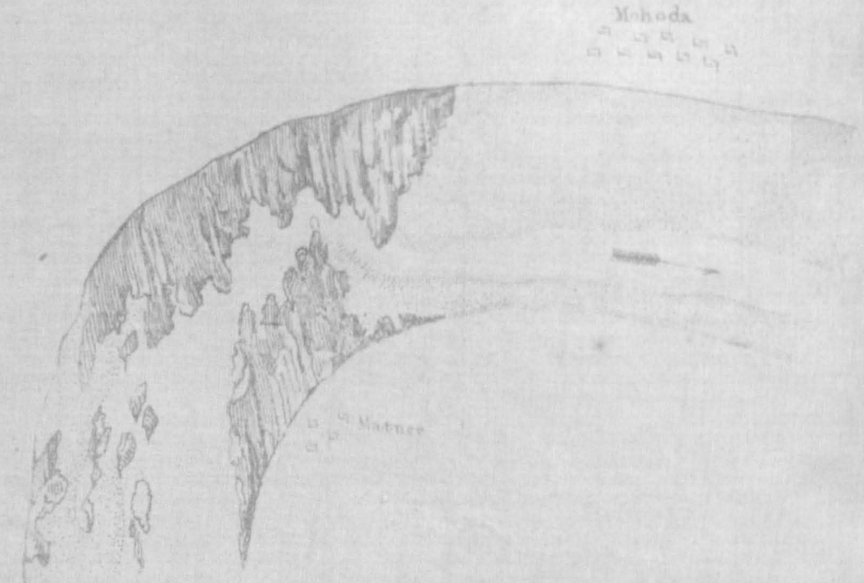
is a mass of rock, with numerous channels through it from a little above Sookree to some distance below Lahiree. The worst place is at (*a*) where the passage is very narrow, with a fall of perhaps 5 feet in a length of 100 yards. I estimated the total fall in this rocky reach, 1½ mile in length, at 13 feet.

Navigation is doubtless practicable in a moderate flood, but it appears to be questionable whether mere blasting would make the passage practicable in the dry-weather navigation.

4. A few rocks are met with here and there down to Cheridie.

5. A mile below Cheridie the channel is much obstructed by large masses of rock for one-third mile. Fall in this distance probably 4 feet.

6. Opposite Matuee, just above Mohoda, the most formidable obstruction of the whole is met with. I give below a sketch of the position of the



rocks at this place. Owing to the manner in which the channel winds through them, it must be almost impossible to pass this spot in the monsoon, save during very high floods; and in the dry weather, when the river is low, the rush of water is so great, and the passage so tortuous, that it requires the utmost dexterity to prevent even a canoe being dashed against the rocks. The rocks being high, this is even a more impracticable spot than the reach at Lahiree above-mentioned.

7. On the whole, I am inclined to think that it may be found impracticable to render the 5 miles of river between Lahiree and Mohoda navigable in monsoon by clearing away rock in the bed.

I estimate the average fall at 4 or 5 feet per mile, and at two or three points it is very much greater than this. It may eventually be necessary to avoid this reach altogether by a canal. This, however, would not be an expensive work.

8. From a point about half a mile below Mohoda, the slope of the river suddenly changes; long deep pools, some of them miles in length, with short shallows between, and mostly quite clear of rock, succeed the rapids and rocky bars met with above Mohoda. From this point, in fact, down to the junction with the Wynegunga, the Kanhan is an excellent navigation, and the fall cannot, I think, exceed 1½ foot per mile. A few rocks are met with, of no great consequence, at the points I shall now mention. I give a detailed description of them merely as a guide in future operations, that an Officer employed in clearing the channel may know where the obstructions are to be found; not that, in the case of nine-tenths of those here specified, they are of the slightest importance, or in any way affect the question of the navigability of the river.

9. Half mile to ¾ mile below Mohoda there are large masses of rock mid-river, but with a board clear channel between them and the left bank.

10. Near Bhamoda (Bomboda in map) are a few small rocks of no importance.

11. About a mile below this the boat-men shewed a point on the bank, 22 feet above present water-level, above which they say floods never rise.

12. Just above Chickna the floods have a tendency to cut out some very large masses which project from the right bank, but do no harm. River channel clear and good.

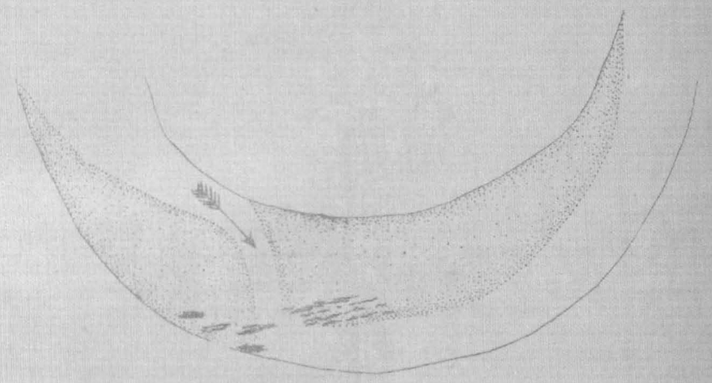
13. At Wandra (left bank) 4 or 5 rocks lie awkwardly in a good clear channel; a few lbs. of powder would remove them, and make the navigation perfectly good.

14. Half mile above Mohagaon a very few rocks lie off left bank, and should be removed. The cost trifling.

15. Near Wourna are one or two large low masses of soft crumbling rock, easily removable.

16. Half mile above Panmara, on left bank, the channel is much silted and obstructed by a number of low rocks scattered along a length of quarter mile. The rock, friable (schist) mostly, removable by crow-bar. A little below the village other masses run out from the bank which are more serious, as the stream hugs the bank and runs in among the rock. There is, however, a good channel outside of them in which a few detached rocks should be removed.

17. Three-quarter mile below Boregaon some low ridges of rock, which may be easily cleared away, cause much silting of the bed, with a fall of 1 foot in a short distance. See sketch below:—



18. Three-quarter mile lower down, some ridges run out from right bank, sloping across stream in an opposite direction to those last mentioned. They cause silt, and injure the summer channel, but do not prevent navigation.

19. A mile above Lohâra some scattered rocks lie off left bank. They injure the channel and require removal.

20. Quarter mile further on, a few similar, but less in number, on the right bank.

21. A few small rocks lie off Ourmarra, right bank; 8 or 10 may require removal.

22. This completes my notes on the Kanhan. From Sookree downwards, this river is clearly divisible into two sections; the first, 5 miles in length, from Sookree to Mohoda, much obstructed by rock, and having a fall of probably 4 feet per mile; the second, 19 miles in length, from Mohoda to the mouth, having a very slight fall, probably not exceeding 1½ foot per mile, and a channel perfectly navigable in its present state, except during low stages of water, and then only obstructed at two or three points where blasting of small amount would be absolutely *necessary* to clear the passage.

23. Judging from Mr. DeGronsillier's account of the river above Sookree, I should suppose that the 18 miles above that place up to Kamptee are about as favourable for navigation as the 19 miles below Mohoda.

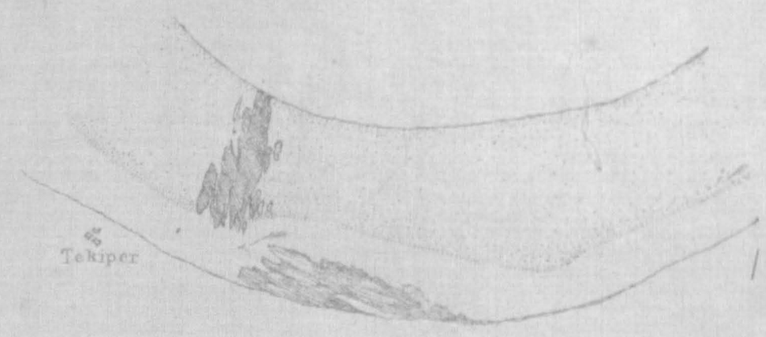
They appear at any rate to be as little obstructed by rock.

WYNEGUNGA.

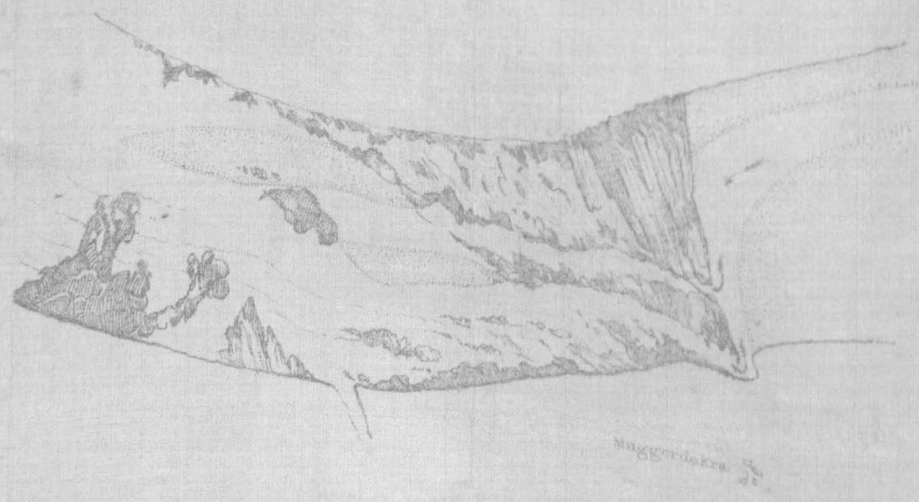
24. I now come to the Wynegunga, on which I launched my canoe at Bhundara on the 16th November.

The Wynegunga at Bhundara, and for 3 miles below that place, to near the hill at the Korumbee, is much broader, and evidently has a much greater fall than at any point for 50 miles lower down. The shoals were very bad. The fall, I should suppose, not less than 3 feet per mile. A very few isolated rocks to be seen.

25. From Korumbee to Kieree the navigation is good, with broad deep channel, except at one place a little above Tékípár, where some large masses of rock running out from both banks must make a very bad monsoon passage. In the dry weather the channel is rather winding, but deep and unobstructed. See sketch below:—



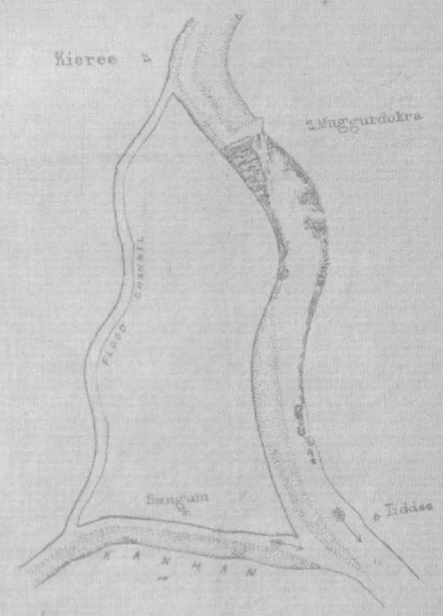
26. A mile or two lower down lies the great mass of rock to which the Chief Commissioner has given the name of the 2nd Barrier of the Wynegunga. A sketch given below.



The river here (at Muggurdokra) would have been completely barred across by an immense mass of rock running out from the right bank, had it not cut for itself a narrow passage round the extreme point on the left shore. Round this point, and through one other channel near it, the stream finds its way in the dry season. The passage is quite practicable for boats at this time of the year, but in the monsoon must be most perilous. Mr. Temple has described these rocks in his Minute on the Wynegunga, and the accompanying illustration will, with the remark that the rocks rise from 10 to 15 or 20 feet above summer level, give a sufficiently clear idea of the nature of this very formidable obstacle.

The obstruction does not extend over above half mile in length of the river. Below that, some large rocks project from the banks, but the passage mid-river is broad and deep. On the whole, however, I think, that the rocks here may justly be styled a Barrier, that is to say, that they constitute such an obstruction as no amount of blasting can effectually remove, and which it will be necessary to avoid in the monsoon by a lateral canal.

27. Mr. Temple has pointed out the curious flood-channel which may possibly be made use of for this purpose. This channel, which has probably been formed by the floods tearing open two drainage channels running into the Kanhan and Wynegunga, starts from a point half a mile above the Barrier, and joins the Kanhan about 2 miles from its mouth at a very favourable point. Its bed is many feet above the summer level in either river, but as this level in the Wynegunga would probably be raised some 20 feet by a weir across the river at Muggordokra, it is probable that this channel would require very little deepening to fit it for a canal to connect the pool above the weir with that below.



28. A few large rocks lie awkwardly in the large pool opposite Tiddee.

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29. From Tiddee to Ambora the channel is good; at one or two places a very few detached rocks.

30. At Ambora there are the remains of what seems to have once been a barrier of rock running right across river from a hill on either side. Portions of this barrier, which is merely a narrow ridge of rock about 20 yards wide, still remain, but with wide and deep channels between them. Mr. DeGronsilliers' description of these, "only narrow shoots for boats to go through" is most incorrect. A Man-of-war might pass through one or two of them without injury. Two at least are 50 to 80 yards in width, and very deep. There was no current through them when I passed, and the blasting away of one rock, at the expense of 100 or 200lbs. of powder, would make a passage 100 yards wide, if required. The rocks here are, in point of fact, of not the slightest importance.



31. Half mile below Ambora are a few rocks mid-river of no consequence.

32. One mile below Ambora, near Chota Ambora, the river is again crossed by a narrow ridge of rock similar to that at Ambora, but lower. For 200 yards in width the rock seldom appears above water, and there are many channels through it. A very trifling amount of blasting would suffice to clear the passage.

33. Similarly, at Chota Ambora, and for a short distance below, some low scattered rocks obstruct the passage, and should be removed.

They are very similar to those about Kivâka below 1st Barrier of the Godavery. The cost would be trifling; the *passage* is quite free enough as it is, but the rocks cause shoals and prevent that concentration of the stream in one channel which is necessary to good navigation.

34. A few similar occur at intervals along right bank to a point half mile above Weirrath, where they end in a long groin of low rock running out 100 or 150 yards. This, however, in no way affects the navigation.

35. Just above Kochee, 5 or 6 rocks are dotted about the bed. They may be removed with a few lbs. of powder. The navigation from Ambora down to this point excellent.

36. Half mile below Sowergaon, where the channel passes from the right to the left bank, 3 or 4 lumps of rocks occur mid-river, and have a bad effect, deflecting the stream again towards the right bank, and so preventing its even flow. They may be removed at the cost of a few lbs. of powder.

37. A little further down, masses of rock project from the left bank, and tend also to deflect the stream and to cause shoals.

38. Half a mile above Balapoor a large rock mid-stream causes a shoal and divides the stream.

39. From quarter mile above Balapoor down to Sonder, the channel is more or less obstructed by rocks. Above Balapoor the obstruction is of a serious nature, the masses of rock being very large.

There is a fine straight passage mid-river between the rocks, 60 yards wide, which is quite sufficient for the dry, weather navigation, and which could easily be widened to 100 yards.

40. At Balapoor the channel passes over to the left bank, which it follows through large masses of rock. The passage is tortuous, but quite practicable down to Sonder. Thence it improves, becoming much wider, the rocks still occurring at intervals on each side.

41. Some heavy blasting will probably be required to make a good dry-weather channel above Sonder, and heavier still for the monsoon passage.

Below Sonder, comparatively little will be required for the dry weather, and much less than above that village for the monsoon passage.

42. A careful and detailed survey of this part of the river will be required, from above Balapoor down to Kappree. There is a considerable fall in this distance, perhaps 3 feet, in the rocks above Sonder.

Below Sonder, however, the channel is broad and deep.

43. Opposite Malchee some low rocks, level with the water, obstruct the channel and cause a shoal. Just below the village a single rock, which 5 lbs. of powder would entirely remove, stands one-third of the way out from the bank. It is dangerous for the monsoon navigation.

44. Off Ghosee, large masses extend out from the left bank, but leave fully a third of the width of river perfectly clear. The removal of the rock at Malchee, and of one more here, would give a clear channel 100 to 200 yards wide.

45. Off Jimnapoor (Joonapoor in map), some very awkward masses lie about the channel which is on the right bank.

A good deal of clearing will be required, but a perfectly good channel may be made at small cost. The channel should probably be cleared along the bank.

46. Thence a fine pool extends down to Sonegaon; five or six small rocks should be removed opposite the village.

47. At Ghosee there is a serious obstruction. A mass of rock, with three or four channels through it, slants from the left bank across to the right. It is highest on left bank, and gradually sinks to the level of the bed as it approaches the right. There is probably a perfectly uninterrupted passage along the right bank during monsoon. The deep channel, however, is on the left bank, and must be cleared there through the rock, probably on the right side of the little island shown in the sketch. The rocks rise about 8 feet above



summer-level on left bank. There are three or four passages through, with a fall of perhaps three feet in the dry season, but in the monsoon there is probably abundant vent for the stream, and no great rush through the channels on left bank by the time the river has risen 6 feet. Blasting only will be required here. A good survey required at this place.

48. Half-mile below Oomree, a low mass of rock, 60 or 70 yards long, lies out in the stream, which it divides causing a shoal. It is of no consequence to the monsoon navigation.

49. In the reach above Korumbee, where the channel is on the right bank, there are a few scattered rocks level with the water.

A fine navigation all the way down to Pohonee. A few small rocks above the village.

50. From Pohonee to Pohona, (left bank) is mostly a succession of deep pools, quite clear of rock, but above Pohona one or two bad shoals occur. The channel is very broad, flat, and shallow.

51. Three quarter mile below Etan, low rocks, seldom appearing above water, lie out 100 to 150 yards from left bank. The passage is tortuous, but there is plenty of water. Some clearing will be required.

52. Below Etan, the river begins to widen, the left bank cutting away, until at Diggoree, and thence, down to where the river turns sharp to the south, the width is very great. The channel, however, which follows the right bank, is good. A few rounded lumps of rock lie awkwardly in it where it crosses at Kyrena, from left to right bank, and should be removed. In the long pool above Morena, there are also a few low rocks of small size which must be cleared away.

53. One of the most necessary improvements to this part of the river will be the protection of the right bank by means of groins. The stream now plunges right on to the bank below Kyrena, and is rapidly cutting it away.

54. Below Balasur a large island is shown in the map. The western channel is now, however, quite silted up, and can only be practicable when there is a good flood in the river. There is thus but one channel in the dry season.

55. We may pause here to note that, from this point downwards, a change evidently takes place in the inclination of the river-bed.

From Bhundara down to this point, a distance of 50 miles, the slope cannot, I think, exceed 2 feet per mile, and very probably is not more than $1\frac{1}{2}$ feet. I judge of course only by the eye, but from the great lengths of the still-water pools, and short length of the streams which connect them, and which have generally a very moderate slope, I do not think the inclination of the bed can exceed the amount stated. The navigation is on the whole excellent. Only at one or two points will any extensive clearing of rock be required (I except, of course, the Muggurdokra Barrier), and the rocks met with at various points, as registered above, are for the most part of trifling importance. In fact, I had no expectation of finding such a good navigation as now exists throughout the whole of this 50 miles of river. It compares favourably with some of the best parts of the Godavery below, and the slope of the bed cannot be much greater than in that river.

Below Oomree, however, which is near the head of the island above-mentioned, where the river, after running some miles in an easterly direction, suddenly bends due south, the fall evidently increases, and I should suppose may be as much as $2\frac{1}{2}$ feet per mile, down to where the lowest barrier commences, some 60 miles above the mouth. The navigation in this lower-half of the river is consequently not so good as in the upper; shoals are more frequent; but still it is good, and with some clearing of rock, will answer all purposes of communication.

I shall now continue the register of the rocks requiring removal.

56. In the reach below Lariji are 4 or 5 masses of low-lying stones which have the worst effect, causing the water to spread over a large surface, and making the channel very shallow.

57. Just above Eershee there are a few scattered rocks under water which divide the stream.

58. Where the channel crosses the river below Eershee, it is obstructed by some large masses of rock.

A good deal of clearing will be required. A good survey will be necessary here. The rock is mostly in small lumps, easily removable without blasting.

59. From Lariji downwards, the river becomes narrower, more so than anywhere above. The banks are of a firm yellow clay. This piece of the river, however, contains broad flats where the bed is perfectly level, and the dry-weather channel of great width, the stream of an even depth and very shallow. Altogether, this is the most difficult piece with regard to ultimate improvement, as far as shoals are concerned, of any yet met with, unless it be the 3 miles immediately below Bhundara.

60. Half mile below Runmuchurn (opposite Mhenda), there is a dangerous rock mid-stream.

61. Half mile below Kurrakurra, some rocks run out from right bank into the pool, and may be dangerous in the still-water. They should be buoyed or marked.

62. A long pool ends one-fourth mile above Pepergaon, and the stream then crosses, in a narrowed channel, over pebbles, and amongst rocks, to the other side. The rocks are the out-lying lumps of large masses which extend from left bank opposite Pepergaon, where they rise 12 feet above water. Those in the channel are low, flat masses, awkwardly placed, some of them below water. The passage is good for boats, not for steamers. A good deal of blasting will be required, and a careful survey.

63. On to Nildza, the left bank is fringed with rock. One lump, very awkwardly situated, lies mid-river a mile above Nildza.

All this part of the river is a deep still pool, some miles in length, extending past Nildza and Pâjgaon to a mile below the latter village.

64. Quarter mile below Nildza, a few large rocks are dotted about the bed. They are badly placed for the monsoon navigation, but offer no obstruction in dry weather. Both banks are lined with rocks.

65. All this part of the river is narrow, not above 400 to 450 yards in width.

66. Below Pajgaon, the river widens greatly, the stream following the right bank, until, near Ogarra, it is crossed and quite blocked by some very low rocks and bushes.

The rock is seldom to be seen, but the bushes which grow in it catch the sand and form a bar. My canoe was dragged through with difficulty. Some clearing will be required.

67. Ogara to Sagaon, the channel is wide and clear except at one place where there is a little rock.

68. Opposite Sagaon, a large mass lies mid-stream, which might be troublesome in the monsoon, but is not so now, there being plenty of room on both sides of it.

69. From Sagaon to Doroolee, the channel crosses to the right bank. At the corner, some awkwardly-placed low rocks should be removed. Opposite Doroolee, a large mass of rock mid-stream should be buoyed for the monsoon navigation.

70. Opposite Shivince (Seonee) large masses are scattered about the bed. There is plenty of room and deep water in the dry weather, but some clearing will be necessary to make a good monsoon passage; a good passage may be made down right bank.

71. At Shivinee, and for half mile below, the rocks are more frequent, but mostly low, and covered with bushes. This continues to a point three-fourth mile below the village, where the river is nearly barred by low lumps of rock not visible above water, in which grow bushes which collect sand and mud. The few openings through these are closed by the demurs, or fishermen, with low dams of stone and stakes. The stakes, being cut from the bushes growing close by, soon strike, and thus fresh barriers of bushes are made, and fresh deposits of sand collected. In this way, the river is fairly dammed across, and the only passages are through the openings left for the bagnets. There is, however, nothing worthy the name of barrier, in the peculiar signification which attaches to the term on the Godavery. There is nothing that may not be cleared by digging and some blasting. A considerable part of the obstruction here, and at many other similar places, is due to the operations of successive generations of fishermen, whose traps and dams are to be met with at every mile almost of the whole river.

72. A good and careful survey is required of all the above part of the river from Ogara downwards.

73. From Dewilgaon and Awurgaon, the channel clears, and so continues with a good fall down to the point where it turns sharp to the west, where the road, shown in the map, from Hurda to Wasser, crosses. Here large rocks commence; one very large mass lie mid-river, and rises 15 feet above water.

Probably this part of the river would be impassable in its present state during the monsoon.

Some heavy blasting would be required to clear a channel which would probably lie along the right bank. The water is deep, and much of the blasted rock might be thrown in where it falls.



The obstruction extends over only a very short distance, not above 300 yards. The removal of one or two large masses, containing perhaps $30 \times 20 \times 3 = 1{,}800$ cubic yards of rock, would suffice to form a channel.

The beautiful dark red rock seen in the 3rd Barrier of the Godavery is met with here also. The first seen in descending the river was at Shivinee.

74. Opposite Korasowlie, the channel is obstructed by two large masses of high rock, one of which should be removed.

75. One mile below the same village, another two similar masses. The passage is good in dry weather, but the channel generally shallow and broad.

76. At Kooroolee the channel is again blocked by a few rocks under water with a thick growth of bushes. At such places as this the existence of rock can only be inferred from the fact of the bushes growing as they do in the bed. So far as my observation extends, such bushes are an unfailing indication of rock beneath, as it is only when they can twine their roots round the rocks that they are able to withstand the force of floods, which otherwise invariably tear them from their bed.

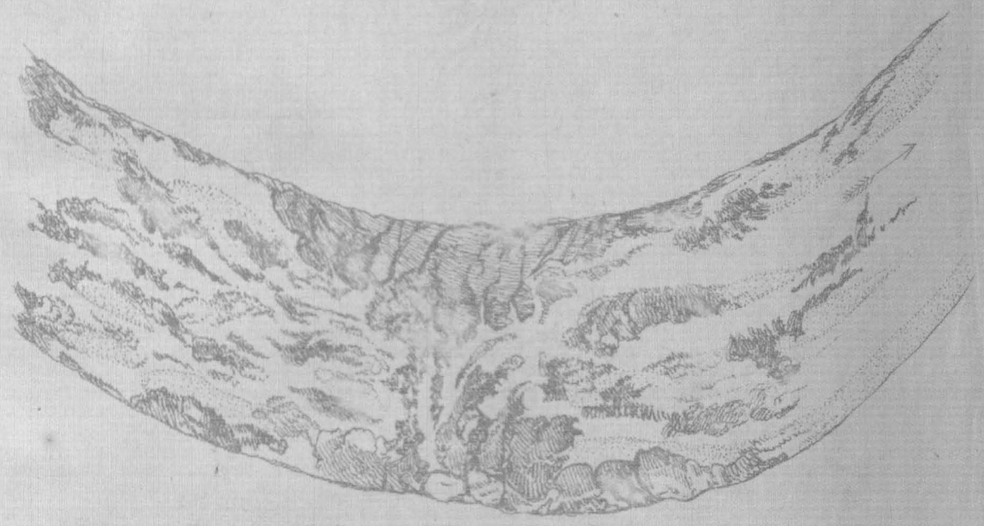
77. From Kooroolee to Deoree, the channel keeps to the right bank. It is clear, except at a few points where there are a few insignificant rocks or bushes.

78. At the confluence of the Nuddee, next above the Kathan Nuddee, rocks are a good deal scattered about the channel.

Thence all is clear to the Kathan Nuddee, left bank.

GHURCHOOROOLEE BARRIER.

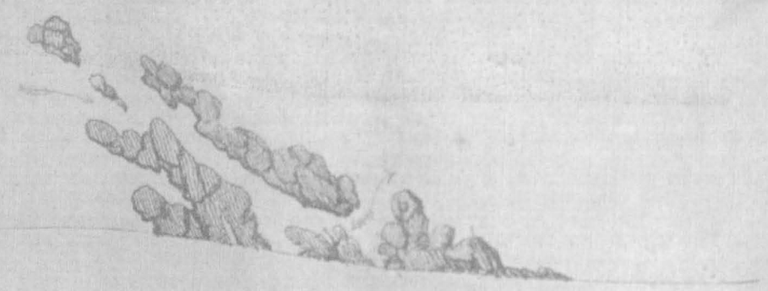
79. About half-mile below the Kathan Nuddee, rocky islands begin to be scattered thickly all over the river bed, the water flowing among them in several channels, but not with any great velocity. Opposite Ghurchooroolee, the rock closes in from both banks, and fairly bars the river across, the stream descending at this point by two rapids, in the upper of which it falls (as I judged by the eye) 6 feet in 100 yards, and in the lower 3 feet in the same distance, there being a pool of about the same length between.



In point of fact, the bed from where the rocks are first met with, down to a little below Ghurchooroolee, a distance of $2\frac{1}{2}$ miles, is a mass of rock, the tops of which only show themselves in the form of islands in the upper 2 miles, but which rises at last to a height of 10 to 20 feet above water near the banks near Ghurchooroolee, and dams the river across. I fear the obstruction at this place must be regarded as a barrier; the first of series which are met with from this point down to the mouth, and which will probably render it necessary to abandon this part of the river, and to connect that above with the Wurda and Pranhita by a canal.

We have here, at any rate, 2 miles of rock bed ending in an abrupt descent of 9 feet (if my estimate is correct) in 300 yards. The 2 miles above have a fall probably not less than 3 feet per mile. The total fall would thus be 15 feet in $2\frac{1}{2}$ miles, or less, which would give an average of 6 feet per mile, supposing a channel to be cut through the bed with an uniform slope. Such slope would be too great for navigation, so that, even if there were no other inducement arising from the existence of similar obstructions further down river, this alone would probably render a a lateral canal necessary. It must be remembered, however, that all my measurements are made by the eye, and an instrumental examination of the spot will be necessary to determine the actual conditions of the case. I entertain, however, little doubt that from this point downwards, the river will be found to be practicably unnavigable.

80. The Ghurchoorolee Barrier passed, the channel is pretty clear of rock down to Dabgaon. Half mile below the village, the channel is much obstructed by large masses of high rock, through which there is a fall of 1½ or 2 feet. The masses are so large, and run out from the bank in such an awkward manner, that it is difficult to say what should be done.



81. The whole river from this point onwards to where it turns to the south, 4 miles, is obstructed every ½ mile by large masses of rock crossing the channel which winds through them. Much expensive blasting would be required to clear a proper channel.

82. At the corner where the river turns south, the rocks thicken. For a mile the bed is all rock, with a passage 50 or 60 yards wide through it, about 150 yards from the right bank. The fall all down this reach is considerable. The reach from the corner down to Sonapoor is also much obstructed. The channel lies along the left bank, from which large masses run out mid-river in a way fatal to any permanent improvement of the dry-weather channel and rendering monsoon navigation most perilous, if at all practicable.

83. From Sonapoor to Neelajnee, the channel is pretty clear; in fact, down to Donara, only occasional rocks are to be found.

84. Just below Donara the river is again barred across by low rocks and bushes, through which there is a fall of 4 or 5 feet in one-fourth mile. The rocks then recede towards the banks, leaving an open basin with rock bottom for half mile. Then comes another short bar of rock followed by another opening with rocky sides. The rock then closes in upon the channel again, leaving only a narrow passage, opening out gradually into a pool fringed with large rocks running out from both banks. This sort of pool continues, the water spreading over a wide surface, with rocks and islets through it, down to Kurroolee, where again occurs a bar of rocks and bushes, with one or two passages closed in the usual manner by the fishermen. The river continues thus onwards to Kooroor; the bed a mass of rock covered with water in which it shows itself in numerous projecting rocks and bushy islets scattered all over the bed.

85. The rocky reach above described, from Donara to Kooroor, 3 miles in length may, I think, properly be regarded as a barrier not improvable by means of clearing and blasting in the bed itself.

Whatever doubt may exist as to the propriety of the designation in this case, there can be no question of its applicability to the next obstacle met with.

HARUMBA BARRIER.

86. At the Chota Nuddee, just above Kooroor, the rocks thicken and soon close right across river opposite Harumba (Arumba), forming a bar down which the river falls in a rapid 350 yards in length, a height of 10 feet, as I suppose. The rocks rise to a considerable height on the left of the main passage, and also in some places on the right. This is a true barrier, and is in point of fact the lower end of the mass of rock of which the bed is composed from Donara downwards, a distance of 4½ miles.

87. From below this barrier, on past Markunda, to where the Kowtee rocks commence, the channel is wide and tolerably clear.

88. Kowtee is the point designated by the Chief Commissioner in his Minute, as the head of the "1st Barrier of the Wynegunga." I need not describe the river below this point. It is a succession of rocky barriers and rapids down to the confluence of the Wurda.

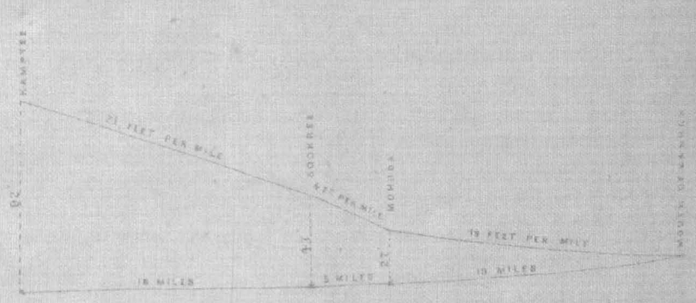
The worst rapids are at Bhoreghât and the Larolee Island. In the last of these, the descent of the rapid cannot, I should think, be less than 30 feet in 1½ mile. The stream runs here in numerous channels through a wilderness of trees and bushes rising out of the rock, the scene being one of the wildest imaginable. I was benighted in my canoe at the entrance of it, and for two hours had to thread my way in the dark through a maze of channels, the water rushing with great velocity through a tangled growth of grass and bushes.

INCLINATION OF THE BEDS OF THE WYNEGUNGA AND KANHAN, AND THEIR NAVIGABLE CAPABILITIES.

89. The foregoing detailed description of the river, tedious as it is, will be found of practical use whenever the work of improvement may be undertaken. It will, as already remarked, serve as a guide in selecting the places where clearing of rock is most required. I must now state the general conclusions at which I have arrived from this examination of the river as to the probable distribution of its fall, and its capability of navigation. I shall refer only to the Wynegunga below Bundara, and to the Kanhan as far up as Kamptee.

These two rivers I have now navigated, and though, in estimating their slope, I can judge only by the eye, still it must be remembered that I have now been for years thoroughly familiarized with the appearance of the Godavery for 300 miles where it has slopes from 1 to 2½ feet per mile, and it is not probable therefore that, within some such limits, I can be far wrong in guessing the probable inclination of the Wynegunga.

90. First, with regard to the Kanhan.—From Sookree to the mouth, there cannot be the slightest question of the distribution of the fall in this river. The bed is composed of two inclined planes, the first, 5 miles in length, with a considerable fall, which I estimate at 4 feet per mile, the second 19 miles in length, with a very slight fall, which I think cannot exceed 1½ feet per mile. And as the navigation above Sookree is described by Mr. DeGronsilliers as good and unobstructed, the slope of the 18 miles from that village to Kamptee is probably not above 2½ feet per mile. The following, then, would be a profile of the bed of the Kanhan.



91. Second, the Wynegunga.—The general distribution of the fall in this river also is very palpable to the eye.

Any one after passing through the succession of long deep pools connected by short shallow runs, which extend from the junction of the Kanhan for 47 miles down to the point at Howree, where the river bends sharply to the south, can tell after he has passed that point that the river thence downwards to Ghurchooroolee, 40 miles in length, has a greater fall, for the pools are not so long, and the shallows with sharp currents more frequent. And, similarly, no one can pass from Ghurchooroolee to Kowtee, and then from Kowtee to the mouth, without noticing that, while both these reaches have a greater inclination than either of those above, the lower has much the greatest fall of the two.

Now, I should estimate the fall of the 47 miles from the Kanhan to Howree at $1\frac{3}{4}$ feet per mile, and that of the next 40 miles at $2\frac{1}{2}$ feet. The levelling instrument must decide how for I am correct. Assuming, however, these to be the true slopes, let us see how we can account for the total fall between Kamptee and the mouth of the Wynegunga.

92. The level of the bed of the Kanhan at Kamptee above the sea has not, that I am aware of, been satisfactorily settled. I take it at 950 feet.

The height of the bed of the Pranhita above the sea we are certain of, two distinct series of levels closely agreeing having determined it. It is 350 feet. The rise in the 3rd Barrier up to the mouth of the Wynegunga has also been found to be at the rate of 4 feet per mile, or 104 feet in 26 miles, making the height of the bed at the confluence of the two rivers 454 feet above sea-level.

We have, therefore, a total fall to account for from Kamptee to the confluence with the Pranhita of 950—454 = 496 feet.

Of this we have as above shown—

1.—In the Kanhan—

				Feet.
18 miles, at $2\frac{1}{2}$ feet	...	...	...	45
5 „ at 4 „	...	...	...	20
19 „ at $1\frac{1}{2}$ „	...	...	...	27
2.—In the Wynegunga—				
47 miles, at $1\frac{3}{4}$ feet	...	...	...	83
40 „ at $2\frac{1}{2}$ „	...	...	...	100
Total fall down to Ghurchooroolee			...	275

leaving 496—275 = 221 feet to be accounted for in the 63 miles between Ghurchooroolee and the mouth, which would give that piece of the river an inclination of $3\frac{1}{2}$ feet per mile. This would probably be distributed thus—

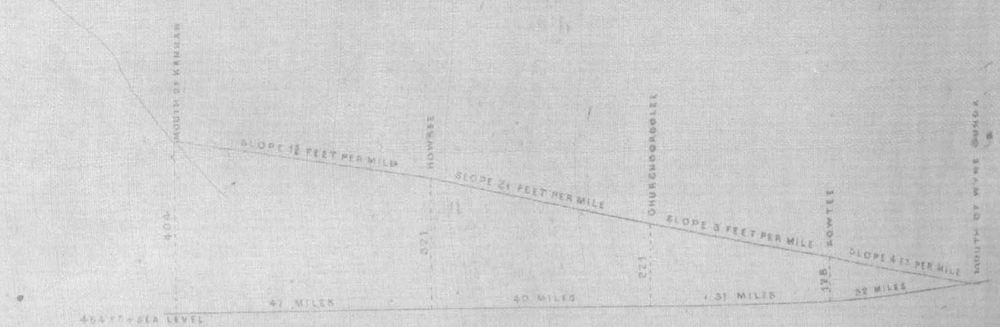
	Feet.
Ghurchooroolee to Kowtee, 31 miles, at 3 feet per mile...	93
Kowtee to the mouth, 32 miles, at 4 feet... ...	128
Total ...	221

I should have been inclined to estimate the fall in both these last reaches above this, but if the level I have assumed for the bed of the Kanhan be correct, the fall may not be more. Even if the level referred to is 1,000 feet + sea, instead of 950 feet, the extra 50 feet would be easily accounted for in this last rocky reach of the river. This confirms my estimate of the slight fall in the two long reaches above Ghurchooroolee.

93. Colonel Fife, in his Memorandum on the Wynegunga, assumes that the total fall in the last 76 miles of the river may be only 60 feet. He appears to have inferred this from some measurements, or rather guesses, of the falls at particular points, given in Mr. De Gronsillier's Report. This, however, is totally erroneous. To suppose that the fall in the most rocky

part of the whole river, where rapids sometimes extend for miles, is less than 1 foot per mile, is palpably wrong. Colonel Fife would never have entertained the idea for a moment if he had seen this part of the river. The fall certainly cannot be less than what I have stated.

94. I feel, therefore, very confident that the slopes of the Wynegunga approximate closely to those above given, which may be represented thus:—



95. This much, then, seems now very certain, that out of the 192 miles of river, from Kamptee to the mouth of the Wynegunga, or, in other words, to the 3rd Barrier of the Godavery, 123 are, both in regard to the gentle declivity of the bed, and their freedom from any serious obstructions, such as will afford good navigation, leaving 69 miles, of which 5 are in the Kanhan, which will require special works to complete the communication. Of course, longitudinal sections of the bed must be taken with the usual instruments before every body will be satisfied about this, and a certain amount of drawing paper must be covered with profiles and diagrams.

This appears to be inevitable. But the fact of the navigability of the Wynegunga and Kanhan, and their value for navigation as compared with the Godavery, is as certain as if we knew the profile and plan of every square yard of their beds.

96. It will be satisfactory to the Chief Commissioner to find that his estimate of the navigable capabilities of these two rivers, as set forth in his Minute on the subject, is quite confirmed by the more detailed examination of them which has now been made, excepting only that it now appears that the lower 60 miles must be regarded as unnavigable, in their natural condition, instead of the last 30 only, as he was led to conclude from the information then available. It will also appear in the sequel that, owing to the great bend in which the extra 30 miles are situated, the extra cost of the works which this reach will render necessary, will be in a very much lower ratio to that of the works for the lower 30 miles, than that of the respective lengths of the two reaches.

97. Before proceeding further, I would guard against two possible misapprehensions which may arise from the perusal of the above account of these rivers: (1), that the estimate of the slopes of their beds, which leads to such highly favourable conclusions as to their navigable capabilities, is based upon very loose data, and therefore unworthy of reliance; and (2), that the long register of rocks above given shows that these rivers must in reality be much more obstructed than is here represented.

98. With regard to the slope of the bed, it is to be considered that we know for certain within 50 feet or so the total fall between Kamptee and the mouth of the Wynegunga. This cannot be more than 1,000—454=546 feet, which, on a total length, as shewn by the map, of 192 miles, gives an average

fall of 2·8 feet per mile. It is more probably $\frac{405}{162}$=2·5 feet. If Colonel Fife quotes correctly from Mr. Hanna's Report on the Kanhan Reservoir, it is only 2·2 feet. That this slope is not uniform is palpable to the most inexperienced eye, as any one can tell the difference between a series of rapids and 50 miles of still drip water pools. Hence it does not require much skill to distribute approximately the total fall between these parts of the river, which manifestly have a more gentle slope, and those which plainly have a considerable fall, and this is all that I have attempted to do. It is quite certain, then, that the distribution of the slopes cannot differ widely from that above given.

99. With regard to the extent of rock-clearing required all along the river, it will be observed that, out of the 53 places where rock is met with in the 130 miles between Kamptee and Ghurchoorooloe, by far the greater part have the remark added that the rocks are of little importance, or that a very trifling amount of blasting will be required for their removal.

There are not above 3 or 4 of these where any considerable extent of clearing would be required for the monsoon navigation, and, as a rule, I believe that even less blasting will be necessary for the dry-weather navigation. The insignificance of the greater part of these obstructions can only be appreciated by actual inspection. I have, however, made a note of them all, with a view to their ultimate removal whenever that may be necessary in connexion with the reservoir system of improvement.

100. We have, then, in the Wynegunga and Kanhan Rivers, whose inclination varies between $1\frac{1}{2}$ and $2\frac{1}{2}$, or possibly 3 feet per mile. The slopes of the Godavery and Pranhita vary from 1 to 2 feet, and in one place below the 1st Barrier, for 10 miles the slope is as much as $2\frac{1}{2}$ feet. In regard, then, to this fundamental point, the slope of the bed, we may conclude that the Wynegunga and Kanhan will afford as good navigation as the rivers below.

101. I need not enlarge upon the value of this line of navigation which would connect the great stations of Kamptee and Nagpoor with the sea. The Chief Commissioner has already described the resources, trade, and population of the great valley drained by the Wynegunga and its affluents. There appears to be reason to conclude that, in addition to the line of navigation terminating at Kamptee, 85 miles more of the Wynegunga extending to the foot of the Sautpoora range, may be navigated, together with 40 miles of its most important tributaries. What I have now to do is, to state what works will probably be necessary for opening this navigation.

SKETCH OF WORKS REQUIRED FOR OPENING THE NAVIGATION.

102. Confining our attention in the first instance to the Kanhan from Kamptee to its mouth, and to the Wynegunga from thence to the confluence of the Wurdah, it is to be noted that, if my estimate of the fall is correct, there is one reach in each river which it will be necessary to avoid by canal. That in the Kanhan extends from Sookree to Mohoda, a length of 5 miles; and that in the Wynegunga, from Ghurchoorooloe to the mouth, a distance of 63 miles by river, but of very much less by canal.

103. With regard to the first of these, accurate levels alone can determine whether it will be necessary, as I suppose, to abandon the river channel. It is possible that it may not be so, but in any case, even if a lateral canal should be found indispensable, the cost will not be great, the length being only 4 miles, and the width of river where the anicut would be placed some 400 or 500 yards.

A sufficient quantity of stone would probably be found in the bed on the spot to build a solid masonry dam similar to that at the 1st Barrier of the Godavery.

The works, then, at this point, will not be of an expensive character.

104. The Barrier on the Wynegunga is of a more formidable character, and will require more expensive works.

I entertain no doubt that the levels will shew that Ghurchoorooloe must be regarded as virtually the head of this Barrier. In the 31 miles between that point and Kowtee, there are at least two rocky reaches which appear to be

incapable of improvement by means of mere blasting and clearing in the bed. Of the impracticable nature of the next 32 miles from Kowtee to the mouth, there has never been any question. I take it, therefore, that we have to choose between two methods of dealing with the lower 63 miles of the river, either by a series of anicuts or dams with locks in the river bed, similar to that at the 2nd Barrier of the Godavery, or by a lateral canal. And whichever plan we may adopt, it is essential that it should include the connection of the Wynegunga navigation with that of the Wurdah and Godavery by means of the 3rd Barrier (Godavery) Canal, or whichever work may be adopted for carrying the navigation past that Barrier.

105. Now, as to the first of these methods, a series of anicuts, Colonel Fife has proposed to throw an anicut across the Pranhita, just below the junction of the Wynegunga and Wurdah, at a point where the bed is 28 feet below the level of the rock on the crest of the 3rd Barrier at Daroor, 7 miles higher up; and he calculates that the water thus dammed up would submerge some miles (it does not appear how many) of the rocky bed of the Wynegunga, and 7 miles of that of the Wurdah, the water standing back on a level with that on the crest of the 3rd Barrier.

Without at all questioning Colonel Fife's ability to plan and construct such a work, I must say that an anicut blocking up 28 feet out of 40 of perpendicular height of flood-section, in a river with a fall of 4 feet a mile, is a work which I should think twice about before I ventured to propose it. But assuming the practicability of such a work, it is easy to shew that the money it would cost would yield immensely superior results if expended in a different plan. What would the effect of that anicut be? It would submerge and render navigable the upper 7 miles of the 3rd Barrier and $\frac{28}{4}$ = 7 miles of the Wynegunga Barrier. It would in no way benefit the Wurdah above the 3rd Barrier, and its beneficial effect would be limited to 7 miles only of the Wynegunga. It would shorten the 3rd Barrier Canal by 5 or 6 miles, which, however, is a comparatively unimportant consideration. To effect all this would require an anicut 28 feet in height and three quarter mile long.

106. Now, suppose that, instead of this, we go 7 miles further up the 3rd Barrier, and place our anicut on its crest, and thence lead a canal off from the *left* bank in the direction of the Wynegunga, in the same way as it has been proposed to lead one from the right bank down to the foot of the 3rd Barrier, we gain at once the following important advantages:—

1st.—The anicut would be only 500 yards long, instead of 1,350.

2nd.—Its height would be only 18 feet instead of 28.

3rd.—It would retain the water at a level of 28+18=46 feet above the bed at the mouth of the Wurdah, instead of only 28 feet.

4th.—It would dam the water back 36 miles up the Wurdah, making the whole of that length of river a still-water pool, and submerging the worst shoals in that river; whereas, Colonel Fife's anicut would leave the Wurdah in its natural condition without affecting its level, or benefiting it in any degree.

107. As to the effect of this anicut on the Wynegunga, we must now suppose the canal carried up (in point of fact it would be carried *down* from the head of Barrier) to the head of the Wynegunga Barrier, and compare it in connection with its anicut at top of 3rd Barrier, with Colonel Fife's series of anicuts up the Wynegunga. As an anicut of, say, 20 feet in height, would be required across the Wynegunga at the head of the canal, we should then have, even supposing the Barrier to extend no further up river than Kowtee, 30 miles—

1 anicut 20 feet high, and $\frac{1}{2}$ mile long,
1 „ 18 „ and $\frac{1}{4}$ „ and 30 miles of canal.

Against—

1 anicut 28 feet high, and $\frac{3}{4}$ mile,
And $3\frac{1}{2}$ anicuts 28 „ and $\frac{1}{2}$ „ long.

I leave out the lockage, as that would be the same in vertical height in both cases, though the locks in the river-bed at each anicut, would, with their accompanying sluices, be far more expensive than in the canal.

There would thus be 30 miles of canal against 3½ anicuts 28 feet high, and ½ mile long. If the canal cost Rs. 40,000 a mile, the total would be 12 lakhs. Would two of the 3½ anicuts be built for that sum? I should think it very doubtful. So that, independently of any other objections which might be cited, I think it will probably be found that the series of anicuts would be a much more expensive plan than the canal. And if, as I have little doubt, not 30 but 60 miles of river must be treated in one or other way, the advantages of the canal method are greatly increased, to say nothing of the irrigation which it would afford to a considerable tract of country quite prepared to benefit by it.

108. If, as I suppose, the river must be abandoned below Ghurchooroolee, the connection of the navigation with the rivers below would, I should think, be best effected by leading off a canal from the right bank at that town, and carrying it down to the Wurdah above the originally proposed 3rd Barrier Anicut. The levels are evidently favourable for such a canal.

From Ghurchooroolee to Kowtee by river is 31 miles, with a fall of not less than 93 feet. Hence the ground on the bank at Kowtee must be this much lower than at Ghurchooroolee, or 58 feet lower than the water-level then, assuming the height of the bank to be 35 feet.

The direct distance across country between the two places being but 15 miles, there is plainly a rapid fall in the ground from north to south. Supposing now an anicut 20 feet in height built opposite Ghurchooroolee, and a canal cut thence direct from Kowtee, the water would, if carried on a dead level, be level with the surface of the country at a distance of only 2½ miles from the head, if the fall in the country was uniform; but as there is a low water-shed further south, this distance would be increased by a few miles. Thus it is evident that there would only be a very short distance of heavy cutting, and that very soon the water-level in the canal would so command the whole country, that there would be ample choice of route. The map shows a river coming down from the north to the west of Rajghur, and falling into the Wynegunga at Ghatkool. I have examined this river west of Rajghur, where it has a fine square well-shaped channel 50 yards wide, and think it may not improbably be found possible to use it for navigation, reducing its fall where required by dams with locks.

If so, the canal would probably be led into it in some such direction as that shewn in the accompanying Sketch Map, and the navigation, after following the course of the river down to Ghatkool, would then be taken by canal down to the Wurdah. It is possible that a more direct cut might be made to this river from the anicut, as shewn by the dotted line.

There would be altogether 221+20—48 = 193 feet of lockage between Ghurchooroolee and the Wurdah, or 33 feet more than that in the proposed 3rd Barrier Canal.

109. It seems probable that, in this manner, the navigable part of the Wynegunga above Ghurchooroolee may be connected with the Wurdah and Godavery below. The length of artificial canal required would not exceed 32 miles by the longest route, or 27 by the shorter. The longest of these is just the length of the proposed 3rd Barrier Canal.

110. Objections may possibly be found, after thorough examination of the ground, to the use of the river, which I shall call the Mhool River for the present, as it flows past that town, which is, I believe, the head-quarters of the District for navigation. In the Delta all the main lines of navigation are formed by thus improving natural drainages, the advantage being that a large channel is thus obtained for little or no cutting. But it may be found impossible so to control the floods of a river draining so large an extent of country as that referred to, as to render it a safe and secure navigation. It will probably be necessary, wherever practicable, to tank some of the water of this river and its tributaries, the whole of which may of course be used

for navigation. A site which would probably be suitable for such a purpose, on the Andaree Nuddee, a branch which falls in a few miles above Pamoorna, was some years ago pointed out to me by Sir A. Cotton, as a likely one for the formation of a small reservoir for the summer navigation of the Godavery.

A reservoir formed here, as I have shewn in the accompanying map, and replenished by an additional supply which might probably be led into it by a cut from the Eraie Nuddee (on which Chanda is situated) would both help to restrain the floods of the Mhool River below the confluence of the Andaree, and afford a store of water which might be led down to Chanda, and after supplying the wants of that town and some irrigation in the neighbourhood, afford also the water to a navigable canal which might then connect Chanda with the Wurdah.

It might be sufficient to dam the Eraie Nuddee at its mouth, and to turn a sufficient quantity of water into it, furnishing it with a boat-lock to connect it with the Wurdah, as shown in the map. Or it might be thought better to extend the aqueduct which would thus supply Chanda in the form of a boat-canal down to the upper end of the still-water-pool formed by the 3rd Barrier Anicut. This arrangement is shewn in the map.

In this way, the important town of Chanda would be supplied with an abundance of good water, and placed in direct connection with the Port of Coconada; boats loading and unloading at its quays.

111. Some irrigation would be afforded in connection with this project. The water led off from the Wynegunga at Ghurchooroolee would command the whole of the country between the Wurdah and Wynegunga, as well as a large extent on the east bank of the Wynegunga (supposing an irrigation canal cut on that bank) south of a line drawn east and west through Mhool. I have sketched on the map a few lines shewing the direction which the irrigating channels would probably follow. I have no means of estimating the extent of land that would thus benefit, or the probable increase of revenue. There are some important towns on both sides of the Wynegunga, and everywhere the people are ready to make use of the water. Rice is grown all over the country now; some fine large fields of sugar-cane are to be seen wherever there is tank water available. I was struck with the rich well-cultivated appearance of the valley of the Mhool River.

112. The extension of the navigation up the Mhool River, by means of a few dams with boat-locks, as far as Gurboree, would probably be an adjunct, though significant one, of the above project.

1 h, then, would be a rough outline of the project which, judging from pr information, and my own inspection of the river, I should think the most p sing for turning what, following the nomenclature adopted by the Chie. ommissioner, may be termed the 1st Barrier of the Wynegunga.

It , in connection with the works at the 3rd Barrier of the Godave improvement of some 40 miles of the Wurdah, and the extension of e navigation to the town of Chanda. As this brings us up the Wurdah about half way to Hingenghât, I may add a few remarks upon the extension of the navigation in that direction.

114. It is quite true that the Valley of the Wynegunga is, in respect of extent, population, and resources, of much higher importance than that of the Wurdah, but I do not think that, on that account, there should be any hesitation about the extension of the navigation up the Wurdah to the highest practicable point, so as to give that valley the full benefit of the communication with the coast. Were there any comparison between the cost of the works required for this purpose above Chanda, and that of those for the opening of the Wynegunga, it might be a question whether one scheme ought not to be postponed until the completion of the other. But the Wurdah, as far as the mouth of the Wunna Nuddee, which comes down from Hingenghât, is so singularly and exceptionally well adapted by nature for navigation, that there is reason to believe that the works required for its improvement will be comparatively inexpensive. The Wunna also has a fall of only 2 feet per

mile from its mouth to Hingenghât; and even if it should be found impracticable to store water in the hills where it takes its rise, sufficient for the navigation of the Wurdah, there can be no doubt that the trifling quantity required for lockage, supposing the Wunna to be converted into a series of pools by means of dams, could easily be provided. It will of course be a question in what manner the navigation of the upper part of the Wurdah should be perfected; but among the alternative plans, that of a small reservoir situated somewhere on its head waters should certainly not be overlooked. When the question is taken up, I think a site might be looked for in three different parts of its valley,—in the southern slopes of the hills, north of Hingenghât; on the northern face of the same range, and on the northern slopes of the hills which bound the Berar Valley on the south. The Beemra, a small tributary of the Wurdah, rises in those hills and joins the Wurdah some 10 miles south of Natchingam.

The practicability of storing water in the hills which shed the water of their northern slopes into the Beemra, and of extending the navigation for boats up the Wurdah and Beemra into Berar, should certainly be investigated. Such a scheme may be found to be not only practicable, but to combine with navigation a considerable amount of remunerative irrigation also.

115. To return to the Wynegunga. It will be observed that my remarks have been confined to that part of it below the junction of the Kanhan only, but the Wynegunga project in its completeness, as sketched out by the Chief Commissioner in his Minute, includes the navigation of 80 miles more of the river up to the foot of the Sautpooras, and some 40 miles of its tributaries.

It will be desirable that the river above Bhundara should be carefully examined in some such way as has now been done for it below that point. There is reason to believe that the obstructions, if there are any, will be found to be of no more importance than those in the open parts of the river below.

The Muggurdokra Barrier is the only place where works of an expensive kind may be found to be necessary for the monsoon navigation, but it certainly would be necessary for that of the dry weather. When I descended the river, the passage through the Barrier itself was made without the slightest difficulty; the channel was quite wide enough, and being very deep, there was little or no current.

The approach, however, where the stream crosses from the right to the left bank, running along the face of the great mass of rock of which the Barrier consists, was awkward at one place where a single rock only of small size require to be removed. For navigation, from 15th October to May, I very much doubt whether anything more than a little blasting would be necessary. In the monsoon, when the river is full, the case is different; this Barrier must then be one of the most dangerous parts of the whole river.

116. With regard, then, to the works that will be necessary either in the river bed, or for conducting the navigation past those parts of it where the Barriers lie, the following will probably be required if both monsoon and dry-weather navigation are contemplated:—

1st.—An anicut with lateral canal and locks at the 1st or lowest Barrier of the Wynegunga.

2nd.—An anicut with similar canal and locks at 2nd or Muggurdokra Barrier; the canal in this case not being above 5 miles in length at the utmost, possibly not more than 2 miles.

3rd.—Another anicut with locks, or possibly with a short lateral canal, at the Mohoda Barrier of the Kanhan.

4th.—Rock clearing at various points along both rivers, and doubtless also in the other navigable affluents.

117. But now, supposing these works to have been constructed, what shall we have gained? We shall have nearly 300 miles of river navigable,—for what length of time? This is a question to which I am perhaps not in a position as yet to give a positive reply, but I have little doubt that the answer

should be three and a half months. On the Kanhan, and on the upper part of the Wynegunga, there may possibly be occasional interruptions even during that time. Upon this point the Chief Commissioner is probably already in possession of better information than I am. Judging, however, from what I saw of the river in November, I think I cannot be far wrong in assuming that the navigation, without any addition to the stream from artificial sources, will be limited to a period of three months in the Kanhan, and perhaps three and a half in the Wynegunga. To what purposes, then, would the river be applied, supposing it to be available to this extent for navigation?

The local traffic which already exists would doubtless be largely increased. Boats would be used instead of the canoes now in use. I doubt, however, whether there would be any important increase of such traffic without the aid of steam. Steam-power is essential to the monsoon navigation of the Godavery, at least for the first three months of it; and it will doubtless be found so for the Wynegunga, which has a greater fall and current. Much more will it be necessary for the export and import trade with the coast: for the monsoon navigation, then, of the Wynegunga and its tributaries, steam-power must be employed.

118. It would not be necessary, I think, for this purpose, that any locks but those at the Muggurdokra Barrier and the Mohoda Barrier in the Wynegunga should be made large enough for steamers. Those in the canal at the lower, or Ghurchooroolee Barrier, might probably be made for boats only.

With so large an extent of river as 300 miles to ply in, steamers might be stationed on the Wynegunga, and work in conjunction with other steamers below the 3rd Barrier of the Godavery, without difficulty or any important increase of the cost of transport. Supposing, then, the works enumerated in 116th para. to be constructed, the locks in the canal at the lower Barrier being boat-locks only, and those at the other two Barriers large enough for steamers, export and import, as well as local traffic, would be practicable for three to three and half months.

119. It appears to me, however, questionable whether, though perfectly practicable, such a traffic would be commercially profitable; or, if it were so, whether the high rates which it would be necessary to charge would not operate to confine the traffic within very narrow limits, and so greatly to diminish the value of the communication to the country. If the steamers are to be unemployed for eight or nine months of the year, the charges to cover interest in the capital invested in them must be a large addition to the cost of transport. Without expressing a decided opinion upon this point, which, in the present state of our information, would perhaps not be possible, there seems to be at any rate no question that the dry-weather navigation of the Wynegunga and its affluents must be of incomparably superior importance, supposing it to be practicable, to that of the monsoon months, and this has led me to consider whether it might not be advisable to confine our attention in the first instance to the means of rendering the river navigable during the dry season rather than to those for opening it during the rains.

120. Before entering upon this question, I would observe that the doubt above expressed, as to the Valley of the Wynegunga as a communication during the monsoon, is in no way inconsistent with that advocacy which I have always maintained of the importance of the rivers below for navigation at that time of the year. The two cases are very different. Starting from Chanda, supposing the 3rd Barrier Canal completed, we have first of all about 40 miles of river navigable at all times of the year; and after passing the 3rd Barrier, we find the united waters of the Wynegunga and Wurdah flowing in a channel no wider than that of the former river, and with only half the fall, 1 foot per mile. These exceedingly favourable conditions continue down to the confluence of the Pranhita with the main Godavery, where the volume of the stream is at once doubled by the contribution of that river, and only 30 miles lower down the Indrabutty falls in, making an important addition to the stream.

This line of navigation is, therefore, practicable for boats and steamers for several months of the year. The Wynegunga, which contributes only a part of the total discharge of the rivers below, has a much greater fall. Its period of navigation is, therefore, proportionately limited.

121. With regard, then, to the dry-weather navigation of the Wynegunga and its tributaries, I would offer the following points for consideration, simply as a contribution towards the thorough discussion of the whole question.

As I descended the river, I was several times struck with the fact that, contrary to what is the case on the rivers below, many of the places where the heaviest rock-clearing will be necessary would require far less work to open a practicable passage for the dry-weather navigation than to clear one for the monsoons.

There will of course be times during the rains when the floods rise so high as to submerge all, or almost all, the rocks; and at such times the navigation would be unobstructed, but such occasions are rare, and are confined in all probability to a few days only of the flood season.

I refer now to the average condition of the river at that season, and I observed that at nearly all the most obstructed places (the lowest Barrier of course excepted), it would require more blasting to render the passage safe during floods than in the dry-weather. The reason is that, at such places, large masses of rock are so thickly strewn about the bed, that to make a passage sufficiently direct for a steamer or a boat to follow, when there is a strong current in the river, would require the removal of much more rock than would be necessary merely to improve a somewhat winding channel, such as is to be found in all of them, and which neither steamer nor boat would have any difficulty in navigating when the current is slack. I believe that the detailed surveys which will be required at such points will show this to be the case. Reference is made to it in some of the notes in the commencement of this Report.

122. In the next place, I would refer to what I have already remarked about the second or Muggurdokra Barrier.

It appeared to me that very little would be required to make this part of the river, so utterly impassable as it must be in the flood season, perfectly passable for eight or nine months of the year. I found two deep passages through it with an almost imperceptible current in November, and thought that, with a very little improvement, these would answer all purposes for the greater part of the year.

123. It is questionable whether the same would be the case at the Mohoda Barrier in the Kanhan, but it certainly would be so as regards the rocks at Mohoda itself, and for 4 miles above it. Those immediately below Sookree, at the upper end of this rocky reach, are more formidable, *but could certainly be sufficiently cleared at small expense for the descending* navigation. For the ascent some special provision would have to be made, (which, as the length would not be above 200 yards or so, could, I think, be contrived) to assist steamers, certainly boats, in the ascent.

124. Now, I think, with the fact before us of the very limited duration of the flood navigation, and the probability that were that in the first instance to be abandoned, and our object were to render the river navigable for the other part of the year, a large sum which would be necessary to render navigation practicable for the shorter period would not be required to open the river for the longer period, it becomes a matter for careful investigation whether the very same, or nearly the same, outlay that would be required for a three months' navigation might not, if otherwise expended, give us a six months' navigation, or more. I mean that it is a question for consideration whether the money that would be required for anicuts, canals, and locks at the Muggurdokra and Mohoda Barriers, as well as for the blasting of rock required only for the monsoon navigation, might not, with much greater advantage, be expended in storing the water which would give us a longer navigation at another time.

125. One important consideration bearing upon this question is this, that a three months' navigation, say from February to April inclusive, supposing the available depth of water to be such as would afford really cheap carriage, would be of much higher value than three months of the monsoon navigation from July to September, for two reasons: *first*, that the current being much less than in the flood season, there would be much less hindrance to the ascent of the river by steamer, and boat traffic without the aid of steam would be perfectly practicable; *second*, that at this time of the year, the crops would be just ready for export, instead of having to wait six months for carriage during the monsoon.

This one consideration it appears to me would be decisive, supposing we have our choice of the two ways of dealing with the river. Must it not be allowed that the superiority of the dry-weather navigation to that of an equal period of the monsoon would justify the outlay of a larger sum to obtain it?

126. But what if it should be found that the same outlay would give much more than three months' navigation in the dry season? That is to say, if the cost of the works at the Muggurdokra and Mohoda Barriers, and the blasting of rock in other places, which works might be dispensed with, would provide water enough for five or six months?

At Muggurdokra the river is about half a mile wide. The lockage would probably be about 25 feet, and it might be found possible to manage with not more than a mile of canal, though this mile would be heavy cutting.

The width of the Godavery at its 2nd Barrier at the site of the anicut is 1,000 yards, and the lockage 41 feet. There will be no canal, but the rise of the floods is 70 feet above summer level against, probably, only 40 in the Kanhan.

The estimate for the 2nd Barrier Godavery Works is 11½ lakhs, which the Committee consider insufficient. Probably the cost of those at Muggurdokra would not be less than this.

Those at the Mohoda Barrier, where dimensions and difficulties are all in a scale of about one-half those at Muggurdokra, might cost 6 lakhs.

Blasting for monsoon navigation might amount to 2 lakhs.

Altogether, the cost of the works above specified, which would be required for the monsoon, but may probably be dispensed with for the dry-season, navigation, might amount to 20 lakhs, or, including establishments, 24 lakhs.

127. Colonel Fife's estimate for the Pench Reservoir to contain 1,457,700,000 cubic yards of water is 16 lakhs, inclusive of establishments. This reservoir would supply a stream of 675,000 cubic yards per hour for three months, or of 506,000 cubic yards per hour for four months, or of 405,000 cubic yards per hour for five months.

Now, if any one of these volumes should be found sufficient for navigation, there can, I think, be no doubt of the superiority of this mode of treating the river to the other. I think it probable that 500,000 cubic yards per hour would be sufficient with the help of a little stone-work for contracting the channel at a few points where the stream spreads over too large a surface, but of course the question must be more fully investigated.

128. If, then, it shall be found that the works above specified as specially required for the monsoon navigation may be dispensed with if the dry-weather navigation only is contemplated, I think the mode of dealing with the river by applying the money thus saved to the formation of a reservoir should be first investigated.

129. But another question deserving of enquiry is this,—whether the natural supply of water in the Godavery is not already insufficient for the requirements of the irrigated lands of the Delta. It was quite certain from the first, that the time must come, sooner or later, according to the rate of increase of the area of irrigated land in the Delta, when the Godavery must be replenished from artificial sources to supply the water required for the

hot-weather cultivation. So far back as 1856, I pointed out in my first Report on the river, that the natural discharge of the Godavery is altogether inadequate to the demands of the Delta. The anicut at Dowlaishwarum commands at least 1,000,000 acres, and the rate allowed for the monsoon irrigation, when the rain of course supplies in part the water required, has always been a cubic yard per acre per hour.

Thus the minimum required for the first crop would be 1,000,000 cubic yards per hour. For the second, or hot-weather crop, a larger quantity is, I believe, necessary. As the discharge of the river is not above 1,000,000 cubic yards at Dowlaishwarum on the 1st January, and gradually decreases from that time to 200,000 cubic yards in the beginning of June, it is inevitable that either an extra supply must be thrown in from reservoirs, or the second crop must be sacrificed, with a corresponding loss of revenue over the greater portion of the Delta. In a district whose revenue, chiefly derived from the irrigated land, already amounts to 40 lakhs per annum, though only a part of the land commanded by the anicut has yet been watered, it is evident that the loss of the second crop must involve a very considerable sacrifice of revenue, and I have repeatedly urged the subject upon the attention of Government. Sooner or later we shall have to deal with it, and I believe the time has come when it should be made the subject of careful enquiry. I know that, years ago, the hot-weather supply was sometimes insufficient, and I have been informed that there have more than once been remissions of revenue in consequence. The following notification is, however, the first public recognition of the fact that I have yet seen, though it is very possible that there may have been such during the two years I have been absent from the country. It is extracted from a recent number of the *Godavery District Gazette*, and is dated 26th November 1866:—

"1st.—Notice is hereby given that, owing to the scarcity of water in the River Godavery, there will be none available for Dalwa or second crop cultivation in the current year in No. 1 Range, comprising the Ramachandrapùr Taluk, Coconada and Coringa Divisions.

"2nd.—All channels in that range will be closed, except the Cocanada and Samalcotta main canals, which will be open alternately for navigation only.

"3rd.—The Tassildar and Sub-Magistrates concerned are, therefore, directed to give due publicity to this notice throughout their respective talooks or divisions, discouraging cultivators from making any attempts to grow Dalwa or any other second crop, which require water from anicut channels."

COCONADA;
26th November, 1866.

J. FRASER,
Collector.

From measurements already made, I believe the supply of water in the Godavery this year to be about an average one, and I am informed by the Executive Engineer here that it is much more than there was last year. In all probability, therefore, the deficiency then led to similar results.

130. Now, here we have a distinct intimation that the cultivation under the anicut has already extended so far that there is a large deficiency in the water-supply, so large that in three important talooks, comprising, I should suppose, about one-fourth or one-fifth of the whole irrigated area, the growth of the second crop must be prohibited. What loss of revenue does that represent?

131. I doubt, however, whether even this shows the whole state of the case. It is deserving of enquiry whether even in those portions of the Delta not thus deprived of the second crop, the available water in the hot months is not applied, in part at least, to the growth of crops requiring less water than others which, were there a sufficient supply, would be more remunerative.

132. At any rate, I submit that there are now grounds for a full enquiry into the question of the water-supply in the Delta, and the Madras Government, so directly interested, will, no doubt, be ready to afford full information. Such an enquiry might probably come under the following heads:—

1st.—Whether there have been already losses of revenue from deficiency of water-supply, and to what amount.

2nd.—The extent of the present deficiency, and in what month it begins to be felt.

3rd.—Its probable rate of annual increase.

4th.—The estimated total deficiency of the water-supply for the second crop, when the whole of the Delta lands shall have been brought under irrigation.

133. On receipt of such information, which doubtless could be obtained in the course of two or three months, the Government will be in a position to decide whether the demands of the Delta alone will not render it advisable to take immediate steps for storing an extra supply of water. Should such prove to be the case, the formation of the Pench reservoir (should that site be selected) either of the full size for which it has been projected, or, possibly, in the first instance, of only such capacity as the immediate demands of the Delta may require, would apply the best possible test to the question of the suitability of that method of improvement to the Godavery and its affluents. This is the course I have always advocated. I have never been a projector of great reservoirs. I have always suggested that, in the application of this novel method of river improvement, we should proceed with the utmost caution, storing, in the first instance, only such a quantity of water as we know to be actually required for irrigation purposes, and then observing its effect on the navigable condition of the river down which it must pass to its ultimate destination. I cannot conceive any more simple, more cautious, more safe method of putting to a practical test a plan of improvement which has received the sanction of the first Engineers in America, which would have been tried there ere now had it not been for the Civil War, and which, even in this country, is admitted by a few to be deserving of investigation.

134. I have recommended this mode of procedure, not because of any doubts in my own mind as to the success of the reservoir system, but out of regard for the very natural and reasonable doubts of those who, not being accustomed to professional questions of the kind, may object to an expenditure upon works, the ultimate success of which appears to them to be doubtful. If the water is really and immediately required for irrigation purposes, there can be no risk of loss in storing, and so applying it.

135. I would not be understood, from what I have just said, to deprecate the construction of such a reservoir as the Pench, supposing that there is a reasonable probability of its water being utilized for irrigation. Looking to the requirements both of the lands immediately under it in the Nagpoor Valley and of those in the Delta, it is probable that the whole of its contents would be required within a very short time for this purpose. I quite expect that the result of enquiries in the Delta will shew that that District alone could consume the whole of the water. If so, the Government would, I should hope, feel no reluctance in sanctioning the construction of such a reservoir.

136. If the result of enquiry into the present and prospective condition of the water-supply for irrigation in the Delta should be to show the necessity for storing at once a certain quantity of water for supplementing the summer discharge of the river, the construction of a reservoir for this purpose, and the application of its water in this manner, would fall in with the plan above suggested for dealing with the Wynegunga. The hot months, when the additional supply will be required, will be those when the navigation of the Wynegunga will be of the most value. The large expenditure still to be incurred to open the navigation up to Chanda, will probably require that the whole of the allotments available for the Godavery for some years to come should be devoted to that line of navigation alone. To carry out the

MAP
of the
LOWER PART OF THE WYNE GUNGA
and 3rd Barrier of the Godavery

TABLE & MILES TO AN INCH

NAVIGABLE CANALS
IRRIGATION CHANNELS

To accompany Major Mant's Report on the Wyne Gunga dated 14th December 1866

(Signed) F. Fong Major R.E

DHAPOOR

Thick Forest Jungle

Teak Forests

Teak Forests

WYNE GUNGA OR PRANHITA RIVER

3rd BARRIER CANAL

Indravati River

Godavery

80°

19°

20°


Bombay
Surat
Baroda
Ahmedabad
Cambay
Broach
Surat
Nagpore
Chanda
Hyderabad
Golconda
Warangal
Ellore
Masulipatam
Guntoor
Ongole
Nellore
Pulicat
Madras
Arcot
Vellore
Chittoor
Cuddapah
Gandicotta
Kurnoolee
Adoni
Bellary
Anantapoor
Sanore
Darwar
Goa
Mangalore
Cannanore
Calicut
Tellicherry
Cochin
Travancore
Tinnevelly
Madura
Dindigul
Trichinopoly
Tanjore
Karical
Porto Novo
Cuddalore
Pondicherry
Gingee
Chillumbrum
Tranquebar
Negapatam
Tranquebar
Karical
Tanjore
Trichinopoly
Dindigul
Madura
Tinnevelly
Travancore
Cochin
Calicut
Cannanore
Mangalore
Goa
Darwar
Anantapoor
Bellary
Adoni
Kurnoolee
Gandicotta
Cuddapah
Chittoor
Vellore
Arcot
Madras
Pulicat
Nellore
Ongole
Guntoor
Masulipatam
Ellore
Golconda
Hyderabad
Warangal
Chanda
Nagpore
Surat
Broach
Cambay
Ahmedabad
Baroda
Surat
Bombay
Gondapelly
Argellee
Barnagur
Kamnerree
Karreelee
Adhere
Selloor
Huldee
Mavallee
Ghatkol
Nandgaon
Vingorla
Goa
Sanguinpatee
Chandia
Koongaru
Ellore
Gondipitt
Rajeora
Sundanna
Chandore
Sinnoor
Chanda
Warora
Wurwal
Ramtek
Nagpore
Seoni
Chillumbrum
Porto Novo
Cuddalore
Pondicherry
Gingee
Tranquebar
Negapatam

Wynegunga project in its entirety, as sketched out by the Chief Commissioner, may be financially impossible for a long time to come, and doubtless the Government will not embark in such an undertaking until fully satisfied of its practicability, or rather, of the value of the navigation when opened; in other words, of the practicability of navigating the Wynegunga during the dry months.

The construction of a reservoir of a capacity sufficient to supply the present wants of the Delta lands, would be a comparatively inexpensive undertaking, while at the same time a safe and remunerative one, and such a reservoir, when once in operation, would speedily afford most conclusive proof as to the practicability, or otherwise, of rendering the river navigable by such means, and so remove all doubt as to the advisability of expending large sums upon its improvement.

137. Should this course be followed, and the result be that all the unobstructed portions of the Wynegunga should be found to be navigable during the time that the reservoir is in operation, the next work would be to clear the rocks requiring removal in the open parts of the bed, on the completion of which there would be a continuous line of navigation from Kamptee and the Upper Wynegunga down to the head of the Ghurchooroolee Barrier. From that point to the Wurdah, at the head of the 3rd Barrier of the Godavery, the communication would have to be temporarily made by land, by means of the ordinary fair-weather cart-tracks, until funds should be available for the completion of the whole line of navigation by the construction of the canal from Ghurchooroolee to Dhaba above suggested, for turning the Barrier. This is the order in which I should be disposed to recommend that the work of opening the Wynegunga navigation should proceed. On any other plan the work must, I should suppose, be postponed for many years, and after all would not be based upon such satisfactory data as this would afford.

138. It will be desirable that the necessary levels for determining the actual fall of the different sections of the Wynegunga and Kanhan, as above described, should be taken at once, and with these might be combined a survey of the 2nd or Muggurdokra Barrier, and of the Mohoda Barrier in the Kanhan, together with that of four or five of the most rocky reaches in the open parts of the bed between the Barriers. For this purpose, Supervisor D. Venkatarutnum, who has had much experience in this kind of work, would be a very suitable person, and with the assistance of two qualified Surveyors of a lower grade, and a small staff of classies and peons, might finish the survey in a single season. The Supervisor, who is, I believe, now attached to a Division not far from Nagpoor, might be trusted to state the exact establishment he would require for this purpose. If he should be appointed to this work, I could send him detailed instructions for his guidance.

CIVIL WORKS.
Communications.

GODAVERY NAVIGATION PROJECT.

Pros. (Civil Works / Commns.) Sept. 1865, Nos. 49—84.
„ („) April 1866, „ 2—4.

No. 267–3079, dated 19th October, 1866.

[No. 1.] *From*—Colonel W. Maxwell, R. A., *Secy. to Chief Commr. of Central Provinces, in the P. W. Dept.,*
To—Secretary to Government of India, P. W. Dept.

In reference to the correspondence marginally noted, regarding the mission of Colonels Anderson and Fife to the Godavery, I am directed to forward a printed copy of the Report made by those Officers, and of the Chief Commissioner's Minute thereon. In that Minute reference is made to the contemplated submission separately of the Chief Commissioner's views regarding the navigability of the Wynegunga. I am accordingly to transmit, with this despatch, a printed copy of a Minute by the Chief Commissioner on that subject also. As these two Minutes comprise all that Mr. Temple has at present to represent on the whole subject, it seems superfluous to touch further thereon in this letter.

Government of India's No. 1221 C of 4th December 1865, to Chief Commissioner of Central Provinces.
Secretary to Chief Commissioner's No. 1127 of 17th July 1866, to Secretary to Government, Public Works Department.

2. It being understood that the Government of India desired to receive these papers at an early date, all practicable expedition has been used in their submission. The report by Colonels Anderson and Fife were received in manuscript, and had to be printed here.

[No. 2.] *Report by* Lieut.-Colonels Anderson and Fife, *on the Upper Godavery Works.*
(Referred to in above No. 1.)
[See Appendix.]

[No. 3.] *Minute by Chief Commissioner, Central Provinces, on the above Report.*
(Referred to in above No. 1.)
[See Appendix.]

[No. 4.] *Minute by Chief Commissioner, Central Provinces, on River Wynegunga.*
(Referred to in above No. 1.)
[See Appendix.]

No. 50 C, dated 15th December, 1866.

[No. 5.] *From*—C. Bernard, Esq., *for Secy. to Chief Commr. of Central Provinces, in the P. W. Dept.,*
To—Secretary to Government of India, P. W. Dept.

In continuation of my letter forwarding printed copies of the Report on the Godavery Works by Colonels Anderson and Fife, and of the Chief Commissioner's Minute thereon, I am now directed to submit the following further papers on the same subject, namely—
Major Haig's Memorandum on the Committee's Report.
The Chief Commissioner's Minute transmitting Major Haig's Memorandum.

Dated 18th December, 1866.

[No. 6.] *Minute by* R. TEMPLE, Esq., C. S. I., *Chief Commr. of Central Provinces.*

Since writing my Minute of September last, on transmission to the Government of India of the Report by Colonels Anderson and Fife on the Godavery navigation, Major Haig has returned from England, and I have had the advantage of conferring with him on the whole subject. I then requested him to prepare a Memorandum of his views after a perusal of these papers. This he has done, and I now desire to lay his Memorandum before the Government of India. He enters at some length into the points discussed in many parts of the Report by Colonels Anderson and Fife. In some passages he criticises their opinions or conclusions in a tone which may, perhaps, be regarded as too controversial, and may on that score be objected to. But as some warmth of expression is apt to occur in discussions on difficult and important subjects, I have deemed it better to transmit the Memorandum as it stands, as the substance of it, at all events, is such as the Government of India may desire to have under consideration.

2. The main topic treated of in Major Haig's paras. 1 to 17 inclusive, is the importance of steam navigation on the river in opposition to the view of Colonels Anderson and Fife, who think that steamers might be dispensed with. The Government of India will have seen from my Minute of September last that, in the above respect, I entirely concur with Major Haig. Nothing need here be added to the arguments I then offered.

3. In that Minute I observed that we ought to be sure that the lock dimensions proposed by Major Haig are fully sufficient for the class of steamers required. I find on verbal consultation with him that he, having recently had further and special means of enquiring in England, is satisfied of the sufficiency of these dimensions, and certainly he ought to be by this time in a position to judge.

4. It will be remarked that Major Haig is still confident of the efficiency of stern-wheel vessels, and certainly his printed pamphlet on American Rivers evinces much enquiry on his part into the matter.

5. When the information from Messrs. Napier, as promised in Major Haig's 6th para., is received, it shall be duly forwarded to the Government of India.

6. In his paras. 19 to 21 inclusive, Major Haig expresses dissent from certain criticisms of Colonels Anderson and Fife on the 1st Barrier design. These points being chiefly professional, do not seem to require comment here.

7. In his paras. 21 and 22, Major Haig adverts to the question as to whether the major or the minor project for the 1st Barrier should be prepared. In my Minute of September last, I expressed a decided preference for the major project, the prosecution of which I earnestly recommended. It will be seen that Major Haig fully concurs in this. Having recently conferred with him on the subject, I am more than ever convinced that the minor project, though it *might* be passably good, or barely sufficient, would never be quite good, would never perfectly answer either for the steamers in the rains, or for the boats in the dry season. On the other hand, the major project, though not free from engineering difficulties, does yet only involve such obstacles as can certainly be overcome, and, when carried out, it would, no doubt, answer well. I would therefore decidedly support Major Haig's recommendation for the prosecution of the major project, as being the one on which all the engineering authorities agree as the most efficient, and as being the one which, upon every general consideration, holds out the fairest prospect of success. After all the delays and disappointment which have occurred, it is apparently most important that the project decided on should be the very best that can reasonably be had, and the one most surely calculated to fulfil the objects in view.

8. Towards the close of Major Haig's para. 22, there are certain expressions which might at first sight be thought to mean that the anicut at 1st Barrier was not necessary for a five months' navigation, such however is not Major Haig's meaning, as is evident from the statement in the same para. that, "even for a five months' navigation, the river could not have been depended on without an anicut." In that statemen[illegible] believe, Major Haig to be quite correct.

9. From his 23rd to 32nd paras., inclusive, Major Haig replies to the criticisms by Colonels Anderson and Fife on his project for the 2nd Barrier. The points being purely professional, comment seems hardly to be required here. I would only remark that, when the project was brought forward in 1864, the designs were thought good by this Administration, and that, if Major Haig is to be relied on to carry out the work, the Government of India may, perhaps, prefer to allow him to decide the engineering details.

10. To some extent, too, the Government seems to be committed to the general scope of the project, inasmuch as it appears from Major Haig's 33rd para. that he has already, during his recent sojourn in England, ordered plant, &c., suited to the design as previously proposed.

11. Major Haig's para. 34 respecting groins, does not require special comment.

12. Para. 35 relates to past expenditure, regarding which I have nothing to add beyond what was stated in my Minute of September last.

13. Major Haig's para. 38 to his concluding para. 43 relate to the separate Memoranda by Colonels Anderson and Fife, respectively. Hereon I have only one remark to make, besides what was stated in my Minute of September last. In his para. 38, Major Haig remarks in reply to Colonel Fife's Memorandum respecting the storage of water for the supply of the navigable channel:—

"It is satisfactory to find that at last one man has been found to come forward, and recommend for investigation a scheme which has always been regarded as the wildest and most preposterous of even Godavery projects."

14. This passage might at first sight convey an impression not quite correct. For whatever may, or may not, have been the views held by some, such has not been the view held by this Administration. Doubtless such storage has always been regarded as difficult, and the scheme has been looked on as uncertain, until the specific localities for such operations should have been found. But this Administration has not only recommended investigation, but has actually investigated the scheme, and has submitted several sets of papers thereon to the Government of India. My Minute on the River Pench showed that sites for such storage *can* be found for the Godavery Proper, but not for the Wurda. What has been thought, and is still thought, almost impracticable, is to supply the River Wurda from storage reservoirs owing to the difficulty of finding sites for such reservoirs.

15. Although, as already observed, some of Major Haig's opinion may be expressed in two positive terms, yet, irrespectively of that, I would solicit for them the consideration which is merited by his great ability and experience and his devoted zeal to the cause in hand.

[No. 7.] *Memo. by* MAJOR F. T. HAIG, R. E., *Supdg. Engr., Upper Godavery Circle, on* LIEUT.-COLS. ANDERSON AND FIFE'S *Report upon the Upper Godavery Works.*

(Referred to in above No. 5.)

[See Appendix.]

Dated 24th January, 1867.

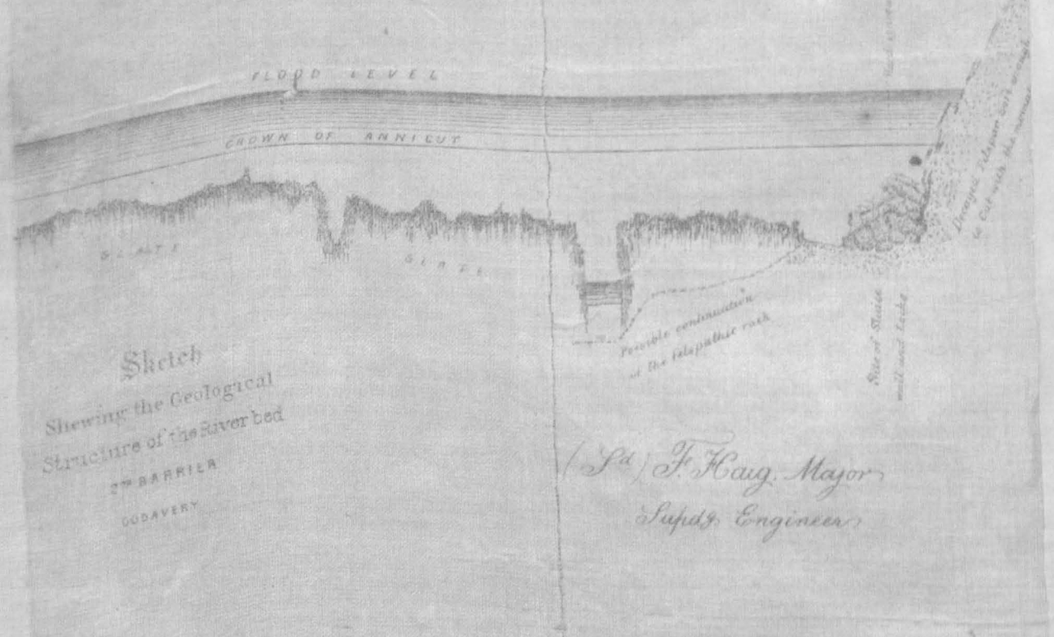
[No. 8.] *Additional Note by* MAJOR F. T. HAIG, R. E., *Superintending Engineer, on the remarks of the Godavery Committee on the 2nd Barrier Anicut.*

In para. 106, page 59, the Committee observe, "Major Haig states that the rock" (of which the river bed is composed on site of anicut) "is not of sufficient hardness to with-

stand a vertical fall, but we have carefully examined the rock, and believe that any serious injury need not be apprehended." As it appears from the Committee's diary of their journey up-river, that they spent one day only at the 2nd Barrier, or at least in the locality of the proposed works, during which time they inspect the whole of the ground, the site proposed for the anicut, the quarries, &c., be surprising if, in the examination of the rock composing the bed of a river nearly fourth mile wide, some points may have escaped their notice. One such evidently has been the geological formation of the bed near the left bank, and as this has an important bearing upon the question of the suitability of an anicut with a vertical fall, I append an illustrative section of the bed on the line of anicut showing the nature of the rock met with.

2. The Committee must have been struck with the fact that such an extraordinarily deep channel is met with all along the left bank up to the site of the anicut. A cursory examination affords no explanation of this, but by sinking pits in the river bed, and in the hill side on the left bank, I ascertained the true cause for this particular conformation. The hill which rises with a steep slope from the water's edge on the left bank, presents to the eye, wherever the jungle permits a view of its surface, only a number of slabs of rock of much the same character as those met with all over the bed, *viz.*, slate more or less altered by heat. The strata of slate forming the surface of the bed have a nearly vertical dip, and it does not take long to see that this alteration of their original position, when first deposited, is owing to the protrusion of the rock forming the mass of the hill on the left bank. The surface of this hill is seen to be covered with slabs of slate, evidently carried up with it in its upheaval.

But when these slabs are removed, the rock underneath is found to be of a felspathic kind, in a state of almost complete disintegration, soft enough (as noted on the sketch) to be cut



with a spade. And similar investigation detects the same rock right down to the water's edge and into the deep channel below the site of the anicut, rendering it probable that the depth to which this channel has been cut is owing to the softness of the material composing its bed. This probability becomes matter of certainty when the river bed itself, for a width of 100 yards out from the left bank on the line of the anicut, and for half a mile above, is examined. As soon as the surface stones are removed, the soft white felspar is seen, and pits have been sunk in it at several points. It has been partially hollowed out above the anicut for the distance just mentioned, and in some places deep holes have been cut in it by the floods,

but the channel thus formed being almost blocked up at the lower end by some large masses of hard igneous rock, the erosion of the bed has not proceeded to the extent it has in the deep channel below the anicut. This decayed felspathic rock is shown in the accompanying sketch, and it will be seen to extend out under the proposed site for the locks and sluice and guard-walls. How much further it extends across the bed is not ascertainable at present. About half-way along the site of the sluice-wall the slate rises, and thenceforward alone meets the eye across the whole of the rest of the river-bed.

But the existence of a deep channel not much farther out into the river, (about one-fourth of the way across) the bed of which, at a depth of over 30 feet below the bed on both its banks, is found to be *sand* in summer, showing that the real bed is at a still greater and as yet unknown depth, leads to the suspicion which would certainly need verification before a masonry anicut, 40 feet high with vertical fall, could be built upon it, that the soft felspar may underlie the slate there also, and that the surface of the felspar may possibly be something like that shown by a dotted line in the Section.

3. It is not necessary that I should express an opinion as to the extent to which such a discovery, if made, or even the ascertained fact of the existence of this soft rock near the left bank, as shown in the Sketch, would affect the question of substituting an anicut with vertical fall for the one which I proposed, but as such an anicut, if decided upon, would be built on the responsibility of the Committee, and not on mine, it is right that so important an element in the question should be brought to their notice.

4. With regard to the doubt expressed by the Committee as to the possibility of making a rough stone anicut sufficiently water-tight to retain the water above its level with its crest in the summer months, I would offer the following considerations in addition to what has already been said in the body of my Memorandum.

The Committee point out that only 2,300 feet in length of the anicut will be about 22 feet high, and that of the rest the greater part is less than 12 feet, while 170 feet only will be exposed to a head of 40 feet of water. The whole work rests upon perfectly impervious rock. Now, as the quantity of water passing over this anicut in the hot months will be almost the same as that over the Dowlaishweram Anicut (for the contribution of the Sebbry at that time of the year is trifling), it will be appropriate to enquire whether any difficulty is met with in retaining the water at a sufficient level at the latter work. The Dowlaishweram Anicut has a height of solid masonry of 14½ feet.

For a length of 2½ miles, or 13,000 feet, it rests upon a bed of course sand of unknown depth, through which an incessant percolation takes place, the water thus passing under the anicut, and rising to the surface again below. There is at the same time a constant draught by the three main irrigation canals of the greater part of the available supply entering the pool above the anicut.

Yet the water only falls a foot or two below the crest in the hottest weather.

Compare this with the proposed anicut at the 2nd Barrier. There none of the available supply will be drawn off by side canals; all the water coming down river must pass either over the anicut, or through it; it cannot pass through the rock underneath.

Yet there we have an anicut 4,000 feet only in length with an average height of 18 feet, resting on a perfectly water-tight foundation, against an anicut of 13,000 feet in length, resting upon a fathomless depth of course porous sand, with the additional drain upon the pool above it of the greater part of the available discharge to supply the irrigation canals.

Can any one suppose that there would be any great difficulty in retaining the water at its proper level above the 2nd Barrier Anicut than is found at Dowlaishweram; or rather, can there be any comparison between the difficulty in the two cases?

As regards the former work, it is easy to calculate the area over which leakage would take place on the Committee's supposition.

The most it could possibly be would be the length of the anicut multiplied by its mean height, or about 70,000 square feet.

But every one who has seen an anicut a[illegible] truth, as the bed above would silt up to w[illegible] in reality the leakage surface would be only a [illegible]

But how are we to estimate the area [illegible] Anicut? No one can say through how great [illegible] above that work percolation takes place. It [illegible] hundred feet from the front wall. Even if [illegible] area of 13,000 × 100 = 130,000 square feet [illegible] head of 12 to 14 feet. The porous surface [illegible] times that of the 2nd Barrier Anicut, even if [illegible] exposed, or 40 times as great if half the he[illegible] addition to this enormous disproportion betw[illegible] the drain by the canals at the lower anicut of [illegible] irrigation.

[illegible] that this would be far in excess of the [illegible] in a few feet of the crown all along; so that [illegible] tion of that just mentioned.

[illegible] e leakage surface above the Dowlaishweram [illegible] readth of the sand (for there is no mud), [illegible] ubtedly may extend to a distance of several [illegible] eckoned on 100 feet only, we should have an [illegible] porous surface constantly leaking under it [illegible] hen, in this case, cannot be less than 70 [illegible] whole of the front slope of the latter were [illegible] of the anicut were silted up. And in [illegible] the leakage area at the two works, there is [illegible] nly the whole of the available supply for

Can it be supposed, under such circumstances, that there would be any difficulty in making the 2nd Barrier Anicut sufficiently water-tight?

5. I cannot but think that the Committee have dealt somewhat hastily with the question of the 2nd Barrier works, and that fuller investigation on the spot, and fuller consideration of all the circumstances, would have led them considerably to modify the opinions they have expressed.

[No. 9.] *Telegram from*—Major F. T. Haig, *Superintending Engineer,*
To—Secy. to Chief Commr. of Central Provinces, in the P. W. Dept.

I request the Government of India may be informed that, unless immediate orders are given to commence excavations for locks, either for larger or shorter project at 1st Barrier, the works must be postponed until after the rains. No masonry in hand now but the anicut, where masons are too much crowded.

No. 50—814, dated 27th February, 1867.

Endorsed by Secy. to Chief Commr., Central Provinces, in the P. W. Dept.

Copy forwarded to Secretary to Government of India, Public Works Department, for information.

No. 17, dated 27th February, 1867.

[No. 10.] *Telegram from*—Colonel C. H. Dickens, R. A., *Secy. to Govt. of India, P. W. Dept.,*
To—Chief Commissioner of Central Provinces.

Go on with short canal project at 1st Barrier; and 2nd Barrier as recommended by Haig. Locks for steamers.

No. 22, dated 4th March, 1867.

[No. 11.] *Telegram from*—Colonel C. H. Dickens, R. A., *Secy. to Govt. of India, P. W. Dept.,*
To—Major F. T. Haig.

Short canal sanctioned with full sized locks for steamers.

No. 24, dated 5th March, 1867.

[No. 12.] *Telegram from*—Colonel C. H. Dickens, R. A., *Secy. to Govt. of India, P. W. Dept.,*
To—Chief Commissioner of Central Provinces.

Proceed with preparation of survey and estimates for opening out 3rd Barrier, and continuation of navigation to Hingunghât; also survey and estimates for fair-weather roads by both the routes discussed.

[No. 13.] *Minute by* Sir R. M. Durand, *and earlier Note referred to in it.*
[See Appendix.]

No. 195 C, dated 8th March, 1867.

[No. 14.] *From*—Colonel C. H. Dickens, R. A., *Secy. to Govt. of India, P. W. Dept.,*
To—Chief Commissioner of Central Provinces.

I am directed to acknowledge receipt of your communications as per margin, on the subject of the prosecution generally of the Godavery Navigation Works.

No. 267—3079, dated 19th October 1866.
„ 59 C, dated 15th December 1866.

2. The whole subject will be referred for the consideration of the Secretary of State; but, meanwhile, I am to convey to you the following orders as to the works to be carried out at once.

3. The Government of India authorize the completion of the 1st Barrier project with the short canal as recommended by the Commissioners.

4. The Governor General in Council agrees with you that locks for steamer traffic should be retained the project; but leaves it to your decision whether smaller locks should t *also* be provided for boats in view to the facility of working. It m be worth while to incur some additional outlay for this object; and t to carry out the views of the Commissioners in regard to boat traffic, v le not acting in opposition to your views in regard to the use of steame

5. The Governor General in ouncil sanctions the estimate amounting to Rs. 11,34,139 for the 2nd B ier works, according to the design recommended by Major Haig; and esires that the work may be pushed forward with all prudent expedi . In departing here from the recommendation of the Commissi rs, the Governor General in Council is sensible of the value of their opi n, but as the subject is one on which there are strong grounds for an dverse opinion based on Major Haig's careful study of the subject; and s preparations have already been made for carrying out his project, it is c sidered best to proceed with that at once, to avoid further delay and di ssion.

6. In all other points than th above noticed, you are authorized to do what is necessary for the e opening of the communication up to the foot of the 3rd Barrier, bject only to the restriction that no work is to be put in hand until a ailed estimate has been submitted and approved by the Chief Engineer of he Central Provinces. Such estimates as require the sanction of the G ment of Ind should be submitted in due course, but the sanction ne ot be waite or when it is desirable to proceed at once with the work.

7. It is observed that Majo ig quest the conclusions drawn by the Commissioners and others a the rates work and cost of construction. On this subject the Govern t of Indi esire to have your opinion after full report from the Controlle d Chief E neer, and further consultation with Major Haig himself. ould seem the Government of India that Major Haig has overlook or under-rated the effect of the difficulties and of the arrangen ts for collecting labour. When all the advances, including paymen for labourers in progress to join the works, losses by absconding, ow to outbreaks of cholera and other causes, and the hutting, maintena of sick, and other expenses are added, no doubt the cost of the work wil e found very much larger than would be due to the mere rate of ges paid to artificers and labourers. Possibly, also, under the circumstr es of the case, the quantity of work to be obtained from each man may b ess than usual. This subject should be carefully considered in the light past experience, and by the aid of the accounts of past work; and al e estimates should be finally revised according to the result of your i igations on the subject.

8. The prosecution of th rk beyond the foot of the 3rd Barrier must await the orders of the S ary of State, whether as regards the question of constructing a road ntinuing the navigation works. The surveys and estimates for both s however, be proceeded with as early as possible under the following angements, the necessary establishments being organized at once.

9. The Government of India a[re] nclined to agree to your views as to the road to Chanda. But as it will necessary to wait for the Secretary of State's orders, it will be best the meantime to prepare and submit estimates for the early constructio[n] f fair-weather roads by both the routes discussed. If this be done pro[m]ly, action may be taken at once on receipt of the Secretary of State's ord[er]

10. The estimate for the exte[n]sion of the navigation works should for the present be strictly confined to [t]he opening out of 3rd Barrier, and continuation of the navigation to H[i]ngunghât. The increase of the water-supply of the river by storage, and the extension of the navigation up the Wurda and Wynegunga must be entirely suspended until the 3rd Barrier estimate is completed, or until further orders are received from the Secretary of State.

11. The scheme for extending the navigation up the Wynegunga, on which you have submitted a separate Minute, will be referred with the other papers to the Secretary of State.

12. The Government of India rely upon your exertions to carry out the arrangements now ordered; and to apply in due form for the necessary establishment. You need not, however, wait for sanction before carrying out such arrangements as may be practicable with the officers and subordinates now under your orders, or whose services you may be able to procure.

13. The Governor General in Council requests that you will convey to Lieutenant-Colonels Anderson and Fife the cordial thanks of the Governor General in Council for the valuable report they have submitted.

14. The sanction accorded in para. 5 has been registered as No. 114 C of 1866-67.

No. 36, dated 8th March, 1867.

From.—The Government of India.

[No. 15.] *To.—The Secretary of State for India.*

We have now the honour to submit the Report of Colonels Fife and Anderson, the Commissioners on the Godavery Navigation Project, with Memoranda by Major Haig thereon, and Minutes by Mr. Temple, Chief Commissioner of the Central Provinces. We have given these documents careful consideration, and, in submitting them, beg to reply to Sir Charles Wood's Despatch No. 11, dated 8th February 1866, on the same subject.

2. It will be seen that the Commissioners are in favour of continuing the works, but in view to boat, rather than to steamer, traffic, they recommend the reduction of the size of the locks, and the construction of a short canal only at the 1st Barrier, and certain modifications of the design for the works at the 2nd Barrier. They further recommend the completion of the survey for the 3rd Barrier, and also the construction of the road from Chanda to Seroncha, not as superseding the 3rd Barrier works, but as tending to open the communication sooner, and as being likely to be useful as a feeder after the navigation works are completed. Colonel Fife also recommends the prosecution of surveys and preparation of projects for storage of water.

3. Mr. Temple differs with the Commissioners in preferring the long canal to the short one at the 1st Barrier, and in adhering to the adaptation of the project to steam navigation, and therefore preferring the large locks. He reads the Commissioners' report as opposed to the construction of a road,

and urges strongly the necessity for constructing a cheap road from Chanda to the foot of the 3rd Barrier, while the construction of the works of navigation at that Barrier must necessarily be expensive, and may be so much so as to prohibit the execution of the works of navigation at all. At the same time he recommends the complete investigation of the entire scheme in its fullest development, and adds a Minute on the probable advantage and facilities of carrying the navigation up the Wynegunga to the Cantonment of Kamptee, near Nagpoor.

4. We concur with Mr. Temple in thinking that the adaptation of the project to steam navigation should not be given up, and that, therefore, steamer locks should be provided. We also concur in regard to accepting Major Haig's Project for the 2nd Barrier. But we agree with the Commissioners in preferring, for the present, the short canal at the 1st Barrier to the longer one. This we do not so much in the conviction that the latter is equally good as a permanent communication as in the belief that it will suffice for the rapid opening out of the navigation, while the greater expenditure, and still immature project for the larger canal, might lead to delay. Mr. Temple appears not rightly to have apprehended the difference of cost between the long canal and short canal projects. The state of the case is as follows:—

	Cost in Lakhs.	
	Long Canal Project.	Short Canal Project.
Spent up to May 1863 (page 42)	4	4
Estimate to complete these (pages 33—5 and 48)	30½	13
Total	34½	17
Deduct spent before May 1863	4	4
Since ditto	7½	4
Total spent	11½	8
Balance to be spent	23	9

making nearly 15 lakhs in favour of the short canal.

5. We submit a copy of the letter from our Secretary conveying orders to the Chief Commissioner to cause the works at the 1st and 2nd Barriers to be carried out according to these views.

6. It will be seen that we have reserved the further extension of the project for your orders; but we have ordered projects to be prepared both for the navigation works to Hingunghât, and for the road from Seroncha, and the foot of the 3rd Barrier to Chanda.

7. We are still of opinion that the road is necessary. The case is strongly put by Mr. Temple. The decision in favour of a road have been three times affirmed by the Governor General in Council (see Resolution forwarded with our Despatch No. 90 of 9th August 1865), and was accepted in Sir C. Wood's Despatch No. 18 of 25th April 1864. We think it is necessary to have at least a cheap road constructed at once either to Seroncha or to the foot of the 3rd Barrier, and we request your permission to order this accordingly.

length being useful for purposes of trade, we would refer to the Grand Trunk Road from Mirzapoor to Calcutta, 450 miles, which for years carried a large traffic of cotton and piece-goods in competition with the Ganges, and still carries a great deal in competition with both the Ganges and the Railway at least while the latter is unable to carry all that is presented to it. This case is not exactly analogous to that of the Godavery, but there is enough of similarity to prove that the road project is not likely to result in a useless expenditure, if the navigation works are to develope any traffic. We think, therefore, that the road, which can certainly be carried out at a moderate expense, and within a moderate time, should be allowed to be carried out at once, whether the navigation works at the 3rd Barrier are to be executed or not.

9. It will be seen, however, that we have ordered the prosecution of the surveys and preparation of detailed estimates for the latter.

10. We do not recommend any further surveys or works at present, preferring to await the estimates on the 3rd Barrier before taking any steps towards further expenditure. We, however, beg to draw attention to Mr. Temple's Minute on the navigation of the Wynegunga.

11. While we have ordered the arrangements above reported to be carried out, as being on the whole the most desirable course to pursue after the steps which have already been taken towards the execution of the works embraced in the Godavery Navigation Project, we are still not convinced that what has been done and ordered will, on the whole, prove to be profitable in any degree commensurate with the expense. We forward a Minute by our colleague Sir Henry Durand which tends to support this view.

Documents accompanying.

1.—Letter from Secretary to Chief Commissioner of the Central Provinces, No. 267, dated 19th October 1866.
2.—Report on the Upper Godavery Works by Colonels Anderson and Fife, dated 27th June 1866.
3.—Minute by Chief Commissioner on above report, dated 11th September 1866.
4.—Minute by Chief Commissioner on the River Wynegunga, dated 18th September 1866.
5.—Letter from Secretary to Chief Commissioner, Central Provinces, No. 50 C, dated 15th December 1866, with enclosed Minute by Chief Commissioner, dated 13th December 1866, and Memorandum by Major Haig, dated 12th November 1866.
6.—Additional Note by Major Haig, dated 28th January 1867.
7.—Minute by Sir H. M. Durand, dated 23rd February 1867, and earlier note referred to in it, dated 26th August 1865.
8.—Letter to Chief Commissioner of the Central Provinces, No. 193 C, dated 8th March 1867.

No. 125—1625, dated 22nd March, 1867.

[No. 16.] *From*—Major C. Pollard, R. E., *Secy. to Chief Commr. of Central Provinces, in the P. W. Dept.,*

To—*Secretary to Government of India, P. W. Dept.*

I am directed to acknowledge the receipt of Public Works Department No. 193 C of 8th current, conveying orders relative to prosecution of work on the Godavery Navigation Project, and to state that the Chief Commissioner has duly acted on all the orders.

(No orders.)

(Appendix No 2)

REPORT

ON THE

UPPER GODAVERY WORKS,

BY

Lieut.-Colonel J. C. Anderson,

AND

Lieut.-Colonel J. G. Fife,

ROYAL ENGINEERS.

NAGPORE,

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COLONEL W. MAXWELL, R. A.
SECRETARY TO CHIEF COMMISSIONER,
Public Works Department,
Central Provinces.

SIR,

WE have the honor to submit a report on the Upper Godavĕry Works, which we examined in February and March last, in conformity with the orders of the Government of India, dated 14th December 1865.

2. Our examination of the upper part of the river, was somewhat more cursory than we could have wished, and we had no time to explore its important branches, the Wurda and Wyne Gunga; in consequence of our receiving orders, when at the 1st Barrier, to proceed to Cawnpore, to attend a Committee on the Ganges Canal, which was to meet towards the close of March; and to postpone the preparation of our report on the Godavery.

3. Our duty on the Ganges Canal was not completed till nearly the end of June, but during the period for which we were necessarily detained before the report of the Committee could be fair copied and printed, we found time to revert to the subject of the Godavery, and to draft our report from the notes which we had made on the spot upon it, by the date which the Committee obtained permission from the Government to disperse.

4. We beg to express our thanks for the assistance we received from the Chief Commissioner and yourself, on our journey through the Central Provinces, and to the Officers employed on the Upper Godavery Works, especially to the Executive Engineer Mr. Isaac and to Mr. DeGrousilliers, who has charge of the Transport Department, and who rendered us much valuable assistance.

To Major Stoddard our special thanks are due, he accompanied us during the whole of our journey, and spared no pains to furnish us with all the information that we could desire regarding the history of the Godavery Works.

We have the honor to be,

Sir,

Your most obedient Servants,

(*Signed*) J. C. ANDERSON, LIEUT.-COLONEL,
Royal Engineers.

(*Signed*) J. G. FIFE, LIEUT.-COLONEL,
Royal Engineers.

ROORKEE,
27th June 1866.

We beg to preface our Report by a Summary of the conclusions we have arrived at, in the form of replies to the questions which were put to us in the letter from the Government of India to the Chief Commissioner, Central Provinces, dated 14th December 1865; and which indicates the nature of the information which the Government wished us to furnish, on the subject of the Works in the Upper Godavery.

These conclusions are to the following effect.

I. Rejecting the portion of the longer line of Canal at the 1st Barrier, we consider that the works executed for the Minor project are sound and good, and likely to stand with but trifling additions to the designs as approved by the Government of India.

II. That the greatest zeal has been displayed by the Officers employed under Major Haig, and his own exertions have been remarkable, but the past management of the Works has not been successful or economical.

III. That the works of the general character of those now in progress and designed, will effect the object in view of affording the means of carrying on navigation by Steamers for 4 or 5 months of the year, and by boats, with occasional interruption during high freshes, for 8 or 9 months of the year; but that a portion of that period will be suitable for boats of very light draught only.

IV. As regards the works at the 1st Barrier, looking at the requirements of a Navigation for 4 or 5 months only, that the Anicut might have been dispensed with, but that in order to allow of boat traffic being carried on for a period of several months longer, its construction was necessary. As regards the 2nd Barrier, that an Anicut near the head of the Barrier and a Canal from it to the open portion of the river below, would have been the most perfect mode of procedure, but

that its cost would be greater than that of the works designed by Major Haig, and that the latter will answer the purpose intended, with some modification as regards details of construction ; and that the cost of the works is not likely to be less than the amount of the Estimate.

V. That before the communication can be pronounced efficient, the line of navigation should be continued as far as Chanda on the Wurda, and that one of us, (Colonel Fife) would advocate a further examination of the river and its tributaries in connection with storage works, with a view to increase the natural supply during the dry season.

VI. Excluding the portion of the Estimate which relates to the construction of a road from Sironcha to Chanda, that the expenditure contemplated, is approximately sufficient for the scheme, as at present defined by the Government.

VII. That we cannot give any figures to show whether the advantages obtained from the proposed communication will be commensurate with the outlay, but we are of opinion that Government will not reap any considerable direct return from the expenditure, but that the general improvement of the country, and the increase of trade, which will be induced by the opening of the communication, will be sufficient to justify the outlay ; further that the works in the Godavery itself having once been completed, any extension of the line of the Navigation, which, on enquiry, may be found practicable, would serve to enhance the value of these works.

VIII. That the construction of the works at the 2nd Barrier, should be carried out simultaneously with those at the 1st Barrier, and with the removal of rocks in the more open portions of the river.

IX. That the Establishment and stock of Steamers should be maintained in the lowest possible scale, consistent with the

supply of food to the workmen, and the transport of material for the completion of the works at the 1st Barrier, and that supplies for the workmen at the 2nd Barrier, should be obtained through the aid of the Civil authorities at Sironcha: further that private stores should be carried only so far as can be done with the minimum Establishment and stock as above recommended.

(*Signed*) J. C. ANDERSON, LIEUT.-COLONEL,
Royal Engineers.

(*Signed*) J. G. FIFE, LIEUT.-COLONEL,
Royal Engineers.

SECTION I.

PRELIMINARY OBSERVATIONS.

1. We left Coconada on the 1st February 1866, and arrived at Chanda on the 10th March.

Description of route.

Of the total distance 385 miles, we accomplished 125 miles in a small steamer drawing 2 feet of water, 190 miles more in a boat drawing 15 inches, and the remainder by land, we were occupied for a fortnight in examining the works at Doomagoodium or at the 1st Barrier, and the sites of those proposed near Enchampilly for surmounting the 2nd Barrier. Further particulars relating to our journey will be found in Appendix A.

2. The general features of the Godavery and of its principal branches have been so fully described in Major Haig's reports, particularly in those written after his exploring expedition of 1856, which were published by the Madras Government; as well as in the comprehensive report of the Chief Commissioner, Central Provinces, in 1863, that we are relieved from the necessity of entering into any topographical details.

Character of Godavery previously described by Major Haig and Chief Commissioner, Central Provinces.

3. We need only mention a few of the leading features, Doulaishwaram at the head of the Delta, is connected with the Sea at Coconada by a Canal 30 miles in length, navigable itself or alternately with two branches terminating at the same point, throughout the year. Doomagoodium the head quarters of the works designed for the 1st Barrier, is about 115 miles above Doulaishwaram; Enchampilly at the foot of the 2nd Barrier is 195 miles; and Mogellee, a small village at the foot of 3rd Barrier, is 285 miles above the same place.

Leading features noted.

4. The distance from Mogellee to the head of the 3rd

Barrier near Salagaon on the River Wurda, is 30 miles, and from the latter to Chanda 40 miles by land and 55 miles along the Wurda, which approaches to within 4 miles of it. Chanda is thus 355 miles from Doulaishwaram by one route and 370 miles by the other, or from Coconada 385 miles and 400 miles, respectively.

5. The Chief Commissioner has recommended that the project for the improvement of the Godavery should be confined for the present to the opening out of the 1st and 2nd Barriers, so as to carry the Navigation up to the foot of the 3rd Barrier; and to the construction of a road from that point to Chanda, in order to complete the connection of the Navigation with the road system of the Central Provinces.

Project as recommended by Chief Commissioner.

6. The Government have accepted these views and are prepared to sanction Estimates amounting to 52 Lakhs of Rupees, or including past expenditure about 80 Lakhs in all, should they feel satisfied after full enquiry, that the works which have been proposed for surmounting the difficulties of navigation, will really answer the purpose for which they are intended. Comparing the whole communication from Chanda to the sea, to a road which will be open for a considerable part of the year; they are prepared to sanction the same outlay as would be required to construct a road for the whole distance.

And approved by Government of India

7. Major Haig's project was not limited to opening out the river for navigation as far as the foot of the 3rd Barrier. He intended to pass round it by a Canal, and then to gain access to the Wurda, and by certain improvements to that river, to obtain an unbroken water communication with Hingunghat, 75 miles above Chanda. Nor was his scheme to terminate here. He looked ultimately to the foundation of storage reservoirs in the upper sections of the Wurda and other confluents of the Godavery: to let out the water from them to increase the scanty summer supply of the river; and partly by such aid, and partly by means of Canals, Dams and other works, to form a perennial water transit from various parts of the Nagpore Provinces to the sea.

Original design of Major Haig.

8. The great cost of the works which have been in progress in the lower portions of the river,—very much greater than Major Haig had counted on,—has engendered distrust both in the minds of the Government and of a large section of the public, as to the feasibility of the scheme, excepting at a cost altogether disproportionate to the objects to be gained; and it has been decided that for the present, Major Haig's project should be cut down to the lowest limit compatible with anything which could be called the opening out of the Godavery. The Chief Commissioner, though he acknowledges the importance of connecting it with the Wurda, and is quite prepared to recommend any project by which this could be satisfactorily accomplished at a reasonable cost, declines to commit himself to it, until the expense and feasibility shall have been fully investigated; and we think, after the manner in which Estimates have been exceeded on the works in progress, he could hardly do otherwise. In the meantime he recommends the construction of a road, which, in any case, is necessary to complete the communication between Nagpore and Sironcha the head quarters of the Upper Godavery District, and which, in his opinion, will help to feed and develope the Navigation of the river.

Major Haig's project curtailed in consequence of expense being greater than he anticipated.

Proposed road from Sironcha to Chanda.
No. 81—No. 930—3 C. dated 13th September, 1865.

9. The approximate Estimate of expenditure given in the 9th para: of the order of the Government of India on the Upper Godavery Works, provides for the construction in all of 125 miles of road which may be divided into three sections, viz:

From Chanda to head of 3rd Barrier, .. 40 miles.
Do. Head to foot of .. .. .. 30 miles.
Do. Foot of Barrier to Sironcha, .. 55 miles.

Captain Glasfurd, Deputy Commissioner of Sironcha, in a memo: which he has lately written on the subject, dated 26th March 1866, has pointed out that the construction of a road from the foot of the 3rd Barrier to Sironcha along the bank of the river could not be carried out except at great expense, as it would have to cross the numerous drainages where they enter the river in deeply cut ravines, and he recommends in preference, a line of road further inland along the *route now generally followed, and on which there is already a considerable traffic.

* Via Kotapully, Bibbree, Seerpoor and Dhaba.

Comparison of routes.

10. Captain Glasfurd enters into the subject very fully, and the arguments he brings forward in favor of the latter route, leave no room for doubt of its superiority to the other. We would add that Mogellee at the foot of the 3rd Barrier is a wretched hamlet in the middle of the jungle: that it is very un likely that merchants will establish themselves there; and that in consequence, goods would be consigned and probably sent by land the whole way from Chanda to Sironcha, if a good direct road were available, in preference to being sent partly by land and partly by water by the Barrier route. In that case Sironcha would constitute the terminus of the river navigation for through

traffic to and from Chanda, and the route to it from the sea coast would be divided into the following Sections:—

Coconada to Doulaishwaram,	Canal,	30 miles.
Doulaishwaram to Sironcha,	River,	230 ,,
Sironcha to Chanda,	Road,	100 ,,
		360

A road from Sironcha to Chanda, not likely to induce a large traffic.

11. Although the completion of the project to the above limit would probably be sufficient to justify the outlay contemplated, and although it would doubtless have the effect of expediting the improvement of the country bordering on the Godavery, and of inducing a considerable trade to and from the coast as far as Chanda, still we are of opinion that the influence would not extend much, if at all, beyond that limit. Chanda is only on the borders of the cultivated portion of the Nagpore Provinces, and on the opposite side the railway approaches to within 70 miles of it. As the distance of any point beyond Chanda from Sironcha is increased, the distance from the railway is diminished, and the traffic towards the Godavery would evidently be carried on with great disadvantages.

Original project for a canal round 3rd Barrier should be reconsidered.

12. While then we consider that the opening of the Godavery to Sironcha is of itself a desirable measure, and that the construction of a road from Sironcha to Chanda, would serve as a feeder to the river, we are of opinion that its influence would not extend to the best part of the Nagpore Provinces, and that the object for which the Godavery works were originally sanctioned, would remain unaccomplished,—we would therefore venture to recommend that the road from Sironcha to Chanda, should be treated as a separate work, and that the formation of a line of water

communication from Sironcha to Chanda should not be definitively abandoned, until it can be ascertained for certain, whether or not it is really practicable at a reasonable cost.

No data as to cost of a canal, but ground supposed to be favorable.

13. We labor under the same disadvantage as Mr. Temple in having no data on which to base a correct estimate of the probable cost of a canal round the 3rd Barrier, to connect the Godavery and Wurda, and of the improvement which would be necessary on the latter river to render it navigable to Chanda or Hingunghat. Inspection by simply riding over the ground is liable to mislead, and we shall not attempt to estimate the cost of a canal, we can only say that the ground is much more favorable for the formation of a canal than that at the 1st Barrier, and that there are no large drainages to be crossed. A line of levels has been taken along the route by which it was intended to carry a road round the Barrier, the Section along the line displays great inequalities on the surface of the ground, but as the country slopes towards the river, the higher ground might be avoided by moving further towards the river, and the lower, by moving further from it. The twelve locks which would be required would probably be the principal expense.

The Wurda is more manageable river than the Godavery.

14. The Wurda is a very much smaller river than the Godavery, its width being only about 1,200 feet at the head of the 3rd Barrier, and considerably less towards Chanda. It has a compact well defined channel, and firm abrupt banks. In many places rock appears both in the bed and banks. The head of the 3rd Barrier extends across the Wurda several miles above its junction with the Wyne Ganga. The rock would furnish a secure foundation for a weir, and the small quantity of water in the river during the dry season would further simplify the construction of the work.

Slope of bed to Chanda moderate.

15. The bed or rather the low water surface of the river is on a dead level for upwards of 20 miles above the Barrier, and the total rise from the Barrier to a village opposite to and 4 miles from Chanda and 50 miles from the Barrier, is 30 feet.

16. Two weirs, one at the Barrier and a second at some intermediate point, would therefore suffice to pond up the water for still navigation.

Wurda suitable for still water navigation.

17. The Wurda in its natural state is navigable for only 3 months in the year and only then with periods of interruption, but there is a sufficient supply for still water navigation throughout the year. Boats from Hingunghat and other places in the upper part of the Wurda could come to Chanda during periods of high freshes, but from Chanda to the head of the Barrier and from thence by a still water Canal 30 miles in length, they would have access to the Godavery at all seasons.

Chanda a favorable terminus for line of Navigation.

18. We have observed above, that Mogellee at the foot of the 3rd Barrier is an unfavorable point for terminating the river navigation, and that in consequence of the difficulty which would be experienced in inducing merchants to establish themselves in such an ill-favored spot, goods would probably be consigned to merchants in Sironcha, and sent by land the whole way. Between 50 and 60 miles of water communication (between Mogellee and Sironcha) would thus be lost. There would therefore be a great advantage in this respect, in selecting Chanda as the terminus of the Navigation. It is a large and important town in a well populated and fairly cultivated country ; roads will connect it with Hingunghat

and other places in the interior, and it would thus be a convenient emporium for traffic to and from the coast.

19. If the arrangements we have recommended are found worthy of execution, the merits of the Godavery route would then be put to a somewhat fairer test, and the Government would be able to obtain a better idea of the nature and extent of traffic the Godavery will carry, before further improving its Navigation.

A water communication to Chanda would give a fair test of the value of the Godavery.

20. Should these views be accepted, the river will be rendered navigable for steamers for five months in the year, (June to December) the exact period of course depending on the draught of the vessels which may be used, and for boats drawing 18 inches—and subject to some delay perhaps up to 2 feet—to the end of February. From the Godavery to Chanda and *vice versa*, boats could ply throughout the year. The total length of the line of navigation would be 400 miles divided as follows.

	Miles.
Coconada to Doulaishwaram, -	30
Doulaishwaram to foot of 3rd Barrier,	285
Canal round Barrier, - - -	30
Wurda to Chanda, - - -	55
	400

21. It is quite possible that a careful examination of the Wurda above Chanda and of the Wyne Gunga, may lead to the conclusion that they might be adapted for still-water navigation at a moderate outlay, and such schemes may be well worthy of consideration even if intended to facilitate local traffic only; one of us (Colonel Fife) considers that the development of the navigation beyond the limit above specified, may with advantage be taken into consideration at the present time, and he has accordingly drawn out a memorandum expressing his views on the subject, which will be found in the Appendix.

Further examination of the Wurda and Wyne Gunga recommended.

SECTION II.

PROBABLE TRAFFIC ON THE GODAVERY—I. BY STEAMER

22. It may seem premature at this stage of our report to enter upon a consideration of the question, as to how the navigation of the Godavery is to be carried on after the obstacles at the Barriers shall have been surmounted; but in fact, an attempt must be made to ascertain what style of vessels is best adapted for the peculiar circumstances of the river, before we can express an opinion of the efficiency of the proposed works.

Style of vessels suitable for the Godavery must be ascertained before an opinion can be formed of the efficiency of proposed works.

23. The Government have decided in having Locks where such works are to be built, 200 feet long and 30 feet wide* in the clear. Major Haig originally proposed locks 45 feet wide,** but at the suggestion of His Excellency the late Governor of Madras, he reduced the width to 30 feet; and the question then arose, can Steamers suitable for the navigation of the river be found, which can be passed through a Lock of this size, or must there be separate Steamers to work between the Barriers? In the latter case, the width of locks, would be unnecessarily great, for no cargo boats are likely to be required of greater beam than 18 or 20 feet, and as a large proportion of the boats which will be used on the river will be small native craft, there could be no necessity, so far as boats only are concerned, of allowing a greater width than 20 feet.

Locks ordered to be 30 feet, to allow of steamers being passed round the Barriers.

* Telegram from Secretary to Government of India, No. 44, dated 20th March 1865.

** Parliamentary Blue Book, Upper Godavery, page 71, para 8, page 81, para 61.

24. The locks on the Canal from Doulaishwaram to Coconada are 100 feet long by 15 feet wide, excepting one which is 50 feet longer; but most of them are in bad repair, and will have, 'ere long, to be reconstructed. They

Locks on Delta Canals 15 feet wide.

could then be made to suit the dimensions of whatever craft is found best adapted for the river, but in the event of its not being considered necessary to use steam on the canal, and owing to the high price of fuel in the delta, we think it will have to be dispensed with; the locks would probably not have a greater capacity than 150 feet, or 200 feet by 20 feet.

Stern-wheel steamers proposed by Major Haig. Doubts as to their efficiency.

25. Major Haig in order to avoid the necessity of having separate steamers in the reaches between the Barriers, and to obtain at the same time, vessels with sufficient beam for the application of powerful engines, has proposed the introduction of stern paddle wheels. He had seen a number of stern-wheelers in America, and had heard them well spoken of: all that Major Haig writes is worthy of the highest attention; but we must own, notwithstanding the testimony he bears in favor of these vessels, that we entertain misgivings of their success. They are applied on certain rivers in America, but there must surely be some points in which they are inferior to the side-paddle steamers, or why is it that the latter are so generally used in the larger class of rivers, and in lakes? We believe that the side-paddles which must act as out-riggers, are a source of security to flat bottomed vessels in a strong current, or in a whirpool, such as is occasionally encountered on the Godavery during the freshes, and that the stern wheels would not be so well under command, and more liable to injury, should the steamer be accidentally swept round against a rocky bank. Mechanical Engineers in England can have little knowledge of the nature of the currents in a river like the Godavery, and any vessel on a new pattern which they may build specially for its navigation, must be regarded as an experiment. So many similar experiments have ended in no useful result, that we are more sanguine of obtaining a good pattern for a Steamer, by a modification of those which have been found after many years experience to answer best for the Rivers of Upper India

than by ordering an entirely new one; as the matter stands, the Government have approved of 30 feet locks, on the understanding that suitable Steamers will be found which can be passed through them. We have doubts, as above explained, of Stern wheel Steamers answering, while side paddle steamers of 30 feet beam in all, would not have sufficient power. We must therefore express our opinion that until this important question, the width of lock best adapted for Steamers, is decided, the Government may be committing themselves to an expenditure which may prove to be ill-judged. The Locks may prove too small for the proper class of Steamers, while they would certainly be needlessly large for any Cargo boats.

20 feet Locks recommended and Steamers between the Barriers.

26. The difficulty would be removed if Government reconciled themselves to what Major Haig considers a serious disadvantage; the employment of separate Steamers between the Barriers. Had the Estimates for the works been approximately accurate, the difference in expense between a lock 200 by 30 and one 150 by 20, might not have been a serious consideration; but it appears, as we shall have to show further on, that even the latest revised Estimates will be largely exceeded, and as moreover the delay in completing a large work as compared with a smaller one, causes a multiplication of the expenditure by the Establishment which must be kept up, and by the contingent charges which must be incurred for a longer period, we consider that the question of boat locks only and Steamers between the Barriers, may be reopened with advantage.

No serious inconvenience likely to arise from having separate Steamers between the Barriers.

27. The distance from Doulaishwaram to the proposed terminus of the Canal at the first Barrier is 112 miles; from the head of the first Barrier to the second, 80 miles; and from the second to the third Barrier, 90 miles. The lengths of the second and third reaches do not dif-

fer to any material extent, and the excess in that of the first represents, at most, a day's steaming up stream, so that there would be no great disparity in the duty to be done, supposing one or more steamers were stationed permanently in each section. They could be taken over the Anients on the tops of the freshes, if required to be changed. There would doubtless be some extra expense if this plan were adopted, as either a spare steamer would be required in each reach to be ready to replace one that might be disabled, or at such times as the Anicut should not be passable, the paddles would have to be unshipped to admit of its being passed through the Locks.

28. Should a Canal round the third Barrier to connect the Godavery with the Wurda be sanctioned, it would at all events be unnecessary to have the locks on it more than 150 feet long by 20 feet wide. It would be still water navigation, and there would be about 12 locks in a distance of 35 miles. Little or no time would be saved by having steamers, as they and the boats towed by them, would have to be locked through separately, so that the time gained in steaming would be lost in the lockage.

20 feet locks sufficient for a Canal round 3rd Barrier.

29. We are the more urgent in deprecating expenditure on Locks of 30 feet in width before their fitness for steamers is placed beyond all doubt, and in recommending for the consideration of Government the alternative of having boat locks only, because we are of opinion that it is highly improbable that steamer Traffic will pay on the Godavery. We are aware that by making a calculation based on the cost of a steamer, and the duty it can perform, it can be shewn that it would pay very well. But on a river where the traffic has to be created, and where the cost of working a flotilla must be matter of uncertainty, such hypothetical calculations are entirely unreliable. The only test which can be accepted as at all valid is, the successful or unsuccessful result of steam navigation on other Indian rivers, allowance being made for any striking advantages or disadvantages for navigation which they may possess as compared with the Godavery.

Steam traffic not likely to pay, and large locks less necessary on that account.

30. The navigation by the Ganges is open for steamers from Calcutta to Allahabad throughout the year, and by the Indus and Chenab, from Kotree to Mooltan, a distance of 570 miles. The steamers draw 3 feet and upwards, they are liable to ground, and are occasionally detained for a considerable period. But this disadvantage is accepted in preference to reducing the draught. On the Ganges there is a command of unlimited traffic, and the Indus is the natural outlet for all the export trade of the Punjab. The terminus of the lines of navigation, Allahabad and Mooltan, are most favorably situated for concentrating the traffic from the Upper Provinces. Yet steam navigation, though it has been long established, does not, as far as we can learn, pay well enough to enable it to compete with the Railway on the Ganges, and on the Indus pays apparently barely 5 per cent. How can it be expected then that steamers can be worked profitably on the Godavery, when the navigation for steamers with draught of 3 feet will be open for only 4 or 5 months of the year, and when the only single advantage to counterbalance this drawback is the cheapness of fuel, and while there are serious disadvantages from the heavy floods and frequency of rocks. Nothing has been spent on improving the Indus: a considerable sum will have to be expended on the Godavery, even for six months navigation; and the Government might reasonably impose tolls to reimburse them for the outlay. If they did so, the profits of the navigation would be still further reduced. Much of the traffic on the Indus pays a high rate for freight; about 3,000 tons of Railway materials were carried up by the steam flotilla in the year 1865, at a rate

Steam traffic on Ganges and Indus.

of 20 pie per ton per mile, for the 570 miles from Kotree to Mooltan. A large quantity of malt liquor is also conveyed for the use of the troops in the Punjab, and troops are also conveyed by the same route.

31. On the Godavery the principal traffic would be in grain, salt, and other articles which would have to be carried at low rates, if the Steamers wish to compete with native boats. The cotton from Berar is likely to go by Railway, and though a considerable quantity might find its way down the river from the valleys of the Wurda and Godavery, it is questionable whether it would be large enough to justify the use of Steam. The circumstances of the Godavery have changed considerably since the project was first brought forward. The works were pushed on in the expectation that they would give the means of transporting the cotton crop of the Nagpore Provinces to the coast; but the object is now accomplished by the G. I. P. Railway, and the fact of Merchants paying a high rate of freight to get the cotton of the N. W. Provinces conveyed by Railway from Allahabad and other places, in preference to sending it down the Ganges by Steamers or native boats, shows that it is vain now to expect that the Godavery navigation will draw any of the cotton from Berar, especially as the terminus of the navigation will be at a considerable distance from the cotton field, while the Railway passes right through it.

Cotton not likely to be sent by the Godavery route.

32. It appears to us, then, since the primary object for which these works were put in operation, and which alone was of sufficient importance to justify these being carried out on a scale which should admit of the application of steam power, is no longer in existence, that the Government may well pause before they sanction any considerable expenditure on Steamer Locks; under

Primary object of Godavery navigation, no longer in existence.

present circumstances, we recommend the capacity of the locks at the Barriers, being limited to 150 × 20. If steam power is introduced separate tugs would then have to be located between the Barriers and would ply along distances as above explained, of 112, 80 and 90 miles.

33. It is probable that the Government will not expect any direct return, unless perhaps a toll sufficient to cover the cost of maintenance, from the Upper Godavery works, but will be satisfied with the indirect benefits to which the traffic will give rise, in the shape of increased land revenue and of increased sale of salt, and with the improvement in the condition of the people, which would not fail to follow. We are of opinion however, that the action of Government should cease with the completion of the works, and that the conveyance of goods should be left to private enterprise. If our surmise that steam traffic will be incapable of returning a fair profit be correct, it will of course be more or less money thrown away, if they introduce the steamers on their own account. Should they be inclined however to make the experiment on a small scale, for the purpose of encouraging private enterprize, we believe that a type of steamers suited (on a somewhat reduced scale) for the navigation of the Godavery during 5 or 6 months in the year, is to be found on the Indus.

Traffic under Government management deprecated

34. We therefore take the opportunity of furnishing the following information on the subject, for which we are indebted to Captain Wood, the Superintendent of the Indus Flotilla. The steam tugs of the Flotilla are 212 feet long, 42 feet beam including paddles, and draw 3′—6″. The engines are condensers, and have 120 nominal horse power.

Description of vessels employed on the Indus.

35. A tug tows two flats, each 180 feet long, 22 feet beam, draught from 3 feet to 3′—6″, and capable of carrying about 200 tons.

36. The cost of a tug and two flats, is about £32,000 delivered at Kotree on the Indus.

37. The Flotilla consists of 11 Tugs, 13 Flats and 20 barges, of an aggregate capacity of 2,925 tons. The capital is estimated at £ 500,000.

38. The receipts for half year ending 31st. December 1865, amounted to Rupees 4,56,285, the expenses to Rupees 2,38,650, the net receipts to Rupees 1,17,635, or 2·35 percent, on the capital for the half year.

Receipts.

39. The quantity of goods conveyed during the half year was 12,320 tons; the receipts to Rupees 3,98, 508.

Traffic.

40. If we assume the average receipts per ton per mile at 1½ annas, this would be equivalent to nearly 7,500 tons carried over the whole distance from Kotree to Mooltan (570 miles), or 3,750 tons each way.

41. The voyages of the steamers are counted from the date they leave Kotree, and as between 1st January and 15th October 1865, (the latest date to which we possess the returns of traffic) 59 steamers had started from Kotree, the number of voyages accomplished during the year, may be estimated at 70 or for the half year at 35. The duty performed by each steamer would therefore be approximately 107 tons carried up and down per trip—exclusive of passenger traffic.

42. The actual period during which steamers with a draught of from 3 to 3′ 6″ could ply upon the Godavery, is a matter of uncertainty, and would of course be liable to vary from year to year according to the character of the season, but it is not likely to extend much, if at all beyond the 5 months between 20th of June and 15th November. Of course a steamer of less draught could ply for a longer period, but it would be less effective during the monsoon, and as we frequently grounded in a boat drawing less than 18 inches in the

Period for which Godavery will be open for steamers.

beginning of March, 18 inches would be maximum water that could be counted on for a steamer, owing to its greater size and to the narrowness of the navigable channel at shoals up to the 15th February; and a steamer with a like draught which should be capable of plying up to that date, would thus extend the period of navigation from 5 to 8 months, but the latter class of steamer would be incapable of working efficiently in the high freshes, and it may be questioned whether the aggregate performance would equal that of a steamer with 3 feet draught for a period of 5 months only, but our want of experience in steam navigation does not entitle us to speak with confidence on this point.

43. In speaking of steam power, we have considered it in relation to the conveyance of a heavy traffic, and the prospects of its proving remunerative seems so very unpromising, that we have suggested great caution in trying any experiment. But our remarks do not apply to the use of small steamers for conveying passengers and a very limited quantity of valuable cargo for a few years, till the value of the navigation has become understood and appreciated by the public, and when private enterprise may be expected to take up the matter. Steamers for such a purpose however already exist on the Godavery, and they will certainly last for some years.

Steamers now employed on the works might be used for traffic for some years.

SECTION III.

PROBABLE TRAFFIC ON THE GODAVERY—II, BY COUNTRY BOATS.

44. We now proceed to enquire to what extent traffic may be carried on by country boats, under the management of private owners.

The months of freshes unfavorable for boat traffic.

45. The three months from 15th June to 15th September, which from the great depth of water in the river are favorable for the working of powerful Steamers, are the most unfavorable period of the year for ordinary boats. During the south-west monsoon the wind is more or less contrary for boats proceeding up streams. There are very strong currents at the gorge between Doulaishwaram and the first Barrier, and at various other places ; and continuous towing is impracticable. In short, boats will probably not attempt to go up the river at that season, though if they were ready with a Cargo at the foot of the 3rd. Barrier, they could make a trip down the river. Should building yards be established in the vicinity of the forests around the 3rd. Barrier, as we may expect will be the case, a considerable traffic might be carried on during the freshes at a very insignificant cost of transport, but the bulk of the regular up and down traffic would probably be confined to the period comprised between 15th. September and the end of February ; and for the smallest class of boats to a somewhat later date, or in all about 6 months. For about half that period the draught of the boats would be limited to 2 feet on the average, if not less. They could of course travel at times when it would be impracticable for Steamers of the same draught, as they would require a Channel of less width, and the delays and interruptions which they would experience at the shoals, would not be of so much consequence to them.

46. The Boats most commonly used on the Canals in the Delta, have a capacity ranging from 10 to 35 tons, and the draught from 2 to 4 feet. They are generally of a nearly circular section and ill-adapted for shallow water. There is another description of boat which is used in small and shallow channels. It has a very small draught and carries about 2 tons. Its shape is not unlike that of a shoe, and it is usually called a Shoe Dhony by Europeans. There are also cargo boats for communicating with the shipping at Coconada, which are built on the European model, and large boats for passenger traffic on the canals, which are also on a good pattern and built under native superintendence.

Style of boats in use in the Delta.

47. For navigating the Godavery, the natives would probably make use of the boats to which they are already accustomed, at all events in this first instance, and it may be assumed with some degree of confidence that their capacity will range from 2 to 50 tons. The larger boats would begin to ply in September, and the smaller would be had recourse to, late in the season. When not employed on the river, the boats would have work on the Delta Channels, and the interruptions of the river navigation would therefore not effect them injuriously. In this respect they would possess a great advantage over steamers which would be lying idle for six months in the year.

Boats could be transferred from canals to the river, and vice-versa.

48. The average carrying capacity of the boats on the Delta, according to the Superintending Engineer, Capt. Ryves, may be taken at 17½ tons, and if we take this for the probable average for the Upper Godavery navigation between 15th September and 15th February, we cannot be far wrong.

Capacity of boats; and number plying on the Godavery Delta.

From the returns obligingly furnished us by Captain Ryves,

we learn that the number of boats licensed on the Godavery Canals in 1865, was 1101, viz. 1023 Cargo boats and 78 passenger boats. The aggregate capacity of the Cargo boats was 17,500 tons.

49. The goods traffic in the year 1865 on 53 miles of 1st. Class Canal, amounted to 44,500 tons carried over the whole distance; and on 142 miles of 2nd class Canal, 11,280 tons, or over the whole distance of 300 miles, 28,782 tons. The total movement was thus nearly 8¾ millions of tons moved over one mile. This does not include the movement of unladen boats, so called; though many of them carried a small Cargo. The passenger traffic amounted to about 620,000 persons, carried over a distance of 35 miles.

Traffic in the Godavery Delta.

The season was not a favorable one for traffic, in consequence of there being a break of 13 miles, for three quarters of the year, on one of the principal Canals.

50. From similar returns obtained from Captain C. J. Smith, R. E. Executive Engineer, Bezwarah, we learn that on the 1st. Class Canals on the Kistna Delta, 125 miles in length, the traffic amounts to somewhat more than 1½ million of tons carried over one mile, or 12,000 tons carried over the whole distance, during the 9 months of the year for which the Canals are open. The number of boats licensed was 138. The average capacity 22 tons; but the licenses issued on the Godavery Delta (on which there are the greatest number of boatowners) hold good also on the Kistna and *vice versa*, and the boats pass in large numbers from one series of Canals to the other.

Traffic on Kistna Delta.

51. Combining the two returns, we find that the traffic on both Deltas, amounting to 10¼ million of tons moved over one mile, was carried on by 1,239 boats, (including passenger boats) along 425 miles of Canal; that along a portion of

Total movement in Deltas.

them, 158 miles in length, 44,500 tons was moved over each mile, and that along the whole length, 24,118 tons were moved on the average over each mile.

52. The rates at which goods are conveyed on the Delta Canals are as follows :—

Rates of freight on Delta Channels, and on road.

Cotton unpressed 20 pies per ton per mile.

Salt.	5 pies per ton per mile.		
Grain.	5 to 7½ pies	do.	do.
Oil seeds.	6 pies	do.	do.
Rubble Stone.	4 pies	do.	do.

The average rate for all goods excepting cotton, may be taken at 6 pies or 3 farthings, per ton, per mile. The ordinary hire of a cart capable of carrying half a ton is 1½ annas per mile, equal to 3 annas (4½ pence) per ton per mile. The saving therefore effected to the Delta districts by the Canals in carrying 10½ millions of tons over one mile, was 2½ annas per ton, or in all, upwards of 16 Lakhs of Rupees.

53. Metalled roads to carry the traffic we have specified, could certainly not be constructed under an average rate of 10,000 Rs. per mile, or maintained under 200 Rs. per mile. The cost of 425 miles, would therefore have been 42½ Lakhs of Rupees, and the maintenance capitalized would represent a further expenditure of 17 Lakhs.

Saving by the Canals.

54. Without insisting on the precise accuracy of the above figures, we consider they are sufficiently true, to prove that the Government and the public have derived vast benefits from the Canals in the Deltas, and to prove that if similar results are obtained by opening out the navigation of the River, the considerable outlay required for the purpose will have been well laid out.

Government and the public great gainers.

55. We consider however that the traffic on the Godavery, along the whole length of a line of water communication from Coconada to Chanda, 400 miles, is not likely to attain the standard of the Delta traffic, 24,000 tons over each mile of Canal, for a considerable number of years.

Godavery traffic not likely to equal that of the Delta for a number of years.

It would be impossible to arrive at any precise results, seeing that the traffic has to be entirely created; but we should consider it rash to anticipate a more rapid development of trade along the Godavery, than which has occurred in the Deltas.

The Canals draw the produce of well cultivated country. The Revenue derived from the Godavery and Kistna districts united, amounted in 1863, to 86 Lakhs of Rupees, and the land Revenue alone to 69 Lakhs. The vast area of the Central Provinces yielded for the same year, a land Revenue of 54⅔ Lakhs of Rupees, and a total Revenue of 85½ Lakhs. In the following year, the land Revenue was raised to nearly 55 Lakhs, and the total to 90½ Lakhs. The Delta Canals intercept by far the largest portion of the traffic to and from the coast, both within the limits of the two Districts and the Nizam's territories beyond.

Madras Land Revenue Reports 1863-64.

56. The Godavery navigation is carried through a wild and thinly populated country, and its terminus only rests on a country which is likely to supply any considerable amount of produce. Of course traffic would increase year by year, the improvement of the country along the Godavery itself, would doubtless be greatly accelerated by the improvement in the communication. The fact too, of the small land Revenue of the Central Provinces as compared with that of the Godavery and Kistna, shows what a field there is for improvement. Still improvements must be the work

Traffic can only spring up by slow degrees, owing to the smallness of the population.

of time, and it would seem to us unreasonable to expect any considerable traffic on the river, under a period of 10 or 15 years after it shall have been opened for navigation.

57. The actual trade of the whole Circle of the Central Provinces, amounted in 1864-65, to between 146 and 147,000 tons. (Imports 68,751 tons. Exports 77,771.) Of this aggregate, the trade with Northern India amounted to 66,579 tons, with Western India to 54,127 tons with Southern India 1,843 tons, and with the Eastern Coast Districts 23,973 tons. The total trade of the Sironcha and Chanda districts for the same year, amounted to 6,315 tons, namely Imports 4,681 tons, Exports 1,634 tons, exclusive of 10,000 tons of timber exported from Sironcha, which article of trade however would not be much affected by the opening of the River.

Actual trade of Central Provinces and of Chanda Division. The Chief Commissioner's Report on trade and resources of the Central Provinces for 1864-65.

	66,579
	54,127
	1,843
	23,973
Total	1,46,522 Tons.

58. There is therefore insufficient existing trade in the districts immediately affected by the Godavery navigation, to yield a traffic equal to that now carried on on the Delta Canals, even allowing for some additional aid from the Nizam's territories; but it is not less certain that the opening of the river will give a great impetus to the trade, and that it will have the effect of improving the condition, and developing the resources of a vast tract of Country.

Existing trade insignificant.

59. It will probably disappoint Government and the projectors of the Godavery scheme, to find that we entertain a view opposed to attempting navigation with large powerful Steamers and Barges; but it should not be inferred that the less pretending kind of navigation for which we think

Country boats may achieve good results.

the River best adapted, will be much less beneficial to the country. Except during freshes, the Current of the Godavery is very much slacker than that of either the Ganges or Indus, and its channels from the heavy course sand and shingle of which the bed is composed, is infinitely less variable. These most important advantages may prove more than sufficient, to compensate for the comparative shallowness of the Godavery.

60. On the Ganges and the Indus we find that, notwithstanding the evident advantage that steam power has over native boats, in contending with the strong current, it has not prevented an extraordinary increase in the native boat traffic by means of the latter. From a return kindly furnished to us by Mr. Galiffe, the Collector of Canal Tolls at Calcutta, we find that the boats passing through the Canals, which we understand principally convey the through traffic to and from Calcutta, have increased as follows:

Boat traffic on the Ganges.

61. Boats above 25 Maunds, from 1,26,350 to 2,04,585 in number, from the year 1854 to 1865. The tolls during the same period, have increased from Rupees 2,13,140 to Rupees 4,74,727.

28 Maunds of 80 lbs. equal 1 ton.

Boats under 25 Maunds, from 16,152 to 46,807 in number, from the year 1859 (up to which period there is no record) to 1865, and the tolls during the same period, from Rupees 1,009 to Rupees 3,625.

62. On the Indus, we find from information furnished by Mr. Howe, the Conservator of the River, that the Registry of boats shows an increase in their total burden, from 16,11,465 Maunds in 1862, to 19,04,141 Maunds, in 1865.

Boat traffic on the Indus.

63. The rate of transit by boats on the Ganges, is about five pies per ton per mile.

64. In 1852, the rate of transit on the Indus was ascertained to be only 4 pies per ton per mile, but the trade has increased since that year apparently more rapidly than the means of transport, and the rate of freight has consequently been enhanced.

65. On both the rivers, steam power has been used for many years, and it will be evident therefore that if, as we consider to be the case, it cannot be advantageously used for heavy traffic on the Godavery during the short period of the year, when there is sufficient depth of water; there is no reason to suppose that the native boats will not carry such traffic economically and with advantage to the country.

Conclusions in favor of boat traffic on the Godavery.

66. We take this opportunity of stating, that we have requested Mr. Howe to have a model prepared, of one of the best light draught native boats used on the Upper Indus, which will be sent to the Godavery, that the construction may have a trial on the latter River.

SECTION IV.

WORKS AT THE 1st BARRIER, COMPARISON OF TWO PROJECTS.

67. The Section of the River between Doulaishwaram and Doomagoodiem, can be navigated the whole way by Steamers only during high freshes. For the greater part of the season they can ply only as far as the village of Golagoodiem, 24 miles below Doomagoodiem. The numerous rocks and rocky islets which protrude from various parts of the channel in the interval, are the cause of this interruption; and together with the similar but more intricate configuration of channel extending for several miles above Doomagoodiem, form what has been termed the first Barrier.

River open to Doomagoodiem only during high floods.

68. The anicut which is in process of construction near Doomagoodiem, is designed to submerge the rocks in the reach above, and by raising the water during the dry season, to reduce the excavation of a channel to the lower extremity of the Barrier. The canal which Major Haig projected, was to extend from Doomagoodiem, to Golagudiem; and in conjunction with the pond above the anicut, was to form a line of navigation free from all obstruction, from one end of the Barrier to the other.

Nature of works designed at 1st Barrier.

69. The Estimate for these works was drawn up by Mr. Schmidt, C. E., and amounted Rupees 35,05,200, or excluding cost of Establishments, to Rs. 30,25,203. Major Haig, considering it unnecessarily high, had a fresh one prepared after remodelling the plans of many of the works. He also lowered Mr. Schmidt's rates, the masonry from 28 Rs. to 22 Rs. per 100, and the earthwork from 10 Rs. to 8¾ Rs. per 1000. The revised Estimate amounted to Rs. 16,34,287.

Estimated cost.

70. The subject was under the consideration of Government, when Major Haig brought forward a proposal to cut short the line of canal at Gongole, 2 miles below Doomagoodiem, and to improve the river itself by blasting away the rocks from thence to Golagudiem. He calculated on obtaining by these means, a sufficiently good navigation for Steamers for 4 or 5 months', and for boats for a longer period. Further he considered that the shorter project would be necessary in any case, as the navigation by the canal to Golagudiem would be liable to occasional interruption from the occurrence of breaches in the Embankment, during extra or ordinarily high freshes. Steamers can already proceed to Gongole during the freshes, but when the River is low, small boats only can ascend. Major Haig did not intend that the longer line of canal should be abandoned finally : he only intended to substitute the less expensive project as a temporary measure, with a view to open up the river navigation more expeditiously, though less perfectly than was possible by means of the complete project.

Modification lately proposed by Major Haig and approved by Government of India.

71. As however the Government of India have stated that they will be satisfied with a navigation open for steamers for 4 or 5 months, and for boats for several months longer, we have to express our opinion whether the modification proposed by Major Haig will effect this object.

Opinion required as to its feasibility.

72. Had the revised estimate prepared under Major Haig's instructions been sufficient to carry out the long Canal in a satisfactory manner, we should not have hesitated to recommend it in preference to the short Canal combined with blasting operations in the river, as being the most complete and certain of the two projects.

Original project the most complete and perfect of the two ; but would cost more than Major Haig anticipated.

It has to be noted, that a considerable portion of the work is already done : 12 miles of Canal are finished ; a Lock is about one-third built ; and some material has been collected for other works. Should the long line of Canal be definitively abandoned, the expenditure incurred in these works, will have been thrown away. But judging from the rate at which the masonry works near Doomagoodiem are being carried on, we are of opinion that Major Haig's Estimate would be largely exceeded ; further, that it is not improbable that rock would be encountered to a larger extent on the Canal excavation than was contemplated, and some additions to the works would sooner or later be necessary ; especially to the embankment for protecting the Canal from submersion by the river, which was only to be 2 yards wide at top ,and 4 feet high above maximum flood level. The Estimate originally prepared by Mr. Schmidt, might admit of some modification, as regards the quantity of work he provided for ; but his rates do not appear to be too high, and his Estimate probably represents the outlay required to carry out the project with a nearer approach to accuracy, than that prepared by Major Haig.

73. As regards the alternative project, we consider that it is QUITE feasible to clear a channel through the rocks in the river between Gongole and Golagudiem, so as to allow of the navigation being conducted within the limits required by Government. Portions of this route are already quite free from obstruction, and there are only three places where blasting of an extensive character is required. At two of these, there are small rapids in the dry season, and owing to the intricacy of the channel through the rocks, loaded boats cannot pass down stream without danger. But the fact of our having gone down in a boat 28 feet long and 8 feet beam in the middle of February, and of several small Coun-

Alternative project feasible and will answer the purpose intended, but will have to be carried out carefully.

try boats having gone up and down at the same time, shews that the route is not altogether impracticable even in its present state, and every rock that is removed from the Channel must serve to render the passage less difficult. At present, boats have to follow a tortuous course, and unless carefully managed, are liable to be thrown broadside on against the rocks in mid-Channel. The removal of such rocks is required to enable boats to pass up and down without danger; but we are of opinion, that the operation is one that will need great judgment, and that unless a chart of the rocks is prepared beforehand, and the course of the improved Channel is judiciously laid out, there will be great risk of failure. Several precautions are necessary. The rocks which obstruct the stream at the rapids, act like the piers of a bridge and hold up the water in the reaches above, in which there are pools of comparatively still water, offering no obstacle to navigation. The removal of the rocks in the rapids must tend, more or less, to lower the surface of the water in the pools, and if carried beyond the proper limit would have the effect of bringing rocks to light which had previously been submerged, and of increasing the current as well as the obstructions at the rapids or shoals higher up. To prevent the occurrence of such results, it is desirable that a Channel of limited width should be cleared for summer navigation, and that a separate Channel of greater width, should be cleared for the passage of steamers and boats when the river is at a higher stage. In the latter, the rocks would not have to be removed to so low a level as those in the Summer Channel, and the alignment should be as free from bends, and follow the direction of the flood streams, as closely as possible. The Summer Channel on the other hand, need not be so straight; but easy bends and footing for the men tracking up stream, or lowering boats down stream, will be requisite.

74. We have had no means of obtaining an accurate survey of this portion of the river, and can only indicate what we

Mr. DeGrousilliers competent to execute the work.

consider the most suitable course to be pursued. We would recommend that Mr. DeGrousilliers, who is now in charge of the Transport Department, should be entrusted with the blasting operations. He has already had experience of this nature, and being thoroughly versed in all that relates to the navigation of the River, would understand exactly what standard of efficiency should be aimed at.

SECTION V.

WORKS AT THE 1st BARRIER.

Past expenditure and outlay required to complete the Works.

Description of project as now curtailed.

75. The project for surmounting the 1st Barrier will now be limited to the Anicut and scouring sluices in the river, a canal 3 miles in length with locks at the extremities, and embanked against the river floods; and the clearance of a navigable Channel in the River from the extremity of the Canal to the village of Budrachellum. If this project is to be final, it is much to be regretted that it did not come under the consideration of Government for approval at an earlier period. The time and money which have been lost in the execution of works which are to be abandoned, would have sufficed not only to have rendered the 1st Barrier passable by this time, but also to have advanced to some extent the works at the second Barrier. Had the clearance of a Channel through the rocks in the River been commenced in the first instance, the Tramway might have been dispensed with, and the considerable expense required to maintain it for the purpose of conveying stores to the head-quarters at Doomagoodium, rendered unnecessary, for steamers or boats might then have proceeded up the River to the immediate vicinity of the works.

Tramways not comprised in Major Haig's original estimate.

76. Major Haig is not responsible for the expense on the Tramways. They were ordered by the Madras Government in the expectation that they would, in combination with the open reaches of the River between the Barriers, afford a means of conveying the cotton of the Central Provinces to Coconada, at an earlier date than could be accomplished by a complete and unbroken water communication. But, as the Government are aware, the Tramways were not completed round the three Barriers; it was ascertained, while they were in progress, that they would not answer the expectation that had been formed of them,

and on the recommendation of the Chief Commissioner they were accordingly suspended, but not before a large outlay had been incurred.

Cost of various Exploring expeditions form no part of the estimates.

77. There are other items of expenditure incurred on the Upper Godavery ; as for example, the cost of various exploring expeditions which really have no concern with the estimates which have from time to time been prepared by Major Haig to represent the cost of opening out the River. It is true that such expenditure must be classified as a charge on the Upper Godavery generally ; but would be unfair to Major Haig to include it in any comparison which may be formed between his estimates and the actual outlay incurred on the works, which alone they provided for.

Statement by Government of past expenditure.

78. In reviewing the past expenditure, the Government of India remarked upon the defective record of expenditure then before it, and give the following figures as the result of an examination as far as can be made out.

Under Madras Government.

1. From 1855 to 30th April 1863 ... ... £ 151,562

Under Government of Central Provinces

2. From 1st May 1863 to 30th April 1865, ... £ 134,513

Total 286,075

Rs. 16,34,287.

79. The revised Estimate for the long Canal project provided for all the work done, and remaining to be done, subsequent to 1st May 1863.

Rs. 10,44,367.

The rough Estimate for the shorter project is to be referred to the same date, and as the latter is not nearly finished, it must follow from the expenditure up to 30th

April 1865, having amounted to upwards of 13 Lakhs of Rupees, that either the smaller Estimate will be largely exceeded, or that a considerable expenditure has been incurred on the first project, which will have been thrown away.

A detailed Statement of Expenditure now furnished

80. We shall endeavour to give an intelligible account of the expenditure, as it has actually been incurred from the commencement of the operations on the Upper Godavery up to a recent date, and shall then proceed to explain what further sum is required to complete the works at the 1st Barrier.

Major Haig's Account of expenditure up to 1st May 1863.

81. Major Haig has furnished Major Stoddard with an Abstract of the outlay on the whole project, from January 1860, to 1st May 1863. It amounts to Rupees 13,78,597, and if to this we add the expenditure on exploring expeditions of previous years, viz :

1855-56	... ...	Rupees 1,30,396
1856-57	... ...	,, 3,075
1859-60	... ...	,, 1,383
		Rupees 1,34,854

The total Rupees 15,13,452, so nearly corresponds with the figures obtained from the Madras Government, and specified in a preceding para : (Rupees 15,15,620) that for purposes of illustration, it may be taken as substantially correct.

82. Major Haig distributes the above-mentioned expenditure under the following heads :

Temporary works and blasting rock	...	Rupees 9,146
Improvement to shoals	....	,, 7,208
Exploring Expeditions 1861-62.	....	,, 6,933
Improvement of River between Doulaishwaram and Budrachellum	.....	,, 52,598
		Rupees 75,883

STOCK.

Steamers and Boats	Rupees	94,651	
Tools, Plant and Machinery ...	„	1,77,051	
Live Stock...	„	4,902	
Materials, ...	„	39,207	
			3,16,111

TRAMWAYS.

1st Barrier...	Rupees	1,97,442	
2nd Do.	„	1,07,521	
3rd Do.	„	70,747	
			3,75,710
1st Barrier, Anicut and Canal,	Rupees		3,93,426
2nd Barrier works ..... } Preliminary operations ..... }	„		7,452
Survey of Wards, ...	„		717
Station improvements, ...	„		3,316
Goods conveyed for private parties for which there should be corresponding credit, ...	„		21,176
Miscellaneous, ...	„		9,900
Establishment, ...	„		1,74,903
			13,78,596

Expenditure on works at the first Barrier up to 1st May 1863.

83. The sum of Rupees 393,426 would appear to be all that pertains to the project at the 1st Barrier, and of this, a considerable portion does not represent work done, but contingent expenses in accommodation for establishment and workmen, recruiting expenses and other miscellaneous charges. The actual work done, cost Rupees 1,39,600 on the Anicut, and Rupees 1,20,782 on the Canal. Total Rupees 2,60,382 ; the Miscellaneous charges were therefore about 50 per cent additional.

Account of expenditure incurred subsequent to 1st May 1863

84. As regards the expenditure incurred subsequently to 1st May 1863, we obtained from the Executive Engineer, Mr. Isaac, C. E. an account current exhibiting on one side the total sum he had drawn from the Treasury up to 31st December 1865, and the manner in which the whole sum had been disposed of on the other.

85. This account may be summarized in the following manner.

Cash in hand 1st May 1863. ...	Rs.	4,253	5	2
Drawn on letters of Credit from 1st May 1863 to 31st December 1865.	Rs.	12,78,636	0	0
Total Rupees		12,82,889	5	2
Deduct Cash in hand on 1st January 1866.		9,375	8	0
Amount expended between 1st May 1858 to 31st December 1865.		12,73,513	13	2

The expenditure was incurred on the following works.

I Anicut	Rs.	1,26,723	4	11
Scouring Sluice	„	91,743	7	5
Removing obstructions from River	„	2,257	2	4
Head Lock	„	53,427	15	3
Flood embankment near Doomegoodium	„	18,096	1	3
Canal above Gongole (short project.)	„	60,744	0	0
Total short project ...	„	3,52,991-15-2		
II. Canal between Gongole and Golagudiem.	Rs.	1,45,872-0-7		
Upper tail Lock	„	35,499-4-4		
Total long project separate from above	„	1,81,371-4-11		

TRAMWAY.

III.	Improvements, laying rails, &c.	Rs.	50,306	13	6
	Repairs	"	18,027	12	5
	Torbaka suspension Bridge	"	5,410	7	10
	Bridge over Torbaka Vagoo	"	2,605	10	1
					76,350-11-10
IV.	Tools and Plant	"	73,961	12	6
	Powder Magazine	"	1,222	0	0
					75,183-12-6
V.	Accommodation for Establishment	Rs.	39,250	2	9
					39,250 2 9
VI.	Station improvements, including conservancy and Sanitary operations.	Rs.	27,211	1	10
	Burial Ground	"	79	3	6
	Garden	"	980	10	2
					28,270 15 6
VII.	Miscellaneous charges against Labor, including Hutting Battu, recruiting expenses, construction of cooly lines, Hospital charges, including cost and maintenance of building.	Rs.	1,21,423	1	6
VIII.	Transport operations.				
	Floating Stock.				
	New Boats, &c.	Rs.	11,069	0	0
	Repairs	"	14,309	14	4
	Accommodation for stores (food) new works.	"	21,618	2	11
	Repair	"	3,735	9	6
					Rs. 50,732 10 9
IX.	Survey of Albaka between 1st and 2nd Barrier	"	664	14	7
X.	Establishments	"	2,21,554	3	5
XI	Outstanding in stock and advances	Rs.	1,25,719	13	4

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ABSTRACT.

I.	Rupees.				3,52,991 15 2
II.	"				1,81,371 4 11
III.	"				76,350 11 10
IV.	"				75,183 15 5
V.	"				39,250 2 9
VI.	"				28,270 15 6
VII.	"				1,21,554 1 6
VIII.	"				50,732 10 9
IX.	"				664 14 7
X.	"				2,21,554 3 5
XI	"				1,25,719 13 4
					12,73,644 13 2

86. If the outlay incurred on accommodation for Establishment, Miscellaneous charges, and transport operations (V, VII, VIII,) Rupees 2,11,405 15 0, be added to the expenditure on items I. II. and III., the cost of the works will be increased by about 34·65 per cent.

Pencentage of expenditure due to Miscellaneous charges.

The expenditure would then be as follows, between 1st May 1863 and 31st December 1865.

ANICUT and SHORT CANAL PROJECT.

Works.		Rs.	3,52,991	15	11
Miscellaneous charges ...		"	1,22,212	15	0
			4,75,204	14	11

ADDITIONAL on LONG CANAL.

Works.	Rs.	1,81,371	4 11
Miscellaneous charges. ...	,,	62,803	0 0
		2,44,174	4 11

TRAMWAY.

Works.	Rs.	76,350	11 10
Miscellaneous charges. ...	,,	26,411	0 0
		1,02,761	11 10

Total expenditure on the Anicut and short Canal.

87. We have previously explained that prior to 1st May 1863, the expenditure on the Anicut and Canal had amounted to ... ... Rs. 3,93,426 0 0

The total expenditure to 31st December 1865, was therefore in addition ..... ,, 4,75,204 14 11

or in all Rupees 8,68,630 14 11

Expenditure on Tramways and on portion of Canal which will be abandoned.

The expenditure incurred on the portion of the long line of Canal, which is to be abandoned, represents a loss of about 2½ lakhs of Rupees; and the Tramways on which there has been an outlay in all of about 4¾ lakhs, though they have been to a certain extent useful, so far as the work of the 1st Barrier is concerned must be pronounced in the main to be unprofitable works.

NOTE.—The Superintendent of the Transport operations draws up an Annual Statement of Receipts and charges; but his accounts of expenditure comprise only the pay of the establishment, and other expenses connected with the actual working of the Steamers and tramway. The cost of the plant, or accommodation for stores and maintenance of the tramway, does not appear in the Annual Statement, hence the rates at which stores of different kinds are said to be conveyed are, to some extent, fictitious.

High charges for establishment, tools and Plant.

88. The other items of expenditure, the Government will observe, are chiefly comprised of charges for establishment and for Tools and Plant. These are extraordinarily heavy, and will be alluded to again, when we speak of the future more economical management of the works.

Expenditure compared with Estimates.

89. We have already observed that the Estimates which have lately been under the consideration of Government, date from 1st May 1863, and include none of the outlay incurred prior to that date. We have also explained that the expenditure on the Anicut and Short Canal project for the 1st Barrier, exclusive of Miscellaneous charges between 1st May 1863 and 31st December 1865, amounted to Rupees 3,52,991-15-11 and inclusive of them, to Rupees 4,75,205.

We propose now to consider these amounts with reference to the Estimates, and to calculate approximately what further expenditure will be required for the completion of the works provided for.

I. ANICUT at DOOMAGOODIUM.

Anicut at Doomagoodium and subsidiary works.

90. It appears from the Progress Report up to 31st May 1865, since which date no work has been done, that 44·35 per cent of the Masonry work had been completed. As the expenditure has amounted to Rs. 1,26,723, and the Estimate to Rs. 2,20,914, the cost of completing the remainder of the work at the past rate, would be Rs. 2,86,000; but as adequate provision was not made in the Estimate for crossing the deep bed of the river, and for the temporary embankment which will be required to aid the final closing of the dam, and as a considerable addition is required in the north flank of the Anicut, in the shape of rough stone groins or pitching,

to prevent it from being turned, we question whether the cost of the work will fall short of Rupees 3,20,000.

2. *SCOURING SLUICE*—is completed at a cost of Rupees 91,743-7-5 against the Estimate of Rupees 71,430 ; excess Rs. 20,313-7-5.

3. Flood embankments and removing obstructions in river bed have cost Rupees 20,354-1-7.

4. Head Lock—Expenditure Rs. 53,427-15-8. Estimate Rupees 97,705-0-0.

It appears that the rubble masonry on the last named work, is costing 28-3 per 100 cubic feet, instead of the Estimated rate 22, and that the cutstone is likely to cost 100 Rupees per 100 instead of 75, and that the contingencies are costing 10 per cent instead of 5. We question if the whole of the rubble masonry will be constructed under 30 Rupees per 100; and we Estimate the probable cost of the whole work at Rupees 1,24,735.

5. For the short Canal from the head Lock to Gongolo we accept Lieutenant Roberts' Estimate as approximately correct ; it amounts to Rupees 1,74,956.

6. The tail lock at Gongole if reduced to a width of 30 feet and a length of 150, instead of 30 feet by 200, will cost about one third less than Lieutenant Roberts' Estimate of Rupees 2,35,690, or Rupees 1,60,000.

Total of Estimates.

91. The above Estimate may thus be summarized:

Anicut.	Rupees	3,20,000	0	0
Scouring Sluice.	,,	91,743	7	5
Flood Embankments, &c.	,,	20,354	1	7
Head Lock.	,,	1,24,735	0	0
Short Canal.	,,	1,74,956	0	0
Tail Locks at Gongole	,,	1,60,000	0	0
	Rupees.	8,91,788	0	0
To this must be added 33⅓ per cent to cover Miscellaneous charges of the nature we have described above.	Rs.	2,97,263	0	0
	Rupees.	11,89,051	0	0

Clearance of rocks in the River.

92. To this must be added the cost of blasting operations in the River, of which we can form no Estimate that can be relied on ; but we imagine it will exceed 50,000 Rupees and may rise to 100,000. If the latter, the probable total cost of the project would be Rupees 12,89,000 or say 13 Lakhs ; of which has been expended, as already explained,..... ....Rupees 3,52,992 0 0
plus Miscellaneous charges,..... ,, 1,22,213 0 0

or Rupees 4,75,205 0 0

Expenditure prior to 1st May 1863 to be added to amount of Estimates.

93. If to the above Estimate of Rs. 12,89,000 be added the expenditure incurred on the Anicut and Canal prior to 1st May 1863, Rupees 3,93,426-0-0, the total probable cost of the work will be ascertained, viz: Rs. 16,82,426-0-0.

Probable cost compared with Estimate.

The Government of India counted on an expenditure of Rs. 10,44,367 on carrying out the short project, but exclusive of that incurred before 1st May 1863. If we add that sum, the total will be Rupees 14,37,793, or about 2½ Lakhs less than the amount of the Estimate we have given above.

High rates of work and causes thereof.

94. We have to remark, that without taking into account the extra charges, the rates at which the works at the 1st Barrier are being executed is excessively high. The workmen are of a very inferior stamp. Good masons, of which only a very limited number are available in most of the Districts in the Madras Presidency, can readily find employment without leaving their homes, and the class of workmen who are skilled in excavation, will not leave their own Districts. Further, such large concessions have been made to the workmen that they have become spoilt. They readily understand

that as a considerable outlay had been incurred to collect them on the work, that it must be the interest of the Executive Officers to keep them upon it; and that the latter will be prepared to give them easy terms, rather than see them desert. The result is, that there is little command over them, and then they cannot be induced to furnish a fair day's work for their ample wages. We learnt that a mason built about 9 cubic feet of rubble masonry a day. This is about a third of what is expected under ordinary circumstances; and as the other labor charges for the masonry work would increase nearly in proportion to the expense of the masons, the work costs about two and a half times as much as similar work on the Deltas. The Miscellaneous charges which we have shown, amount to between 30 and 40 per cent on the purely construction expenses, and the total cost becomes therefore nearly three and half times as much as similar work on the Deltas.

High rates not attributable to want of management on the part of the Engineering Staff.

95. We are far from attributing these heavy charges to a want of economical management on the part of the officers. We believe that in Major Haig and the Executive Officers generally, the Upper Godavery has been fortunate in having a more than usually efficient Engineering Staff, and that the high cost of the works is the natural consequence of the very unfavorable conditions under which they have been prosecuted. It was quite impossible that the Estimates, at all events the earlier ones, should have had any pretension to accuracy. The whole of the workmen had to be recruited from a distance; they had to be paid during the journey; many deserted almost within sight of their destination; and, in some cases, the stoppage of Funds obliged the Officers to discharge a number of the men who had thus been collected at a heavy cost. The hutting is an unusually heavy item. In most cases it would suffice to give the workmen a small sum to enable them to house themselves; but the extreme unhealthiness of the country along the Godavery, rendered desirable a more regular alignment and more careful style of construction, than could be entrusted to the workmen to carry out themselves. The workmen had also to get batta when in Hospital, during rainy days, or on other occasions when the work might be stopped.

Budget rules act unfavourably on the works

96. These causes are quite sufficient to account for the expensive style of the work on the Upper Godavery, and they have no doubt been enhanced by the stringency of the Budget rules, and a want of knowledge on the part of the officers, as to the Funds they might calculate on obtaining, which prevented them from knowing what number of workmen they could count on employing permanently, for the performance of the work in the most economical manner.

Quality of the work.

97. We have to add a few remarks expressive of our opinion as to the efficiency of the several works at the first Barrier.

Anicut.

The Anicut across the River is about one-half built. It is a simple rubble masonry wall based on a rock foundation, and cannot fail to be durable and inexpensive to maintain. The cement which is used on this and the other masonry works, is of the most excellent quality, far superior to the mortar generally used in other parts of India.

The only difficult portion of the Anicut has, however, yet to be built, and the damming off of the water by means of temporary bunds to allow of the wall being carried across the deepest portion of the bed, must be a troublesome and expensive operation. It is worthy of consideration whether instead of continuing the Anicut in a straight line to the

west bank of the river, as provided for in Major Haig's design, it would not be better to deflect the flank more up-stream, to take advantage of a more favorable configuration of the rocky bed of the River. Major Haig has himself suggested this modification, and it will, probably, render the final closing of the deep portion less difficult and expensive.

98. The East flank of the Anicut abuts on an island formed of alluvial soil. The head of this island is about half a mile higher up the stream, and the Channel between it, and the main land is intended to form the navigable approach to the head of the canal at the distance of a mile below the flank of the Anicut. We consider it would have been preferable to have continued the Anicut in a straight line to the main bank of the river, and to have opened the canal on its flank, or to have followed the plan originally proposed (1856) by Major Haig, of constructing the lock at the head of the Island, and of turning the branch between it and the main land, into a portion of the canal. According to the present arrangement, the flank of the Anicut is not secure from the encroachment of the River, and a breach has already been formed through the island almost close to the Anicut. It will now be necessary, in order to protect the Island from further erosion, and to prevent the flank of the Anicut being turned, either to revet the head of the island with rough stone pitching, or to construct a masonry wall in continuation of the Anicut, as far as the Branch Channel. As rock is available for the foundations, neither work will be of an expensive character. We have provided for it in the Estimate we have already given for the completion of the Anicut, and also for a slight addition to the height of the embankment connecting the flank of the Anicut with the Head Lock.

Additions required.

99. As regards the other works, we have only to remark, that the Lock at the head of the Canal must by this time be nearly

Head Lock.

completed. It is 200 feet long and 30 feet wide, and if our suggestion to limit the capacity of the Locks on the Godavery navigation to 150 feet by 20 feet be approved, it will be too late to make any alteration in the Head Lock, further than to contract the width in the immediate vicinity of the Gates, and to cut the latter down to 20 feet. They would be so much more manageable than Gates 30 feet in width, under the considerable head of water to which they will be exposed during the high floods, that we do not hesitate to recommend this alteration.

SECTION VI.

WORKS AT THE 2nd BARRIER.

100. The Anicut which Major Haig proposes for the 2nd Barrier, is to be formed of a mass of loose stone thrown in blocks and pieces of all sizes, from what a man can carry, up to 10 tons in weight. He considers that a rate of 6-8 per 100, will suffice to cover the whole expense of this work. He ascertained that the rate that prevailed at the Kistna Anicut, which was constructed upwards of ten years ago, for quarrying and delivery was Rs. 2-3-6 per 100, and he had doubted this rate, and added 2 per 100 to cover the cost of tramways, plant, and hutting workmen.

Style of Anicut proposed by Major Haig.

101. On reference to the Statement of Expenditure on the Kistna Anicut as it approached completion, we find that actual cost of the rough stone were 10·9 annas per cubic yard, and that the proportional charge for plant would increase the cost by 3·38 annas per cubic yard. The total cost was therefore 14·28 annas per cubic yard. Now the quarries at the Bezwarra Anicut are in close proximity to the work, and on both sides of the river, while the average distance of the quarries at the 2nd Barrier, will not be less than a mile, and the facilities of working are far less than at Bezwarra. At the present day, the Anicut at Bezwarra could not be constructed so cheaply as it was ten or twelve years ago. Again, Major Haig proposes to throw in stones up to 10 tons in weight. None of the stone used on the Kistna Anicut exceeds 5 or 6 tons, and blocks of that size are exceptional. We do not think that the labor and expense of manipulating stones of the enormous weight of 10 tons, or of carrying them along a common tramway, has been fully appreciated by Major Haig. We consider that in practice, such heavy material would have to be avoided, and that.

Professional papers Madras Engineers, Volume IV. page 70, rates compared with those of Kistna Anicut.

the upper course of stone would instead have to be carefully packed.

Probable cost of rough stone for the Kistna Anicut at the present day.

102. For similar work at the Kistna Anicut at the present enhanced rates, we think it highly improbable the whole mass of the rough stone work, including the packing of the upper course, could be thrown in, for a less rate than 1-8 per cubic yard, or about 5-8 per 100 cubic feet.

Liberal allowance must be made for Contingent expenses.

103. We have seen that the cost of the work at the 1st Barrier, inclusive of all charges, is upwards of three times that of similar work in the Deltas. We see no reason to conclude that the work 2nd Barrier, will be in a much lower proportion. It is true that a larger number of workmen will probably be obtained from no great distance, and that food may also be obtained with greater facilities, than was the case at the 1st Barrier. But the country is fully as wild as that at Doomagoodiem, it is not likely to prove less unhealthy ; and though the cost of hutting and other charges may be on a less liberal scale, a considerable allowance must still be made.

Expense of rough stone would be much in excess of Major Haig's rates.

104. It is impossible to know precisely before hand, what work will actually cost, when there are really no data on the spot for any calculation ; but the experience gained at the 1st Barrier, would lead us to the conclusion, that the rough stone work is not likely to cost less than 3 times what we have shown to be the probable cost of similar work at the Kistna Anicut, or about 16 Rupees per 100 cubic feet, instead of 6-8 as computed by Major Haig ; but if Major Haig's anticipations of effecting a reduction on the charges for labor, recruiting, &c. are

realized, and taking his standard of probable expense of rough stone, as compared with the work at the Kistna, after the corrections we have made above, the cost will still be 11 Rupees per 100 cubic feet, and the total expense of the rough stone work of the Anicut, would be 10,37,000 Rupees, instead of 6,12,775, as computed by Major Haig.

Major Haig's rates for masonry also too low.

105. As might be expected, we are also of opinion, that his rates for masonry work are too low. Major Haig assumes that a rate of 21 Rupees per 100 for rubble masonry was sufficient for the work at the 1st Barrier, and that a reduction of 3 Rs. per 100 would be effected at the 2nd Barrier, in consequence of the greater facility of obtaining materials, and of labor being procurable at lower rates. But in reality the rate at which rubble masonry is being carried out at the 2nd Barrier, is nearly 30 Rs. per 100 instead of 21, and if a reduction is effected as anticipated by Major Haig, it would still leave the rate nearly 26 Rs. per 100, and to this must be added the per centage due to hutting, batta, transport charges, and other extraordinary expenses. These latter charges may possibly, however, be largely reduced in the case of the 2nd Barrier works, especially if the Deputy Commissioner of Sironcha can induce merchants to establish shops to supply the workmen with food. But still allowing for such a reduction, we think that the Estimated rate should not be lower than 30.

Engineering objections to a rough stone Anicut—for 2nd Barrier.

106. If the plan of Anicut proposed by Major Haig is adhered to, it thus appears that the outlay required for overcoming the difficulties at the 2nd Barrier, will be much in excess of his estimate. We are of opinion however, that there are serious objections, independently of the ex-

pense, against the construction of a rough stone weir, intended to withstand a pressure of 40* feet head of water. We are quite satisfied that the leakage would be so great, that it might be quite impossible to pond up the water to the requisite height, when the supply in the river would be small; Major Haig considers that there is no single objection to such a work in an Engineering point of view, and from his not mentioning in his report No. 58 dated 24th May 1864, that the rough stone dam would have to be carried across the deep bed of the river for a distance of 170 feet, and where consequently the full head due to the pressure of 40 feet of water would act against it, he evidently made light of what appears to us a serious difficulty. If the use of very large blocks of stone were found to be economically impracticable, the repairs of a rough stone dam would be heavy. The floods of the Kistna dislodge a considerable portion of the packing of the Anicut at Bezwarra, and a number of the large blocks of cut-stone from the coping of the front wall. In one year, a hole 250 feet long, 50 feet wide, and a depth up to 8 or 9 feet was formed in the rough stone work. The repairs of damage of this nature are not however very expensive, owing to the very low rate at which stone is procurable. The proposed dam at the 2nd Barrier is about double the height above low water of the Bezwarra Anicut. The rise and volume of the Godavery flood is double that of the Kistna, while the length of both dams is almost the same. At full flood the depth of water, and the quantity discharged along each running foot of the 2nd Barrier Anicut, would be double. Similar quantities at Bezwarra. The velocity would therefore be the same in both cases. But the Kistna Anicut being only 16 to 18 feet high above summer level, while the solid portion of the proposed Anicut at the 2nd Barrier is to be 37 feet, so that when the water is ponded up in summer at the latter work, the difference of

* 37 feet stone work.
3 feet planking.

level between the upper and lower pools, will be double what it is at Bezwarra. At extreme floods, the afflux or difference of level, between the up and down stream surfaces, will be nearly reduced to an equality in the two cases, and in neither would probably exceed 1½, or at most 2 feet. So that in the Bezwarra Anicut, we should have between high and low stages of the river, a difference of level in the upper and lower reaches, ranging between 1 and 18 feet, and in the 2nd Barrier Anicut, a difference ranging between 1½ and 37 feet. We must therefore conclude, that the afflux during moderate floods, would be much greater at the proposed Anicut than is the case at Bezwarra; that the velocity would be greater, and that the action on the rough stone work, would therefore be more severe. On the grounds both of economy and efficiency, therefore, we recommend the substitution of a solid masonry work, with a vertical fall. Major Haig in para. 11 of his report, states that the rock is not of sufficient hardness; but we have carefully examined the rock, and taking into consideration that of the whole length of the dam, 367 out of 1,000 feet, are to be less than 12 feet high; and that 2,300 feet more, less than 22, (on the average.) We believe, that any serious injury need out be apprehended, and it would not be a very expensive operation, to reduce the destructive action of the over fall, by means of a second dam, of about half the width and height of the main dam, built 50 or 100 feet in rear of it, and thus forming a pool for the water to fall into. The remarkable configuration of the bed of the river, strata of slate running parallel to the banks, and presenting a seriated outline on cross section, gives great facilities for the construction of secondary dams in rear of the main one, on different levels to suit the varying height of the rock; the ridges of rock forming ready-made partition walls, nearly at right angles to the line of the dam, which would prevent the water in the different pools from communicating, and thus from falling to a uniform level.

107. The construction of a solid masonry dam, would be an easy operation along all parts of the bed, excepting for a distance of 170 feet, where, as already mentioned, the river has scooped out a deep channel. The depth of water in summer is 14 feet at the centre, and the average is about 12 feet, as the anicut is to be 37 feet high above summer level. The total height of the masonry for a distance of 170 feet, would then be close on 50 feet.

A solid masonry weir preferable.

108. It would be hopeless to attempt to bale out the water from the pool, after the stream should have been diverted into one of the secondary channels, and it appears to us, that the simplest and most efficacious mode of proceeding, will be to build the foundation of concrete in the water. The width of the base, would be upwards of 40 feet, and we would propose to build the faces to the proper slope, by means of caissons (or boxes without top or bottom.) The Hydraulic cement prepared for the Upper Godavery works, is of so excellent a quality, that a concrete foundation of the kind we have described, would be equal if not superior, to any rubble masonry that could be built.

Crossing the deep bed of the river the only difficulty.

109. The masonry wall at the deep channel, would be 36 feet high from the base to the general level of the crest of the proposed dam, and we purpose to give it a width of 30 feet at base and 10 feet at top*. The water, when the lower pool would be at its minimum, would fall from a height of 37 feet, and the depth of the pool is 12 feet. This would seem to break the force of the falling stream to some extent, and thus to protect the foundation; but it would add con-

Nature of work proposed

* NOTE.—The width of crest should not be less than 10 feet. An accident lately occurred to a dam across the Kistna in the Sattara District, of which the width of crest was 8 feet. A large mango tree was brought down by the floods, and in passing over dam, carried away the masonry to a depth averaging 6 or 7 feet, and to a width of 45 feet.

siderably to the expense, and cause great additional delay if a second wall were built to pond up the water to a greater height, in the manner proposed along the rest of the Anicut where the bed of the river is high; and we consider it advisable to obtain the necessary additional security to the foundations, by preventing the water flowing over the crest of this portion of the work, until the depth in the lower pool shall have increased. We calculate, that when a depth of 3 feet of water is passing over the crest of the Anicut, the surface in the lower pool will be upwards of 20 feet above the summer level. We would therefore propose to build up the portion of the work along the deep channel; say per 200 feet, in all 3 feet higher than the remaining 3,470 feet, and as the water in rising above this level, would then fall into a pool upwards of 30 feet deep, there would be no reason to apprehend any injury to the foundation.

110. We have observed before, that the height of the Anicut for 2,300 out of 3,670, will be less than 22 feet. For a considerable part of that distance it would be very much less, and the average for the whole is considerably under 22 feet; an Anicut with a mean thickness of 14 feet, 24 feet high, would at the liberal rate of 30 Rupees per 100 cubic feet, cost 100 Rupees per running foot. Major Haig's Estimate for the rough stone work was at the rate of 170 Rupees per running foot, and that rate, as we have explained, is too low. It would thus appear that the masonry dam, is the less costly style of work of the two; and we are of opinion that both it, and the smaller wall in rear, which we think necessary for forming a pool to break the force of the water in falling, may be carried out for less than the amount of Major Haig's Estimate for the rough stone dam, allowing also for the extra cost of coping the deep bed. Major Haig's rates for masonry being nearly two-thirds only what it is likely to cost,

Proposed alterations could be carried out within the amount of Major Haig's Estimate

an excess would occur in the construction of the locks or sluices; but if our recommendation to cut down the size of the locks from 200 by 30, to 150 by 20, meets with approval, the saving thus effected will serve to balance the under estimate of rates, and thus allow of the whole work being carried out for the amount of the Estimate.

Additions required to under sluices.

111. We consider the under sluice wall might be strengthened with advantage, and that a pool should be formed in rear, similar to that above recommended for the body of the anicut. It is to be observed, that there will be a head at times of fully 10 feet of water on the under sluice vents, and the water would then issue with a much higher velocity, than rough stone work would stand.

SECTION VII.

Improvements to the River Bed between the Barriers.

References to former Estimates

112. In resolution No. 930—3 C., dated 13th September 1865, Para. 9, the sum set down for works between the 2nd and 3rd Barriers is Rupees 6,50,000. Major Haig, in his Report dated 3rd May 1856, states in Para. 207, when speaking of the total probable cost of all the works, excepting storage required for the Godavery, that the removal of Rocks, &c., from the River bed will cost Rupees 1,40,000.

Expenditure on Groins deprecated

113. In subsequent Reports, Major Haig speaks of Groins, to contract the River at wide places and increase the depth of water; and the Chief Commissioner in his Report on the Godavery, dated 23rd January 1863, mentions the probable cost Rs. 6,50,000, which includes 3,50,000 for Groins. This corresponds with the sum set down by Government.

But in the present state of knowledge of the navigability of the River, except at the particular times when a voyage has been made, we deprecate any outlay whatever for Groins. For protecting the bank of a River they are simple enough; but for contracting a River to increase the depth of water, without at the same time injuring an adjoining reach, they are not so simple; and without a most careful survey and complete information of the River in all conditions of its stream, large sums may be entirely thrown away.

Nature of obstructions between the Barriers which require to be removed.

114. With respect to the clearance of rocks, which alone should now be undertaken, the same care would be necessary as in the case of the rocks near Budrachellum. The clearance may be overdone, and the depth of water seriously reduced above the obstructions. There are three points between the 1st and 2nd Barriers, where rock offers a seri-

ous obstruction to the navigation, when the supply of water is small. Proceeding up stream, the 1st spot is about 12 miles above the 1st Barrier. A narrow ridge or reef of rocks runs completely across the river. The second point Albaka, 20 miles higher up, is well known; and the rocks extend longitudinally for about a mile, over which there is an ascent of about 7 feet when the river is low. The third point is at Jyoorpettah, about 10 miles below the foot of the 2nd Barrier; the obstruction is like the 1st one, merely a narrow ridge of rock which produces a short rapid, with a descent of about 3 feet.

115. At the first and third points, a passage merely wide and deep enough for the largest size boat that can navigate the river when the stream is low is required, and to facilitate warping up or lowering down stream, ring bolts should be fixed to the rock above the rapid, and opposite the shoot, because the chief difficulty is caused from the insecure footing the boatmen get upon the slippery rocks, and the awkward angle at which they are obliged to track, which doubles the labor and makes the steering of the boat very difficult.

116. At the second point Albaka, the same plan should be adopted that we have recommended for Budrachellum. A narrow passage should be provided for boats when the river is low, and a wider passage at a higher level for both boats and steamers when the river is higher. In the first, the channel may wind through the rocks and ring bolts should be fixed at convenient intervals to facilitate warping. In the second, the channel should be as straight as possible, and follow the direction of the current, as the velocity will be very great down it, and the steering must be rendered as easy as possible.

Obstruction at Albaka, how to be treated.

117. In all other places where the removal of rocks is necessary, the quantity of work to be done is comparatively small. These rocks rather endanger navigation than obstruct it, and their removal will be a matter of no difficulty.

Detached rocks here and there to be removed

118. The removal of the rocks both where they occur in ridges, and detached, may be deferred till the work at Budrachellum is completed.

119. There are also detached rocks which occur below the 1st Barrier and between the 2nd and 3rd which should be removed; and altogether, we do not think the expense will be less than the sum mentioned by the Chief Commissioner, excluding the cost of the Groins, viz., Rupees 6,50,000 — 3,50,000 = Rupees 3,00,000.

Probable cost

120. Probable cost of Navigation works, to foot of 3rd Barrier, exclusive of expenditure incurred prior to 1st May 1863

Total probable outlay required for the works from 1st May 1863

1st Barrier works	Rs.	12,00,000
Rocks at and above Budrachellum.....	„	1,00,000.
Rocks between 1st and 3rd Barrier	„	3,00,000
2nd Barrier Works.....	„	13,00,000
Total Rupees...		28,00,000

SECTION VIII.

General Remarks on Expenditure.

Disproportional cost of Establishments, Plant, &c.

121. The experience obtained on the Upper Godavery has been dearly bought, but there is still time to turn it to account in the completion of the works at the 1st Barrier and the execution of the other works not yet commenced. An analysis of the expenditure upon the works up to 31st December 1865, shows an extraordinary disproportion between the outlay for actual work and that for Establishment, Plant &c.

The following are the various items which, collected under the different heads from previous paras, show the expenditure since the Godavery was first examined in 1853 by Major F. Cotton up to 31st December 1865 :—

Actual work on Canal or in River bed	Rs.	8,63,696
Tramways	,,	3,75,710
Improvement and repair of Tramways	,,	76,350
Steamers and Boats	,,	1,20,329
Tools, Plant and Machinery ...	,,	2,52,234
Live Stock	,,	4,902
Materials in Stock and advances ...	,,	1,25,719
Miscellaneous charges, Huttting, Recruiting &c., ...	,,	2,64,367
Preliminary operations at 2nd Barrier	,,	7,452
Station improvements	,,	31,586
Establishment	,,	4,96,457
Accommodation for Establishment ...	,,	39,250
Buildings for Grain and for Transport Departments... ...	,,	25,353
Exploring expeditions and Surveys...	,,	1,43,169
Balance due for goods conveyed by Transport Department for private parties	,,	21,176
Outstanding Advances	,,	[illegible]
	,,	28,47,750

Note 1.—The item improvement and Repair of Tramway, is for maintaining the Tramway at 1st Barrier for the prosecution of works.

Note 2.—Under the head of exploring expeditions and surveys, is included some expenditure incurred for clearing rocks. It is not charged under the head of Works, because it was executed prior to the regular commencement of the 1st Barrier works, and forms no part of the project.

122. A large proportion of the outlay for Tramways, is for iron rails and some portion of this is recoverable by the sale of iron. The construction was too light in the first instance, and the expense of maintenance and the heavy cost of transit for conveying such a limited quantity of traffic as suffices for the works, make the Tramway a very heavy drain upon the resources, and we recommend that it should be taken up and the iron disposed of. The number of workmen now engaged on the works may easily be supplied with grain by River Transport for 7 months in the year, and during the remaining 5 months, the grain may be conveyed to Budrachellum by boat, and thence to Doomagoodiem a distance of 14 miles, by Bullocks.

Tramway at 1st Barrier should not be maintained.

123. The outlay for Steamers and Boats was, of course, necessary for the Navigation, and we have no remark to make upon it.

124. The cost of Tools, Plant and Machinery, is disproportionate to the expenditure on work. As the expense has been incurred there is no course, but to use the Machinery; but whenever it gets seriously out of order and is expensive to maintain, it should be replaced by the ordinary Bullock power Machines; and we recommend that no additional Plant or Machinery be ordered from England either for works

Costly Machinery to be avoided.

at the 1st or 2nd Barrier. There is abundance of Cattle power obtainable on the Godavery, and in a bad climate which renders Establishments costly, Tramway and Machinery which require much supervision and skilful treatment, should be used as little as possible.

125. Under the head of materials in Stock and advances, there is we fear a considerable sum which is not recoverable. Tramways were laid to two Quarries which proved to be useless, the stone being too soft. In so wild a country as the Godavery, the Engineer has a serious difficulty to contend with, in not possessing reliable information respecting the nature of the stone procurable; but a more careful examination should have been made before laying down Tramways.

Losses.

126. The miscellaneous charges are very heavy, and we have already in a previous para: explained that the system of obtaining laborers does not answer. At the 1st Barrier, the people have got accustomed to expect aid of all kinds, and it will be somewhat difficult to effect an entire change now; but still every opportunity should be taken by the Executive Officers to place the laborers on a footing more nearly corresponding with that which obtains on other Public Works. At the 2nd Barrier works, the ordinary plan should be tried of giving the people liberal wages, and trusting more to their coming to the works without other inducement. Experience has shown that it would be infinitely more economical to commence with a small beginning with a minimum establishment, than to attempt at once to collect a very large body of workmen.

System of recruiting should be changed.

127. The cost of the establishment employed on the works at the 1st Barrier has been most disproportionate to the expenditure on the works, and to the amount done, and

Unnecessarily large Establishment.

we would recommend an immediate reduction. At present it is as follows :—

1. Executive Engineer.
1. Assistant Engineer on the works.
1. Assistant Engineer in charge of workshops, Machinery and Tramway.
1. Sub-Engineer on the works.

Transport Department.

(*Exclusive of Officers on Steamers.*)

1. Superintendent.
1. Assistant Superintendent.

There are other Assistants in the Transport Department but as they are not stationed near the works, we have not included them.

128. The works now to be executed consist of :—

Completion of Anicut. A gap of about 1,000 feet in length to be closed.

Completion of short canal 2 miles in length, with its locks, one single and one double.

Blasting rocks to form clear channels in the river, to a distance of 12 miles from the canal works.

129. The difficulty of collecting a very large body of labourers is as great as ever, and considering the moderate number that is likely to be engaged, and the circumstance of the works, all being comprised within a space of a few miles, we are of opinion that the following Establishment should suffice exclusive of Overseers :—

Reduction recommended.

1. Executive Engineer.
1. Assistant Engineer.
1. Sub-Engineer.

Transport and Supply Departments.

1. Assistant Superintendent.

130. We have in another part of our report recommended that the blasting of the rocks in the bed of the River should be entrusted to Mr. deGrousilliers, of whose intelligence and zeal we entertain a very high opinion, and as he has already been engaged in the construction of the Anicut, and has a most thorough acquaintance, with the nature of the works now in course of execution on the Canal, we would further recommend that he be appointed Executive Engineer at the 1st Barrier, and that he should retain the general management of the Transport Department, which will now be reduced to the steamers on the River. In this duty he will have the valuable aid of Captain Barber, who has a thorough acquaintance with the navigation of the river. The Assistant we recommend under the head of Transport and Supply, will attend to the supply of grain for the work people under Mr. DeGrousilliers direction, and should reside near the works, instead of at Golagoodiem as at present.

131. This arrangement would enable Government to appoint Lieutenant Roberts, at present Executive Engineer, and one Assistant Engineer, to the charge of the 2nd Barrier works, where there are engineering difficulties which will call for a great deal of attention.

(Signed) J. C. ANDERSON LIEUT-COL.
Royal Engineers.

ROORKEE
27th June, 1866.

(Signed) J. G. FIFE, LIEUT-COLONEL.
Royal Engineers.

APPENDIX A,

NOTES OF JOURNEY UP THE GODAVERY RIVER.

1st. February 1866. Started at 7 P. M. from Cocanada in the "Fawn," a very small steamer 8 horse power, and drawing barely 2 feet of water—Proceeded by the Samulcottah Canal to Dowlaishwaram, which was reached at 2 A. M. 2nd February, Distance 39 miles. The Fawn's greatest speed, with steam well up, is only 6 miles per hour, and she very seldom does this.

2nd February. Started at noon and ran up the Godavery to Danputnum, which we reached at 8 P. M. distance about 30 miles by River. The stream at this season is generally from one half to three quarters of a mile wide, except at the shoals, where the sand banks reduce it to a few hundred feet. We grounded three times, but had little difficulty in getting off. The sand of which the bed of River is composed, is coarse and heavier than that of the Indus and Ganges, and at this season is subject comparatively to but little movement.

3rd. February—Started at 2 A. M. and ran up the gorge by moonlight to within 6 miles of Korda by 5 A. M. Afterwards put back to have a better look at the Gorge. River in places not more than 600 feet wide. Floods said to rise 60 feet above present level. Banks consist of Rock. Sometimes in solid masses running out into the River and contracting the Channel; sometimes in broken fragments of large size.

During the highest freshes, it is said present steamers on Godavery cannot pass up the gorge, owing to the velocity of current and tremendous eddies, very high freshes last 4 or 5 days and occur about 3 times during the monsoon.

Afterwards proceeded on to Korda which we reached at 10 A. M. Started again after taking in fuel, and got as far as Marrigoo-

dum by 7 P. M. Distance from Danputnum about 42 miles. Detained by Shoals at 3 places above Korda. The stream above the gorge is generally about 600 feet wide. There are a few detached rocks in the stream, which could be removed at a small expense. They are a source of danger when the River is somewhat higher than at present, as they cannot then be distinctly seen.

In passing mouth of Sibbree, River, took discharge of that River roughly, and found it to be 500 cubic feet per second, or 66,660 cubic yards per hour.

4th. February. Started at daylight but detained an hour at Shoals. Reached a point two miles above Gollagoodem by 3 P. M. and were then stopped by a very bad shoal. Distance run about 21 miles. The Shoals encountered during the day, the worse we had yet met with: met with detached rocks which endanger navigation.

5th. February. Took discharge of River at Gollagoodem, and found it to be 2,825·6 cubic feet per second, or 376,746 cubic yards per hour.

From 4th to 11th February, engaged in examining works at first Barrier.

12th. February. Resumed examination of River—in a row boat about 28 feet long 8 feet beam, and drawing only 10 inches of water. Started at 7 A. M. from Gongole, and pulled down with stream to the point where our examination in the Fawn terminated by 2 P. M. Distance 16 miles. Passed the rocks above Budrachellum, but not without some difficulty; also grounded on two shoals where the Fawn was stopped. Met with detached rocks below Budrachellum, some of which should be removed.

The Rocks above Budrachellum are very formidable, and in their present condition, render the navigation with loaded boats difficult and dangerous. During freshes most of them are sub-

merged and steamers can get up; at the low season small boats can find their way up and down; but it is difficult work—at all intermediate stages, the River may be said to be practicably unnavigable. The rocks are of all heights, and are studded about the River in such a manner as to prevent a fair channel being any where formed, at the same time that they permit the stream to find its way through.

From 12th to 16th February—examining works at first Barrier.

17th February. Examination of River resumed from head of 1st Barrier. Started at noon from Parnasala up stream in a row boat 28 feet long, 8 feet beam, flat bottomed. Draught with load 15 inches, crew not trained boatmen, but trained coolies. The greatest speed 3 miles per hour, but could not be kept up. Average speed through water about 2 miles per hour. Reached Managoor at 6 P. M. Distance 9 miles: with exception of ridge of rock about 7 miles above Parnasala channel very favorable. Shoals met with at two places only. The ridge of rocks is almost level and extends completely across the River. The stream was escaping over its whole length, and gave it the appearance of an artificial weir. Boat was unloaded and warped up.

18th. Fedruary. Started at 6 A. M. and reached Nadthera at 6 P. M. Distance 10 miles. Met with several shoals during the day. Met with rocks 8 miles above Managoor.

The stream through them was very strong; when there is more water in the River, there is no difficulty in passing this spot.

19th February. Started at 6 A. M, and reached Natlaguntapillee at 7 A. M. Distance 14 miles—met with bad shoals soon after starting; afterwards met with rocks, a few of which should be removed to afford an easier passage to laden boats. At noon

came to the Albaka rocks, they extend for about a mile, in which there is a succession of small shoots or rushes of water.

We warped up four of them and succeeded in rowing the boat up the remainder. There appeared to be about 8 feet perpendicular rise in the mile. The rocks are nearly all about the same height, and it would not be difficult to improve the passage through them. Except at the low season, the whole of the rocks are submerged, and boats or Steamers have no difficulty in passing up or down.

20th February. Started at 6 A. M. and reached Yedithelapillee 3 miles below Mungapeth at 6 P. M. Distance 11 miles—met with 3 bad shoals which detained us some time.

The channel is very wide at Mungapeth, below which the worst shoals occur, and the stream even at this season, is about 120 feet wide.

21st. February. Started at 6 A. M. reached Deodoolah at 7 P. M. Distance 12 miles. The navigation was good with exception of one shoal, as far as Tyoopettah. At that place there is a remarkable ridge of rock, like a low weir almost uniform in height, and stretching across the River, which it ponds up to a height of about 2 feet. We warped through a passage close to left bank. This passage might easily be improved. After passing the natural weir, we were detained by a shoal.

22nd February. Started at 6 A. M. and reached Enchampillee at noon. Distance 9 miles. The navigation of the River over this portion is excellent at this season. The Channel is narrow and deep with rocky banks, and the stream is hardly perceptible. But during the flood season the navigation must be attended with considerable risk, and the current must be exceedingly strong between Tarlagoodum and Enchampillee.

The Channel is also encumbered with rocks, and is not clear like the "Gorge" below the 1st Barrier.

During the day, examined the site of the proposed weir and locks. Rock generally good for foundations.

23rd February. Examined hill, where proposed Quarries are to be commenced. At 3 P. M. Started up River and got to Nilampillee, where there was a strong rapid. Distance 2 miles. The channel is a mere gap in the rocks the whole way. It is generally about 100 feet wide and very deep.

24th. February—Unloaded boat and warped her up rapid. Afterwards unloaded boat and pulled up to Sindoor rapid, over which we warped in a few minutes. Arrived at foot of Somnoor Fall at noon. Distance 4½ miles. The fall is about 12 feet, and the whole descent takes place on a few yards; unloaded boat preparatory to hauling her over the rocks and relaunching her above Falls. Observed, that the Idrawuttee River was contributing only 150 cubic feet per second.

25th. February. Examined site originally proposed for upper weir or anicut. The rock extremely hard.

26th. February—Started again at 8 A. M. up River and reached Annipilly by 6 P. M. Distance 10 miles. Met with rocks and strong stream at a few places within a mile of the Falls—some of the rocks should be removed to afford a clearer passage for boats. At about 2 miles above the Fall, the character of the river entirely changes again. The Channel is about 2 miles wide and the bed sandy. We met with shoals but had no difficulty in getting over them; they were however of greater extent than any yet passed over; near Annipilly, the river is narrower.

27th February. Started at 6 A. M. Reached a point about 5

10th. March.—To Chanda, a large town formerly; when under native rule a place of great importance, and fortified with extensive masonry walls. Examined the Wurda at Bularpoor. Channel well defined with steep banks, 500 feet apart. Rock running out into River from left bank, but not stretching across bed. Met Lieut. Sartorious, Assistant Deputy Commissioner, who gave us much information about the place.

11th. March.—Chanda.

12th. March.—Conferred with Major Lucie Smith, Deputy Commissioner of the district, on subject of the navigation works and road from Chanda past the third Barrier; also on the cotton trade and resources of the District. Major Smith shewed us some of the coal found in the bed of the Wurda and other places, extending over a space of about 25 miles, in the vicinity of Chanda.

APPENDIX B.

Memorandum on Storing water to increase the natural stream on the Godavery during the dry season, and to extend the navigation up the Wyne Gunga.

Major Haig, in a supplementary part of his report, dated 3rd. May 1856, para 202, mentions, that to maintain a sufficient depth of water on shoals in the Godavery for vessels of 3 feet draught, the quantity of water required, is 1,928,400,000 cubic yards. Major Haig however, admits that his observations on the River, are insufficient to allow of his being quite satisfied of the correctness of this, and from his description of the shoal on which the calculations were based, and from what Colonel Anderson and myself noted in passing up the river, I much fear, that the quantity of water required was greatly underestimated. The section of the stream on which the calculations were made, was in fact so deep, 4 feet, that we should not have called it a shoal at all.

2. In a subsequent report, dated 3rd. February 1862, nearly six years later; Major Haig writes as follows, extract para 39. "Much more careful and detailed measurements of the River "will be necessary, before we can be in a position to form "reliable estimates of the quantity of water required to "maintain given depths in the navigable channel." Major Haig afterwards in paras. 50 and 51, goes on to show what quantity of water would have to be added to the River's natural supply, to maintain the stream in a channel of assumed dimensions 5 feet deep. The result of the calculation is 4,089,200,000 cubic yards, or a little more than double the result first arrived at.

3. I have been unable to find in the records, any facts to support or upset either of the calculations, except in one instance, where, in a report, No. 467, dated 22nd October 1863, para. 11, on the 2nd. Barrier Works, the following passage

occurs:—"But I was not aware then of the great defects of "the open part of the bed immediately above that point "(top of the 2nd Barrier), defects which subsequent observa- "tion, has shown it to be most desirable to remove."—Major Haig adds that the River in this part "is impassable as early as the 1st. of October." Now, it is known that in that month, the stream in the River is far in excess of the quantity which Major Haig's highest Estimate even gives as necessary, and if there should be other shoals as bad or even half as bad, it is clear that the reservoir system is not so applicable as was supposed, or if the bad spots are very few, that some modification of the works now under consideration by Government, should be made.

4. It is not my wish to point out inconsistencies in Major Haig's reports. The calculations he gives are, as he tells us, merely approximations, and we should not be surprised at the varying results. What I am anxious to bring prominently forward, is the serious want of *certain* information, as to the depth of water on the shoals when the river is not flooded by the monsoon rains; and on this point, which vitally affects the success of the whole scheme for rendering the River navigable, I cannot help expressing surprise that with such a large Establishment of Steamers and boats on the river, so little should have been ascertained and recorded, during the ten years which have elapsed, since the regular investigation of the navigation project was commenced.

5. I would suggest, that no further time be lost in obtaining the necessary information. It is absolutely necessary to enable a fair opinion to be formed of the applicability of the reservoir system to this River, and I believe it to be most desirable also, in connection with the works now under consideration by Government. I may mention, that the result might lead to a material modification of the 2nd. Barrier works. A very bad part of the river was noticed during our late ex-

amination, several miles above the spot mentioned by Major Haig as "impassable" during October, and should that part be also impassable or even defective, while much of the river is in a good condition, it would be very desirable, in my opinion, to place the Anicut or weir at the *upper* end of the Barrier, where there is an admirable site for it, quite free from the constructive difficulty which occurs on the site at the lower end of the Barrier, and to carry a canal thence to below Enchampilly, where the navigation is safe at all seasons. A high Anicut at the upper end of the Barrier, would improve the navigation above it, for a very long distance, and the canal to below Enchampilly, would enable boats to pass this most dangerous part of the river (a contracted rocky Channel with a rapid current), with perfect ease and safety, during the monsoon, or whenever there might happen to be a strong stream running.

6. The result of such an examination of the shoals, might even lead to greater modifications, and to change in the ultimate treatment of the River. It might show that the reservoir system is quite inapplicable, and that in place of cutting passages through the rocky ridges or reefs above Parnasala and at Albaka, we should construct weirs upon them, and obtain slack water navigation over defective parts of the river. Such works, would doubtless cost more than the mere rock clearances; but their value would be great, and possibly they may prove actually indispensable to the proper success of the Godavery navigation. In such a river, which has already a considerable stream flowing, the effect of weirs would extend far beyond the mere level pond which is formed immediately above them. The bed of the river above each weir would be raised, its slope reduced, and the stream retarded. The depth of water would be increased, and this, without the draw back of the increased velocity of current, which is unavoidable with the reservoir system.

7. It will be time enough to consider the respective merits

of the slack water and Reservoir systems, as applied to the Godavery, when the information now so much needed is supplied; but there are some points of detail, on which I differ from Major Haig, and some which I concur with him; and I think it right to briefly mention them.

First.—The velocity of the Stream. Major Haig assumes that this will be proportional to the depth when the volume is increased, and I should concur with him, if the shoals were continuous and the depth of water uniform; but they are not so in reality. The stream runs with a varying velocity, as the water deepens or shoals. It does not in a natural Channel attain its full accelerated velocity, without again and again losing head or "charge", as it is sometimes called. The stream is continually starting down shoals and pausing in the deep spots. But directly the volume of water is increased, the want of uniformity in depth is diminished, and there is less variation in the velocity of current, which retains its full acceleration without such repeated losses of head. The effect is, that instead of starting from almost a state of rest at the commencement of a shoal, it approaches the spot with a high velocity, and glides rapidly over. In practice, the result will be, that the water when increased in volume will flow with greatly increased rapidity over shoals, without much increasing the depth.

Second. The cause of the shoals above 2nd. Barrier and their treatment. Major Haig considers, that the width of the River causes these shoals, and I so far concur, that I think the great width of the River is one of the causes. But there is another cause and I think a greater one, in the extraordinary manner in which the contracted deep channel of the 2nd Barrier, acts upon the River above. During Floods, the Barrier holds up the water to a great height, and thus slackens the stream, and causes the deposit of sand for a long distance up stream. But when the floods

subside, the deep channel at the Barrier draws the water rapidly off the comparatively shallow portion of them above, and leaves the navigation defective. The effect is not merely local, though it would be so at first, supposing such a phenomenon as an obstruction like the second Barrier, to be suddenly produced. In the course of time, the merely local sand-bank produces another above it, and the process continuous till there is a vast accumulation. Major Haig proposes groins for contracting the width of the River at the wide part; but I question whether this is an economical or satisfactory mode of dealing with the difficulty. If the river is contracted so as to deepen it, the reach above the shoal may suffer seriously. The stream when the river is low is not by any means wide at the shoals; it runs in a low level channel of moderate width, but has a great slope and velocity, and the best mode of dealing with this part of the River, in my opinion, is to raise a very high weir at the head of the Barrier, and thus prevent the escape of the water at a low level during the dry season. Major Haig would appear from what he says of the 2nd. Barrier works, to have been inclined to this view also; but he has since recommended a weir at the lower end of the Barrier only, the effect of which on the wide part of the River above, will be very slight. At the upper end of the Barrier the rock is remarkably hard, and there would be no difficulty in making the weir 30 feet or more in height above summer level. The top of the weir might be on about the same level as the bed of the River 20 miles further up, and its beneficial influence would extend for a distance of perhaps 40 or 50 miles up both the Pranheeta and the Godavery proper.

Third.—The loss of water by absorption in the River bed. I quite concur with what Major Haig has advanced upon this point. It agrees with all I have noticed of Rivers in the Dekhan, whose stream is constantly increased by springs in the

bed. In the rivers of upper India, whose beds are every where of pure sand of unknown depth, and where the substratum of the Country on both banks, partakes of the same character, the stream during the dry season has actually been found to diminish after the steep slopes and shingle at the base of the Hills are left behind; but those cases are not analagous to those of Rivers in a totally different formation and when, as far as can be ascertained, the substratum consists of Rock. The frequency with which rock occurs in the Godavery, and the manner in which the stream during the dry season is augmented as it flows onwards, leave no doubts on my mind as to the correctness of Major Haig's conclusion.

Fourth.—The sufficiency of the water which must be added to the Godavery, to render the tributary down which it will pass navigable. This cannot be conclusively settled till surveys have been made; but I am inclined to agree with Major Haig.

Fifth.—The comparative cost of the slack water and Reservoir systems. This cannot be properly determined without a survey and most complete information; but in Major Haig's sketch of the cost of the two plans in his report dated 3rd February 1862, I think the estimate is evidently much too high for the slack water, if that for the reservoir system is further. I observe that the cost of the Dams for the slack water is estimated as they all had to be built on sand, but there are rocky sites which may be taken advantage of to very greatly reduce the cost. Again, in fixing the number of, these works it is assumed that the water will stand nearly level from one dam to another; but this cannot be the case. The natural stream of the Godavery impeded as it would be by a series of dams, would itself afford a sufficient water section to float the Boats, and the Dams might be placed at much greater intervals than Major Haig allows. The loss by absorption of water which is urged against the system, is, I think, no more applicable to

this than to the Reservoir system. In the case of dams at intervals, the absorption of the water would take place most when the River is in flood, and there seems to be no reasons why the water should not be set free again, and return to the river in the shape of springs during the dry weather, especially immediately below each Dam. Indeed, it seems almost certain that the construction of a number of dams at intervals, would actually increase the River's stream during the dry season as they would retard and raise the water when in excess of the minimum supply and charge the springs. There are very large sums, 10 and 31½ Lakhs, allowed in the approximate estimates of the slack water and Reservoir system for traming walls, the necessity of which I do not perceive. These works appear to be quite distinct from the groins and rock clearances provided in this and other sketch estimates; so large an expenditure as 31½ Lakhs for traming walls in connection with the Reservoir system, would, I fear, if found indispensable, condemn the system, at least as far as the Godavery is concerned.

8. I have alluded to these points, because it is very necessary that they should be carefully considered when an endeavour is made to obtain more information respecting the river.

9. It is possible that the great variety of circumstances under which the river finds its way down the valley, may lead to the adoption of a system which is neither exclusively that of slack water nor of Reservoirs, but a combination of the two. The impression left on my mind, however, is very much in favor of the reservoirs which Major Haig so strongly advocates. Major Haig may have been much too sanguine at first and may still be so, but as his aim is to obtain 5 feet depth of water on shoals, while even 4 feet would in my opinion afford admirable navigation, if it can be obtained without a great acceleration of the velocity of stream, it may be found that the Reservoir system is still really the

best. Major Haig has mentioned that a body of water sufficient to make the main river navigable, will make the tributary down which it flows, also navigable; and if this should prove to be the case, it will tell greatly in favor of the system. He has also explained that the most expensive period of the year to maintain the navigation is in May and part of June, and that if for a short period at that time of the year, the navigation is closed, the quantity of water to be stored will be reduced by about one-half. This is most important, because it would allow of a gradual extension of the reservoir system, the financial advantage of which is evident.

10. Altogether, I think the system a most promising one, and I should deeply regret if Captain Haig's views did not receive the attention, it appears to me, they deserve. The value of the navigation may possibly be enhanced threefold by a moderate outlay on Reservoirs.—I will now proceed to speak of the Wyne Gunga, on two of the tributaries of which the Kunhan and the Pench, most promising sites for large reservoirs have been discovered.

11. Major Haig from the first, regarded the navigation of the Wyne Gunga, along with other branches of the Godavery as most important; but my attention was more particularly drawn to the Wyne Gunga by a remark made by the Chief Commissioner, in a report dated 23rd January 1863, on the Godavery and its feeders. In describing the different branches of the river and noticing the unnavigability of the Wyne Gunga, in its natural condition, Mr. Temple remarks, "this is a very unfortunate circumstance," and the statistical information given in other parts of the report, indicate why it is so unfortunate. The valley of the Wyne Gunga is fertile and populous, and it is almost destitute of means of communication with the coast to the eastwards; while to the westward, it does not possess the same advantage as the Wurda Valley in proximity to the Railway. Under the circumstances, I cannot but re-

gard the opening of the Wyne Gunga, as of greater importance than that of the Wurda, now that the Railway already passes through the valley of the latter, and that its opening is necessary for the proper development of the Godavery navigation.

12. From a memorandum forwarded by Mr. deGrouilliers, who examined the Wyne Gunga in October 1861, it appears that the Channel is rocky for the first 76 miles above its junction with the 3rd Barrier on the Pranheeta, and that there are several rapids or falls, whose total descent is about 60 feet. From the 76th mile to the 145th, beyond which the examination does not appear to have extended, the Channel is clear. Again, from a report on the Kunhan Reservoir by Mr. Hanna, Executive Engineer for Irrigation, it appears that the difference of level between the Kunhan, a branch of the Wyne Gunga near Kamptee, and the point where the Wyne Gunga enters the 3rd. Barrier, is about 438 feet, the distance measured along the course of the Rivers being 200 miles. The average fall per mile is thus 2·19 feet. But the slope of the Kunhan in the vicinty of Kamptee is 3·6 feet per mile, and from this it would appear that the slope, as is commonly the case, is not uniform, but is steeper in the upper part of the channel. The average fall of the Wyne Gunga itself, is therefore probably very much less than 2·19 feet per mile. Further, from the longitudinal section of the 3rd. Barrier, it appears that the point where the Wyne Gunga joins, is 28 feet below the top of the Barrier, and at a distance of 8 miles.

13. Now, if a weir of about 28 feet in height or rather more, were constructed across the Barrier at the point where the Wyne Gunga enters it, and if the Canal already under consideration for the 3rd Barrier, were carried thence to Mogellee, the foot of the 3rd. Barrier, we should secure the following important advantages:—

1st. The connection of the Wyne Gunga and Wurda navigation.

2nd. The shortening of the proposed 3rd. Barrier canal, by about 8 miles, and a reduction in the Lockage.

3rd. The overcoming of probably 20 out of the 60 feet perpendicular measurement of Falls and Rapids in the lower part of the Wyne Gunga.

14. It is of course impossible without a survey, to state how many weirs would be necessary to overcome the remaining falls and rapids on the Wyne Gunga; but as the river drains about the same area on the Wurda, and has apparently at least as great a slope of bed, the channel will probably be of the same moderate dimensions, and as the bed is of course rock where the falls occur, the construction of the weirs need not be a difficult or expensive matter. Experience in the Dekhan has shown that where the foundation is rock, weirs may be constructed of the roughest rubble, provided good mortar is used, and at rates which do not materially differ from those for ordinary walling, expensive work is unnecessary. There is also great latitude for the height of such works. The quantity of material required is not large, and where the rock may not promise to be hard enough to bear the direct action of the overfall, it is generally easy to meet the difficulty, by constructing a subsidiary weir immediately below the main one, and thus form a cushion of water between them for the overfall.

15. It is true that the placing of a weir at the confluence of the Wyne Gunga, would not benefit the Wurda, so much as if it were placed at the summit of the Barrier, 8 miles higher up; but the Wurda's bed is so flat immediately above the Barrier, that the effect of a weir placed on the lower site,

will extend a long way, and beyond this limit, a suitable site for another weir, where the Wurda is comparatively narrow, may be found. These remarks of course apply to the slackwater system on the Wurda. If a site for a reservoir can be found up its valley, the weir at the foot of the Wyne Gunga, would answer for both Rivers.

16. For the extension of the navigation up the Wyne Gunga, I will now refer to the surveys which have been carried out under the direction of the Chief Commissioner, for Storage Reservoirs.

17. From Mr. Hanna's report, dated 6th July 1863, on the Kunhan project, it appears that the contents of the Reservoir, up to the 110 feet level is 100,000,000,000 cubic feet, and that allowing 12,000,000,000 for

evaporation, there will still be = 88,000,000,000, cubic feet or 3,260,000,000, cubic yards available.

The deduction for evaporation is unnecessarily large, but till accurate plans are made, it will suffice to take the figures, as they are given.

18. The Gorge to be closed, is 6,000 feet wide, and greatest height of dam in centre, 120 feet. The subject of the waste weir is not alluded to by Mr. Hanna; but from what he says of the rock-cutting, necessary to liberate the water for distribution, it is concluded that facilities exist for turning the water over a rocky saddle. The area occupied by the Reservoir, or Lake as it might properly be termed, is 500,000 acres, and in this space, there are about 100 villages, containing 50 houses each, and occupied by about 10,000 people.

19. From these data and rates, which have been deduced

from works in the Dekhan, I have drawn out the following approximate estimate :—

		Rupees.	Rupees.
Earthwork in Dam,	...	$\frac{6,000 \times 60 \times 170 \times 2}{100} =$	12,24,000
Pitching slope of do.,	...	$\frac{6,000 \times 200 \times 3 \times 8}{100} =$	2,88,000
Waste weir, supposing circumstances favorable,	...	...	1,00,000

Regulating Arrangements.

Rock cutting,	...	...	...	...	...	1,50,000
Masonry,	...	...	...	...	...	50,000
Valves,	...	...	...	...	...	20,000
					...	18,32,000
Add, 20 per cent for Establishment and Contingencies,	...	...	...	...	...	3,66,400
				Total for works=		21,98,400

Add Compensation for Land and Houses.

For land, 2,50,000 acres (supposing one-half of whole area destroyed), at Rs. 1 annual rent and 20 years purchase,—5,00,000.		
100 Villages containing 50 houses each, at Rs. 160 for each house =	8,00,000	
		13,00,000
		34,98,400
Supposing that an earthwork Dam is not considered sufficient, and that masonry must be used, the addition would be,	... ...	6,00,000
Making altogether,	...	40,98,400
or say, 41 Lakhs =		41,00,000

20. The quantity of water available, after deducting for Evaporation is 3,260,000,000 cubic yards. The rate is thus 800 cubic yards nearly per Rupee. The general rate which Major Haig allows for storing, is 1,000 cubic yards per Rupee, and as the calculations are given above are approximate merely, and differ by one-fifth only from that rate, the result as far as can be seen at present, bears out what Major Haig has advanced.

21. I will now endeavour to estimate the cost of storing water on the "Pench" River. A minute, dated 2nd July 1864, by the Chief Commissioner, clearly describes the nature of this project, and it is unnecessary for me to do more than extract the dimensions, and arrange the items of the estimate in the same manner as in the preceding case.

22. The area of the Lake will be about 30 square miles, and the ground is at present occupied by a vast forest of ordinary jungle trees, which are of small value. There are only four Villages which will be submerged. The contents, of the Lake, up to the 120 feet contour are estimated

at	41,817,600,000	cubic feet
or	1,548,800,000	cubic yards
Deducting	111,100,000	cubic yards for evaporation, there
remains	1,437,700,000	cubic yards available. The loss by

evaporation has been taken at 8 feet perpendicular as in the former case,—as already mentioned the allowance is unnecessarily large, still the loss bears but a small proportion to the contents of the Lakes, and alterations therefore will not materially affect the result.

23. The Gorge to be closed, is 2,500 feet wide, and the Dam will be 130 feet high in the centre. The river bed is rocky, and it is concluded that facilities exist for the waste weir.

24. From these data, I have prepared the following approximate Estimate.

		Rs.
Earthwork in Dam.	$\frac{182 \times 65 \times 2,500 \times 2\frac{1}{2}}{100}$	=6,65,437
Pitching Slopes of Do.	$\frac{210+3 \times 2,500+8}{100}$	=1,26,000
Waste weir, ...		1,00,000
Regulating Arrangements, ...		1,20,000
Total Rupees		10,11,437
Add, 20 per Cent for Establishment and Contingencies, ...		2,02,287
Total for works Rs.		12,13,724
Add Compensation for houses and Land.		
For Four villages say		35,000
For Lands of Do.		35,000
Grand Total, Rupees		12,83,724
Supposing, as in the former case, that an Earthen Dam be considered insufficient, and that Masonry should be used also, there would be an addition of about		3,00,000
Making altogether Rs.		15,83,724

or say, 16 Lakhs of Rupees.

25. The amount set down in Mr. Temple's minute as the approximate cost, is 13 Lakhs. The excess over this in the Estimate I have given, is due to extra masonry work in the Dam, deducting this, the totals would correspond, though the details differ.

26. The quantity of water, available, after deducting loss by evaporation, is 4,57,700,000 cubic yards. The rate for

storing, therefore is 900 cubic yards per Rupee, which pretty closely agrees with Major Haig's rate.

27. The facilities for storing water, are very remarkable in both the Kunhan and Pench projects ; compared to one of the best Tank sites we have been able to discover in the Dekkan part of the Bombay Presidency, I find that the Kunhan reservoir has advantages in proportion of nearly 7 to 1. The rate for storing water in the Dekhan, being 114 cubic yards only per Rupee.

28. If the rate obtained from the Kunhan Reservoir be taken, 800 cubic yards per Rupee, the cost of storing 2,000,000,000 cubic yards, the quantity Major Haig mentions as necessary in his latest report for 10 months navigation, would be Rupees 25,00,000.

Now, if for this outlay, and some moderate addition for Weir and Locks to ascend the falls and rapids on the Wyne Gunga, an addition of 200 miles of navigation up the valley of that river can be obtained, and at the same time the Godavery itself can be rendered navigable for vessels drawing 3½ feet of water for 10 months in the year, the gain would evidently be immense, and it may be possible even to obtain these desirable ends at even a less cost, as Captain Haig speaks of preserving a depth of 5 feet, which is more than is necessary.

29. It is quite unnecessary for me to add more respecting the advantages of such an extension and improvement of the navigation, as they are already so well known by the Chief Commissioner, I will therefore now conclude by sketching out the arrangements which seem to me best suited for collecting the requisite information, to enable a correct view to be formed of the feasibility or otherwise of improving and extending the navigation by means of the Reservoir system.

30. I would suggest, that Mr. Hanna be requested to

prepare regular Plans and Estimates of the Kunhan and Pench Reservoirs, and also that he should make a general examination of other tributaries of the Wyne Gunga and of the Wurda, to ascertain whether still better spots cannot be found for Reservoirs.

31. I would further suggest, that an Officer of the Godavery establishment, be deputed to survey the Wyne Gunga at the conclusion of the present monsoon. The survey to consist of a line of levels down the river, properly checked by connection with Mr. Hanna's Levels and cross-sections, where it may appear necessary to construct weirs, to overcome the falls and rapids.

32. Finally, I would recommend, that opportunity should be taken during the present monsoon, to get the "Pewra" or some other small steamer of very light draught, over the 2nd Barrier; and that similar small steamers should be stationed between the 1st and 2nd Barriers and between the Gorge and the 1st Barrier; instructions being issued to the Transport Department, to run the steamers up and down at short intervals, and ascertain carefully the depth of water on the shoals, from September when the monsoon floods begin to subside; and to take cross sections and ascertain the discharge of the river by observed velocities, in the usual manner wherever bad shoals occur. I have suggested the employment of the small steamers for this purpose, as they afford good accommodation and shelter, but if they cannot be made available for the purpose, the examination may be conducted in the "accommodation boats." For a similar examination of the Wurda and Wyne Gunga, I would recommend that Mr. Thompson of the Transport Department, who has a sound practical knowledge of navigation, should be employed. He should be furnished with two light boats, one for the Wurda, and one for the Wyne Gunga, and should watch his opportunity whenever there may be a break in the monsoon, to pass down each river (the Wurda from near the junction of the Wunna, and the Wyne Gunga from Kampta, about 50 miles above junction of Kunhan), and note carefully the depth of water on all shoals, take cross-sections by measuring the depth at intervals, and ascertain the velocity of the current. In taking sections and the velocity of current, he should receive instructions from the Executive Engineer at Doomagoodiem, and he should be furnished with a watch with a second hand,—a half seconds pendulum, which could be made up in the workshops, would also be useful to him in case of accident to the watch. Mr. Thompson should make some marks on the river bank or bed, when he takes his sections, and note them carefully in his log book, that they may be identified after the monsoon, when the instrumental survey of the river is made. Mr. Thompson if possible, should time his journeys down the Rivers, so as to see them when the discharge is not more than 500,000 cubic yards per hour in the Wurda, and 1000,000 in the Wyne Gunga. He will probably be able to make two trips down each during the monsoon. One other examination after the monsoon is over, would suffice. In the logs kept on board the steamers or boats, all points affecting the navigation of the Channels should be entered, such as whether they are intricate or easy to get through, and what length of boat they will answer for; whether clear of rocks or not; whether there is more than one Channel and small islands or sand banks, or whether there is only one stream. The general velocity of the current should also be noted. The lead should be kept constantly going, and all soundings under 12 feet, carefully recorded with the date and locality. Gauges should at once be fixed at Golagoodiem below 1st Barrier; at Mungapett between 1st and 2nd Barriers; at Siroucha between 2nd and 3rd Barriers; at Ballarpoor near Chanda on the Wurda; and immediately below the junction of the Kunhan on the Wyne Gunga. All the gauges should be registered, morning and evening from the time they are put up, till the

conclusion of the survey. For the purpose in view, the G
ges are required in the open portions of the rivers, and
near barriers.

33. The information such an examination and survey
the Godavery will afford, would be invaluable. At pre
there is too little known of the shoals, and it is impossible
state with any certainty, what sized boats could navig
the river at the conclusion of the monsoon. The passage back
wards and forwards, of steamers between Doulaishwaram
Golagoodiem, the lower end of the first proposed long Ca
at the 1st Barrier, is no criterion whatever of the state of
navigation above. Between those two places, the river ha
advantages. The great anicut or weir at Doulaishwaram
benefits the lower portion, and the upper is all of moderate
width, while the volume of water is greater than it is anywhere
above. When Colonel Anderson and myself, passed up the
river at beginning of February last, we found we could not get
the "Fawn," drawing 18 inches only, more than about 2 miles
above Golagoodiem. There were shoals then, which had less
than one foot of water on them, and we actually grounded
twice, a few days after when passing down in a row Boat draw-
ing 10 inches only. I can only say, that I trust the survey will
show that bad shoals are exceptional, and that on the whole
the navigation is good.

(Signed) J. G. FIFE, Lieut-Colonel,
Royal Engineers.

Masoorie,
Dated 27th June 1856.

The above memorandum is signed by Colonel Fife alon
partly because the Government of India have expressed thei
intention of limiting the Godavery project for the present t
the opening out of the River, in the partial manner which co

be effected by means of its natural supply, without the aid
storage works; and partly because the information available, i
far too vague in my opinion, to allow of any reliable Estimate
being formed of the cost of such works.

I therefore forbear to enter upon the subject at all. I will
merely remark, that as the cost of the works already sanctioned,
is proving so much greater than the Government of India an-
ticipated, and as moreover the outlay still required to complete
them, is a matter of uncertainty, it appears to me in the highest
degree inexpedient, that the Government should be committed
to the construction of any works, which cannot be shown to
be indispensable for effecting the object which they have ex-
pressed themselves desirous of obtaining, and that only.

The only point which we have brought forward in the body
of the report, which does not come within the specific instruc
tions we have received, relates to the mode of dealing with
the 3rd. Barrier As the Chief Commissioner's preference of a
road round it, to a Canal; is based mainly on the uncertainty
of the cost of the latter work, we have ventured to suggest, that
the approximate cost should, if possible, be ascertained before
this portion of Major Haig's scheme be definitively abandoned
The reason for our recommending a Canal, instead of a road
are given in the body of the report. But even should Gov
ernment order the preparation of an Estimate for a Canal
and for the additional works required to carry the naviga
tion as far as Chanda, and should it be on so moderate a
scale as *apparently* to justify the expenditure, I would still
advocate the entire completion of the works at the 1st and
2nd. Barriers, and the clearance of rocks at other parts of the
River, before the 3rd. Barrier canal is commenced.

When the navigation is once open as far as Sironcha, and
the passage of boats up and down the river between that place
and Doulaishwaram becomes an established fact, the Go-

ernment will then be able to calculate with some degree of certainty, what improvement of traffic may be expected, from continuing the navigation to Chanda. Hereafter, good reasons may be brought forward for extending and improving the navigation still further; but such reasons must be based on the results of the works, which shall have actually been carried out.

The calculations of returns from the Irrigation works that were proposed in the Godavery and Kistna Deltas, were in the first instance, hypothetical, and the Government had not much confidence in them. An Anicut and several channels were, however, sanctioned and carried out, and a large increase of revenue, made a matter of fact. Government has thus the opportunity of feeling their ground, at every stage of further proceedings, and every additional work which was sanctioned, and which still further improved the revenue, served to engender a confidence, which nothing can now shake.

The Upper Godavery may be treated in the same way. If the works within the limits above recommended, yield satisfactory results, the Government will have facts to guide them to a conclusion, as to the merits of any extensions which may afterwards be recommended. If the results are unsatisfactory, they will not have been committed to a larger expenditure than was necessary, in a laudable attempt to develope the resources of a large tract of country.

(Signed) J. C. ANDERSON, Lieut.-Coll.
Royal Engineers.

Roorkee,
27th June, 1866.

(Appendix Nº 3).

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MINUTE

ON

COLONELS ANDERSON AND FIFE'S REPORT

ON THE

Godavery Navigation Project.

By R. TEMPLE, Esq.,

Chief Commissioner of the Central Provinces.

NAGPORE:

PRINTED AT THE CHIEF COMMISSIONER'S OFFICE PRESS.

MINUTE

BY THE

CHIEF COMMISSIONER OF THE CENTRAL PROVINCES.

By the letter No. 1221C of the Government of India in the Department Public Works, of the 14th December 1865, I was informed that Colonels Anderson and Fife would be deputed to examine and report on the Godavery project. After consulting with them, I was directed to submit their Report, together with my own observations, to the Government of India.

2. I had an opportunity of conferring with these Officers in March last, after their visit to the Godavery. But their Report was delayed by reason of their having been intermediately deputed to other duty, and it did not reach me till the 5th September: it was then in manuscript, and has had to be printed, together with this Minute. This will account for some slight further delay in the submission of the papers.

3. I now proceed to record my observations on their Report herewith transmitted, following the order of topics as brought forward by them.

4. Colonels Anderson and Fife preface their Report by a summary of their conclusions, which are replies to the main questions put by the Government of India. To each of these I will advert very briefly.

5. Conclusion 1 is that "rejecting the portion of the longer "line of canal at the first barrier, the works executed for the "minor project are sound and good, and likely to stand."

To this I have no observation to make, save that I do not altogether concur in rejecting the portion of the longer line of canal, for reasons which will be stated further on.

6. Conclusion 2 is that while the greatest zeal has been shown by Major Haig and his Officers, "the past management "of the works has not been successful or economical."

Hereon I would observe that the question put by the Government of India was whether the management had been successful and economical "considering the difficulties involved "in the undertaking." The above conclusion thus seems hardly to meet the latter clause of the question. Viewing the whole thing in the abstract, I should admit that the operations have hardly as yet been successful, and certainly not economical. But, "considering the difficulties involved in the undertaking," the Report goes to show that the works have been very fairly successful; and that though there has been a great and not altogether remunerative expenditure, yet there has been no disregard of economy on the part of the Officers engaged.

7. As regards the management of the works, the first conclusion, as already seen, declares the works executed at the 1st barrier to be good. Further on, the fifth conclusion states that the "works designed at the 2nd barrier will answer the "purpose intended." In a subsequent portion of the Report, para. 97, it is remarked, in reference to the anicut, the largest of the works, that it "cannot fail to be durable and inexpensive to maintain. The cement which is used on this and "the other masonry works is of the most excellent quality, far "superior to the mortar generally used in the other parts of "India." Again, in regard to the 2nd barrier design, it is observed, para. 108, that the "hydraulic cement prepared for "the Upper Godavery works is of so excellent a quality that a "concrete foundation of the kind we have described would be "superior to any rubble masonry that could be built."

8. As regards the economy or otherwise in the management of the works, it is shown in para. 94 of the Report that the work at the 1st barrier costs three and a half times as much as similar work in the Delta districts. But the para. 95 runs thus,—"We are far from attributing these heavy charges to a "want of economical management on the part of the Officers. "We believe that in Major Haig and the Executive Officers "generally, the Upper Godavery has been fortunate in having a "more than usually efficient engineering staff, and that the high cost "of the works is the natural consequence of the very unfavourable conditions under which they have been prosecuted."

Then there follows an account of those conditions, and para. 96 runs thus:—

"These causes are quite sufficient to account for the ex-"pensive style of the work."

9. In para 87, indeed it pronounced that "the tramways, on "which there has been an outlay, in all of about $4\frac{3}{4}$ lakhs, are in "the main unprofitable works." But in para. 76, it is said "Major Haig is not responsible for the expense on the tramways."

It is explained that these works were ordered by the Madras Government to meet an expected emergency, which did not actually occur, and were afterwards given up. They have been indeed useful in other ways, but not to an extent commensurate with the cost. Again, it is shown in many parts of Section 5 of the Report that there has been much expenditure on explorations and other preliminaries. But though this does indeed swell the total outlay, yet it cannot be set down to any want of economy. In para. 121, it is noted that plant and establishment are excessive for the actual work. In support of this (para. 124), there is said to have been too much machinery ordered from England—and the greater use of bullock power is recommended. This may be true; but the question is probably a moot one; and there may be doubts as to cattle power being obtainable in the manner suggested. Again, where the establishment is said to be excessive (para. 127), a revised establishment is proposed in para. 129, which gives a saving on the present establishment of one assistant Engineer, and one Superintendent of Transport. These reductions may be feasible, but still they are not considerable enough to show that the old establishment was excessively large. In para. 125, indeed it is shown that "tramways were laid to two quarries, which proved "to be useless, the stone being too soft." This must have involved a loss of perhaps half a lakh of rupees: and this is the only tangible instance I can find throughout the Report of any real failure in respect of economy. But then in the same para., it is justly observed that "in so wild a country the "Engineer has a serious difficulty to contend with in not pos-"sessing reliable information."

10. In para. 75 indeed, it is remarked that "if the "minor project for the 1st barrier is to be considered final, "it is much to be regretted that it was not submitted earlier;" for then much time, money, and trouble would have been saved. This remark, however just in itself, would not show any want of economy; for it really involves the question in respect to the relative merits of the major and the minor projects. First, Major Haig proposed a full and complete project, the execution of which he commenced. Afterwards, with a view to diminishing the immediate outlay, he proposed a lesser project, as a temporary measure only, while adhering to the superiority of

the first project. Colonels Anderson and Fife now propose to substitute altogether the minor project for the major. In this, however, as will be seen hereafter, they embrace questions of some difficulty, in respect to which some may differ (as I for one do differ) from the conclusions they arrive at. Thus the circumstance that Major Haig did not, in the first instance, propose and commence with the minor project, cannot be set down to any want of economy or management.

11. These observations are offerred to elucidate rather than to controvert the dictum of conclusion 2. I have recorded them in justice to the Officers employed on the Upper Godavery, who seem still to be worthy of all the confidence heretofore reposed in them by the Government of India.

12. Conclusion 3 is to the effect that works such as those now in progress or designed will afford navigation by steamers for four or five months in the year, and by boats during eight or nine months.

Hereon I have to observe that these anticipations are more favourable than any which I ventured to put forth in my Report of January 1863. In that Report the expectations did not exceed a period of five months in the year (*vide* paras. 118 and 122). But now Colonels Anderson and Fife themselves managed to get up the river over the greater part of the way to the 3rd barrier by steamer or boats—a distance of 125 miles by steamer, and 190 miles by boats—in the midst of the dry season. This naturally impressed them with the capabilities of the stream for navigation. Also since submitting my Report in 1863, I have examined the Mahanuddy. I have seen country boats toiling up and down midst shoals and sandbanks and rapids in a manner which would hardly be deemed possible by any, save those who had seen it. On the whole, I should be prepared to accept this conclusion, which is fully unfolded in Section 8 of the Report on the "Probable traffic by country "boats," with the [illegible]ration that too much must not be expected of these boats in [illegible] season, and that Colonels Anderson and Fife themselves [illegible] that during a portion of the eight or nine months only boats of very light draught will be able to ply. I have only to observe, in addition, how satisfactory it is to find that Officers of such experience and ability as Colonels Anderson and Fife entertain such hopes of the river, surpassing those formed by this Administration in 1863, when recommending the execution of the project now in progress.

13. Conclusion 4 is divided into two parts. The first part is thus put: "As regards the works at the 1st barrier, looking at the requirements of navigation for four or five months only, the anicut might have been dispensed with; but that in order to allow of boat traffic being carried on for several months longer its construction was necessary."

The above dictum is not so specific as to make me feel sure that I rightly apprehend it. And the subsequent Section 5 of the Report (paras. 90, 97, and 98) does not seem to throw any light on the meaning. If the original, or major, project of the barrier be undertaken with a long canal, then the anicut is admitted to be necessary. If the new, or minor, project only (as now recommended by Colonels Anderson and Fife) be undertaken with a short canal, still there must be an anicut. No canal from such a river as this can be led off, apparently, without either an anicut, or else some sort of head work equally costly. If, again, it be meant that for a four or five months navigation no canal need have been allowed, and that it would have sufficed to blast the rocks here and there, then I should decidedly consider that such navigation would not be safe nor continuous. It might be practicable during freshes—I myself went down on such an occasion, but was unable a few days afterwards to come back in the same manner;—but there would be dangers to vessels on any temporary subsidence of the water. Again, without an anicut how could the bad rocks alluded to in the Report be submerged so as to always let vessels pass over them?

So far, then, as I understand this part of the conclusion, I should be obliged to dissent from it.

14. The remaining part of the conclusion conveys a general approval of the designs and estimates for the 2nd barrier, as now submitted for approval of the Government of India. Hereon no remark seems necessary, save that it is very satisfactory to find this to be the opinion of such competent authorities as Colonels Anderson and Fife.

15. Conclusion 5 begins thus:—

"Before the communication can be pronounced effective, the "line of navigation should be carried on as far as Chanda."

This point is further discussed in paras. 8 to 19, inclusive, of the Report. It involves, of course, the execution of large works at the 3rd barrier, and also certain other works intermediate between that barrier and Chanda. Recently, also, a

despatch from the Secretary of State has been transmitted to me by the Government of India, whereby the prosecution of operations at that barrier appear to be decided on. The above part of the conclusion does not demand any lengthened comment. But I must observe that it either goes too far, or else not far enough. For though the probable maximum cost of works at the 3rd barrier, and thence up to Chanda, is not at all known (in the absence of designs and estimates), yet the minimum cost may be clearly apprehended. Colonels Anderson and Fife recommend (*vide* paras. 13 and 14) an anicut with a canal round the barrier. Now they justly observe in another place, paras. 69 to 72, that similar works for the 1st barrier (which includes a lesser distance) must cost 30 lakhs (exclusive of establishment). The original projectors always regarded the 3rd as the longest and worst of the barriers, and put down its cost at one-fourth more than that of the 1st. Thus we may be sure that the works at the 3rd barrier cannot cost less than 35 or 40 lakhs, though they may cost more. And still there are the works in the river near Chanda, which must amount to several lakhs more. Thus to open the navigation from the foot of the 3rd barrier to Chanda would cost more than 40 lakhs, or £400,000. As the Government of India are aware, the works at the 2nd barrier, already sanctioned, afford navigation to the foot of the 3rd barrier, 300 miles from the sea. The distance on to Chanda will be 70 more miles. Colonels Anderson and Fife now say that the navigation should be opened for the additional 70 miles. But this will cost 40 lakhs of rupees. And while fully acknowledging the importance of this section of the line, I should yet regard a proposal to expend forty lakhs of rupees, for seventy miles of navigation, as excessive. And this is one out of several reasons why I refrained in 1863, and do still refrain, from recommending this part of the scheme. No; if the works as far as Chanda are to be undertaken, we could not stop there; it would probably not be worth while for Government to proceed so far and no further. In that case, indeed, Government must be prepared for various other works, which would supply a further line of navigation above Chanda. And this principle indeed is prescribed in the Secretary of State's despatch above alluded to.

16. The second part of Conclusion 5 proceeds to recommend a further examination of the river and its tributaries. In this I quite concur; indeed I recommended this officially in 1864. The subject is more fully explained in a separate memorandum by Colonel Fife (*vide* Appendix II.), to which I will advert in another Minute.

17. Conclusion 6 is in this wise:—

"Excluding the portion of the estimate which relates to the "construction of a road from Seroncha to Chanda, the expendi- "ture contemplated is approximately sufficient for the scheme, "as at present defined by the Government."

It is, of course, very satisfactory to know that such is the opinion held by Officers with such good means of judging.

I have only to observe, that although in some parts of the previous correspondence this proposed road may have been mentioned as being from Chanda to Seroncha; yet the road recommended in my Report of January 1863, and sanctioned by the Government of India's despatch of July of that year, and since surveyed, is only from Chanda to Mogellee, at foot of 3rd barrier. The distance from Chanda to Mogellee is 70 miles, whereas from Chanda to Seroncha it would be about 120 miles. I have never recommended, and still do not recommend, a road being made all the way to Seroncha; but only to Mogellee. The above distinction is noted here, because, inasmuch as Colonels Anderson and Fife object to that road, partly on account of its cost, the difference, as above explained, is considerable.

18. The substance of Conclusion 7 may be thus extracted:—

"Government will not reap any considerable direct return "from the expenditure, but the general improvement of the "country, and the increase of trade, which will be induced by "the opening of the communication, will be sufficient to justify "the outlay."

In this I would express a general concurrence. In my Report of January 1863, indeed no expectation of immediate direct return was held out (*vide* paras. 56 and 100). Indeed there will not be any such return for the first few years. However, if the navigation shall be really well opened, there will be hundreds of boats, and thousands of tons of merchandise, within a comparatively brief period—and then tolls may be realized. Thus, ultimately, there will be a direct return. But when all that shall have happened, a large indirect return may be looked for with some certainty in the general increase of the public revenues. This was indicated in my Report of January 1863. Since then those anticipations have derived strength from experience. The revenues of the Seroncha District have increased about threefold in five years; those of the Chanda District (including local funds) have increased thirty

per cent. in the same period; those of the Nagpore country by fifty per cent. The trade returns, prepared by actual registration, for the Nagpore country during the past three years, show an increase of from 35 to 40 per cent. within that period. If all this happens without navigation, and without railways, what may be expected to happen when the country shall have been placed in the enjoyment of both these advantages?

19. Conclusion 8 is as follows:—

"The construction of the works at the 2nd barrier should be "carried out simultaneously with those at the 1st barrier."

In this I would express entire concurrence; and I would invite attention to paras. 100 to 111 of the Report, where the reasons for this are given.

20. In Conclusion 9 it is urged that the stock and establishment should be kept up at the lowest scale, compatible with efficiency—on which I have nothing to observe. It is then said that "supplies for the workmen at the 2nd barrier should be ob- "tained through the aid of the Civil authorities." In this I entirely concur; and would ensure the Deputy Commissioner of Seroncha doing all that might be possible. It is said further that "private stores should be carried (*i. e.*, by the "Transport Department) only so far as can be done with the "minimum of stock and establishment, as above recorded."

This accords exactly with paras. 127 to 129, inclusive, of my Report of January 1863.

21. The several conclusions having thus been severally touched upon, it is necessary now to proceed to the sections of the Report itself.

22. Section 1., paras. 1 to 21 inclusive, contains "Preliminary Observations." The substance is, that Colonels Anderson and Fife recommend works being undertaken from the foot of the 3rd barrier to Chanda; and consider that to make a road from Chanda to Seroncha would not, under the circumstances, be appropriate.

23. As respects the works from the foot of the 3rd barrier to Chanda, the main objection, on the score of expense, has been stated in the foregoing para. 15 of this Minute, and need not be repeated. In this section of their Report, Colonels Anderson and Fife say that—

"The completion of the project to the above limit (that is "up to the foot of the 3rd barrier, as heretofore sanctioned) "would probably be sufficient to justify the outlay contem- "plated" (para. 11).

Still they recommend that the work be carried on past the 3rd barrier to Chanda, because "the merits of the route would "then be put to a fairer test, and Government would be "able to obtain a better idea of the nature and extent of the "traffic" (para. 19).

I would admit most of these arguments; indeed they agree essentially with paras. 121 and 122 of my Report of January 1863.

But there remains the objection of expense, as already given, and the probability that when once Government undertake the works at the foot of the 3rd barrier to Chanda, they are virtually committed to several other operations.

24. But, in so far as the recommendation of Colonels Anderson and Fife comprises professional enquiry as to the possible works at the 3rd barrier and the river above, I would fully support it. Indeed in 1863-64 I did particularly advocate that the requisite engineering staff should be told off for this duty.

25. As respects the road from Chanda to Seroncha, it is shown that if the navigation be carried only up to Seroncha, a sufficient effect would not be produced on the country round Chanda, and that the line along the river bank would not be so good as a straighter line proposed by the Deputy Commissioner of Seroncha (Captain Glasfurd). All this may be very true; and indeed if such a road were really proposed it would be open to the above criticism. But it may suffice to observe that no such road has ever been recommended by this Administration or sanctioned by the Government of India. What has been recommended, approved, and surveyed (but not commenced), is not a road from Chanda to Seroncha of 120 miles, but a road from Chanda to Mogellee of 70 miles; and the things are quite different.

26. Referring to Mogellee, at foot of 3rd barrier, Colonels Anderson and Fife remark (para. 10) that "it is a wretched "hamlet in the middle of the jungle; it is very unlikely that "merchants would establish themselves there; and consequently "goods would be sent by land the whole way from Chanda to "Seroncha." This view is repeated too in para. 18. Now the above description is true enough as regards Mogellee as it

now is. But if it is to be argued that, therefore, Mogellee could not be changed and so improved as to be transformed, then I submit that such an argument is not entitled to any weight: for this description of Mogellee would be equally applicable to any place on the whole length of the Upper Godavery from Chanda to the Delta. What were Doomagoodium and Seroncha a few years ago but "wretched hamlets"? Yet now the former is studded over with European houses and workshops: and the latter has a Court-house, Jail, Barracks for native troops, and so on. As sites are on the river bank, there is no particular objection whatever to Mogellee. It has much culturable ground in its neighbourhood, and if selected as the head of the navigation, it would soon become what Seroncha and Doomagoodium now are. In fact, in para. 45 of their Report, Colonels Anderson and Fife look forward to extensive building yards for boats being set up at or near Mogellee. But in reality, any questions about a mere local site do hardly deserve a place in this discussion. The real question is, whether the navigation should commence from the foot of the 3rd barrier or not. If it should not, there is nothing further to be said. If it should, then Mogellee would very soon be improved as a site, in a manner befitting its new position, and would be quite as good a spot for warehouses and traders as Seroncha or any other place.

27. Section 2 of the Report relates to the "Probable traffic on the Godavery by steamers."

The substance is, that Colonels Anderson and Fife do not consider, judging from the experience of the Ganges and the Indus, that steam navigation on the Godavery is likely to be successful or remunerative; that the idea of having locks of sufficient size for steamers of any considerable beam or draught should be abandoned; and that the proposed dimensions of the locks, namely 200 feet by 30 feet, should be reduced to 150 feet by 25 feet, inasmuch as thereby a considerable sum of money would be saved. Under this view, they would only have a few "small steamers for conveying passengers and a very limited "quantity of valuable cargo" (para. 43)—such indeed as we now have for the use of the Public Works Department; but there would be no Tug steamers, and reliance would be entirely placed on country boats.

28. In support of this view, they note that the 30 feet breadth of lock was intended by Major Haig for steamers with stern-wheels, such as those used on American rivers: and that the Government of India sanctioned this dimension on the

understanding that suitable steamers of sufficient power would be found. But they urge that stern-wheel vessels might not suit the "currents" and occasional "whirlpools" of the Godavery (*vide* para. 25), and that side-paddle-wheel vessels might be too broad for a 30 feet lock, or rather that "side-paddle-wheel "steamers of 30 feet beam in all, would not have sufficient "power" (para. 25, towards the end). They then proceed thus, "Until the width of lock best adapted for steamers is decided, "the Government may be committing themselves to an expen- "diture which may prove ill-judged; the locks may prove too "small for the proper class of steamers."

Now I have always supposed, and still suppose, that Major Haig will be able to find steamers, or to get such made, which will be strong enough for the service required, and also pass through a lock of 30 feet breadth. The doubts expressed in the Report may or may not be well founded; still the point is one of fundamental importance; and I would fully endorse the opinion that there ought to be assurance, based on decisive enquiry, that the locks are really broad and long enough for the requisite class of steamers.

29. If, then, Colonels Anderson and Fife had stopped here, I should have been able cordially to agree with them. But they proceed (paras. 26 and 27), first, to suggest the alternative of having locks for country boats only, with the prospect of having steamers in the intermediate reaches. This would be open to manifold objections. The extra plant, stock, establishment, and the extra expense, would be such as to deter any private company, and would probably be more than even Government would bear. Again, if wanted for change or repair, how are the vessels to be brought backwards and forwards over the barriers? It is remarked indeed (para. 27), that "they could be taken over "the anicuts on the top of the freshes." But if they got down the river in this way, how would they return? The returning would be critical and uncertain. Indeed the remark above extracted seems an inadequate description of a business which would be really serious; as was indeed found to be the case with the small flotilla in 1862. It was an arduous operation to conduct those vessels over the barriers, even at the full flush of the floods. But it does not appear that Colonels Anderson and Fife actually contemplate such an alternative being adopted, for they go on in para. 29 to deprecate any expenditure being incurred for providing steam navigation on the Godavery, because "it is highly improbable that such traffic will pay."

30. In support of this view they give, in paras. 30 to 42 inclusive, much valuable and interesting information in respect to the Indus, and some considerations respecting the Ganges. The result may be summed up by the following extract:—

"Steam navigation does not pay well enough to enable it to "compete with the Railway on the Ganges; and on the Indus "pays barely five per cent. How can it be expected it can be "worked profitably on the Godavery"?

Now whether steam navigation on the Ganges has or has not answered all the hopes formed of it, still it was long carried on by Government; it was most valuable throughout the troubled years of 1857 and 1858. It is still carried on by private companies, notwithstanding that Railways run parallel with the river, both on the east and on the west. Surely its existence has been, and is still, reckoned as an element in the national resources. So with the Indus the steam navigation is surely considered an integral part of the system of communication. If it pays five per cent. now, private companies will be formed and obtain a larger return ultimately. Again, has it not always been the cherished hope of the Punjab Government to obtain powerful steamers with light draught for the five rivers?

31. I could not, therefore, recommend that when an outlay of a million sterling is to be incurred for the navigation of the Godavery, the Government should give up so important an adjunct as steamers, on the view of saving some items of cost in lockage.

32. The uses of steamers on the Godavery might be both commercial and political. The commercial use would be to tug up the river convoys of country boats freighted with merchandise, or else to tow flats, as is done on the Indus and the Ganges. One of the expectations of the advocates of the navigation project has always been, that as the river rose in June whole fleets of laden boats would run down in a few days from the Nagpore country to Cocanada on the sea coast; and thereafter boats would constantly be passing down the river while the rainy season lasted. In this manner, the great bulk of our exports would be carried away. This is what actually happens, and has always happened on our own Mahanuddy river on a lesser scale; and the same thing was expected to happen on the Godavery on a much larger scale as soon

as the navigation should be opened. Then, as these boats shall in great numbers have passed down stream with ease, they would return up-stream with difficulty. If they return while the water is high and the current comparatively strong, then they must either be towed from the banks or tugged by steamers. If the import trade should be valuable, then tugging might be resorted to. If tugs were not available, then the boats would have to wait for the tedious and laborious navigation of the autumn or winter months, and to labour up stream in the same way as boats now ascend the Mahanuddy in the winter and spring months. Some could afford to wait; others could not. Those which could not wait might be broken up for timber at Cocanada, in the manner which used to prevail with the Indus boats at Kurrachee. The possible exigencies of the export and import trade of these Provinces does not seem to have been fully adverted to by Colonels Anderson and Fife in their Report; but from the above brief sketch, it may be evident that steam tugs *may* play an important part hereafter on this river, and that it will at all events be prudent to make provision for employing them, should they be wanted. Or again, if it pays private companies to despatch steamers with flats up and down the Ganges, despite the competition of Railways on all sides, it may be remunerative for them to do the same on the Godavery, where there will be no competition of any kind.

33. Regarding the political use of steamers on the Godavery (which would appear not to have presented itself forcibly to Colonels Anderson and Fife), the following passage may be extracted from a memo. prepared in 1865 by Major Haig in England (page 48):—"The map shows that for 400 miles "the Govadery and the Wurdah form the dividing line between "the British territories on the north bank and those of the "Nizam on the south. I have shown that with light draught "steamers, the river only partially improved may be navigated "for the whole year. It will thus afford the means of delivering "a body of troops at any point, at any time, along the whole "of this length of frontier. Hyderabad is now only accessible "from the south-east and west, and in each case by road only; "on the north it is distant 400 miles from Nagpore."

All this is quite true. This right bank of the Godavery is near to the old haunts of the Rohillas. It has often been overrun by them in 1857 and other times of disturbance. In the event of any general trouble arising, it would have to be

well watched. Recently, on grounds of general prudence, Soroncha has been garrisoned by a detachment of Native troops. And that is the only military station between Chanda in the Nagpore country and Rajahmundry in the Madras Presidency, or between Hyderabad in the Deccan and Raepore in Chutteesgurh. If, then, the British Government is to incur a great outlay on the navigation of the Godavery, it seems but proper, indeed indispensible, to provide the means of despatching by steamers both troops and stores to such localities as those above indicated.

34. I would add that Colonels Anderson and Fife justly adduce (para. 30) "cheapness of fuel" as being in the favour of steam navigation on the Godavery; indeed it is difficult to imagine a line in any country possessing greater advantages in that particular than this river. In this way, steam navigation, if it came largely into play, would cause the overwhelming jungles to be gradually cleared, and the climate rendered more salubrious thereby.

35. The main reason why they advocate the relinquishment of all provision for steam navigation is, that some money would be saved by constructing smaller locks for country boats, instead of larger locks for steamers. Now what would the saving be? In para. 90 of the Report, they show that by reducing a lock from 200 feet by 30 to 150 feet by 20, there will be a reduction of cost from 235,000 rupees to 160,000 rupees, which represents a saving of three quarters of a lack, or £7,500, on each lock. This saving could be effected only on one lock (the tail) at the 1st barrier,—the head lock having been now finished on the sanctioned dimensions of 200 by 30 feet. At the 2nd barrier there would be perhaps 2 locks. If the works at the third barrier, and thence to Chanda, be undertaken we cannot yet say how many locks will be required; but there may be 3. Thus at the three barriers there might be 6 locks of contracted dimensions, and a reduction of three quarters of a lakh on each of these would represent a total saving of 4½ lakhs. Supposing the total outlay to amount to 100 lakhs, or one million, for all the three barriers, the saving would be under five per cent. Thus, according to the proposal of Colonels Anderson and Fife, provision for steam navigation would be sacrificed to save some 5 per cent. on the total outlay, and a valuable part of the project would be sacrificed for the sake of a comparatively diminutive saving.

36. Section 3 refers to the "Probable traffic on the "Godavery by country boats," and constitutes an interesting and valuable portion of the Report. Colonels Anderson and Fife show the great boat traffic which has arisen since the construction of canals in the Deltas of the Godavery and the Kistna; the "extraordinary increase" of trading craft on the Ganges; the recent expansion of water carriage on the Indus:—they apprehend that such a developement would not occur for some time on the Upper Godavery, but that something of the kind would ultimately occur; and they deem that "if similar results are obtained by opening out the "navigation of this river, the considerable outlay required for "the purpose will have been well laid out" (para. 54). Further, they anticipate "that the bulk of the regular up and "down traffic (by country boats) would be confined to the "period comprised between 15th September and the end of "February; and for the smallest class of boats to a somewhat "later date, or in all about six months. For about half that "period the draught of boats would be limited to 2 feet on "the average, if not less" (para. 45). They add, too, that, "except during the freshes, the current of the Godavery is "very much slacker than that of either the Ganges or the In"dus," and "its channel is infinitely less variable" (para 59).

37. These anticipations are more sanguine than any which were held out in my Report of January 1863. Still, the above dicta are in the main very satisfactory to this Administration. The only expression in which I should not quite concur, is that which implies that the boat traffic would be *confined* to the period between September and April. It has been seen from the preceding para. 32 of this Minute that we have heretofore looked to large number of laden boats going down-stream in the monsoon season. In their para. 45, indeed, Colonels Anderson and Fife do contemplate the last-named class of traffic; for they say "If boats were ready with a cargo at the "foot of the 3rd barrier, they could make a trip down the river," and thus "a considerable traffic might be carried on during "the freshes at a very insignificant cost of transport." This is no doubt very true; still they seem hardly to have attached sufficient weight to this very important circumstance, because they remark that "the three months, from 15th June to 15th "September, are the most unfavourable period of the year for "ordinary boats." This remark is only applicable to the up-stream trips. For the down-stream trips this season would be the best possible.

38. In this Section (para. 55) Colonels Anderson and Fife, when considering generally the prospects of trade in the country of the Godavery, advert to the revenues of the Central Provinces, which they observe to have risen from 85½ lakhs to 90½ lakhs. This is exclusive of local funds, which, as explained in the Administration Report for 1864-65, really form part of the public income. With these the total income of these Provinces will be 120 lakhs for the current year 1866-67. But in reality no such calculation can really be of service in solving the Godavery problem, for these figures refer to the *whole* of the Central Provinces; of which the northern districts, comprising the Vyndian region and the basin of the Nerbudda, have no concern or interest whatever in the Godavery. Therefore, any sort of calculation depending on aggregate statistics of the whole Central Provinces would be much too favourable to the Godavery project. The country really interested in this project is that of Nagpore Proper, primarily; and secondarily, that of Chutteesgurh; as explained in my Report of January 1863. But if the Mahanuddy shall be opened, then most of the Chutteesgurh trade would tend towards that river. Now the revenues (including local funds) for the country of Nagpore Proper stands for 1865-66 at 44½ lakhs (£445,000), and for Chutteesgurh at 11 lakhs (£110,121).

39. Sections 4 and 5 relate to the 1st barrier project, the past expenditure, the works now in progress, and those proposed. These Sections may be conveniently treated of both together.

40. It will be in the recollection of the Government of India, that for the navigation at this barrier there are two projects—the major project, originally proposed by Major Haig, and now being proceeded with, involving a canal of twenty miles from Doomagoodium to Golagoodium; the minor project, proposed subsequently by Major Haig, as a *quasi* temporary work, to save immediate expense, involving a canal of five miles from Doomagoodium to Gongole, together with blasting of the rocks in the river bed for some distance below the last named point. Colonels Anderson and Fife advise that the major project be relinquished, and the minor project only carried out. I regret that I am unable to support this advice.

41. Colonels Anderson and Fife base their recommendation, as above, upon grounds, not of efficiency, nor of suitableness of the works to the future navigation, nor of engineering propriety, but solely on reasons of expense. They explain (in para. 69) that Mr. Schmidt's estimate for the major project amounts to 30 lakhs of rupees (exclusive of establishment); that Major Haig's revised estimate amounts to 18 lakhs; but that Mr. Schmidt's "estimate probably represents the "outlay required to carry out the project with a nearer "approach to accuracy than that prepared by Major Haig" (para. 72). Then they say (same para.), "Had the revised "estimate prepared under Major Haig's instructions been "sufficient to carry out the long canal in a satisfactory manner, "we should not have hesitated to recommend it in preference "to the short canal, combined with blasting operations in the "river, as being the most complete and certain of the two "projects."

42. Now they show (para. 93) that the minor project will cost, inclusive of work already done, Rs. 16,82,426, or seventeen lakhs. To this, however, must be added the sum of upwards of 2½ lakhs already spent on the long canal of the major project, which would be thrown away in the event of the minor project only being adopted. So that the total cost, in justice to the comparison with the major project, must be set down at nearly twenty lakhs. But while the estimate of thirty lakhs for the major project is a tolerably certain one (so far as anything like certainty is attainable at all), there is one particular element of uncertainty in the above estimate for the minor project. In discussing this last-named estimate (para. 92) Colonels Anderson and Fife remark:—

"To this must be added the cost of blasting operations in "the river, of which we can form no estimate that can be "relied on; but we imagine it will exceed 50,000 rupees, "and may rise to a lakh."

43. In para. 73 they very justly point to the difficulties of this blasting, as "the operation is one that will need great "judgment," and one that "if carried beyond the proper limit "would have the effect of bringing rocks to light which had "been submerged, and of increasing the current as well as the "obstructions at the rapids and shoals higher up."

All this coincides exactly with what I learned when examining the Mahanuddy in 1868. There, also, the obstructions are caused by rocks, which it was once proposed to remove by blasting. But this method was deprecated by the Government Superintending Engineer, Mr. Armstrong, and

was rejected by Colonel Rundell, the Chief Engineer of the Orissa Irrigation Company, and in consequence of this a canal was proposed. It may be remarked, too, that in the earlier projects for the Godavery, when the efficiency of this a canal gation was mainly regarded, the Engineers thought of canals, and rejected the blasting plans. This view, as I believe, pre-vailed up to 1863. It was when the estimated cost rose high, and considerations of expense became so pressing, that blast-ing began to find some favor.

44. In the case of the 1st barrier, therefore, it will be well, if possible, to avoid having recourse to blasting. It is true that we propose to adopt this method at the 2nd barrier, and perhaps we may have to try it at the 3rd barrier, and no reason why it should be adopted at the 1st barrier. But that is the contrary, knowing the objections to blasting, it were pre-feable that we make quite sure of the 1st barrier by having a canal there, if that be reasonably practicable.

45. If, then, the minor project recommend itself only on the score of saving outlay, it is to be noted that thirty lakhs is the estimated amount for the major project, and twenty lakhs for the minor (establishments being excluded in both cases); though the thirty lakhs does seem to be a maximum; while the twenty lakhs may be exceeded, owing to the doubtfulness of the blasting. The saving, then, may amount to ten lakhs. Is this saving so great, in relation to the total outlay on the whole scheme, which must ultimately amount to a hundred lakhs, or a million sterling, as to induce the Government to abandon a major project admitted to be "more complete and certain"— which, too, has already far advanced—in favour of a minor project of an inferior character respecting efficiency, and at least one point of uncertainty respecting cost?

46. I would submit that inasmuch as the major project does agree in its principles with the proposal of the eminent officers who first projected the general scheme,—as it is pre-ferred by Major Haig, by Mr. Schmidt, by Mr. Isaac; as it is pronounced by Colonels Anderson and Fife to be the more complete and certain scheme; as it has been commenced and has far advanced, so that, besides the head-work, there have been twelve miles of canal done at a cost of 2½ lakhs, all of which would be thrown away if the project be changed,—I would recommend that the major project be completed at the full estimate. Doubtless, the difference in cost (10 lakhs) is

considerable; but still with operations of such magnitude, it re-presents a proportion of not more than one-tenth. Doubtless a portion of perfect efficiency has sometimes to be given up, when the outlay proves excessive. But in a case like this, where Government has determined on a large outlay, it were apparently preferable to do the work *well*; to have, what Colonels Anderson and Fife term, "a complete and certain "work;" and not to sacrifice efficiency in order to save a pro-portion of the outlay of not more than one-tenth. In other words, I doubt whether the saving is large enough to justify a departure from the most approved designs on an occasion like the present.

47. Supposing it be thought that if the minor project only be completed now the major project could be added on hereafter, should necessity be practically demonstrated, I would submit that such a course would not be likely to prove satisfactory to Government. If *after* a work had been finished with a heavy outlay, it were proposed to add another fifteen miles of canal, such a proposition would surely be discouraging, and would give rise to the idea that there was no finality in the works. It would seem better to avoid, if possible, second-rate measures, and to follow from the first those plans which are seen to be the best according to our engineering information.

48. In para. 70 of the Report, there is this passage :—

"Further he (Major Haig) considered that the shorter "(*i. e.* the minor) project would be necessary in any case, as "the navigation by the canal to Golagoodium would be liable "to occasional interruption from breaches in the embankments "during extraordinary high floods."

To this it may be replied that if the full project, as estimated for by Mr. Schimdt, and supported by Mr. Isaac, and as origi-nally designed by Major Haig himself, be adopted (as I would propose that it be adopted), then the minor project would not be required as an adjunct to the major.

49. In para. 75 of the Report, Colonels Anderson and Fife observe to the effect that if the minor project had come under the consideration of Government at the outset, some time and money would have been saved, and some sort of channel, though not the best, might by this time have been opened. This may be correct, though open to the qualifications as explained in the foregoing paras. The fact is, however, that

the major project is the one approved by all the Engineers, including Major Haig. And as they had a general authority to proceed with the work, they naturally worked upon *that* project. The minor project was subsequently and intermediately suggested by Major Haig merely as a temporary measure, and with a view to saving of immediate outlay (*vide* Major Haig's letter to the Secretary to the Chief Commissioner of the 16th November 1863).

50. In their paras. 94 to 97 inclusive, Colonels Anderson and Fife very justly note the high rates of charge for work at the 1st barrier, and correctly explain the main causes thereof. This matter having been already adverted to in the preceding paras. 8 and 9 of this Minute, need not be dwelt on here. To some extent, these high charges may prove unavoidable even in the future works at the other barriers. But endeavour will be made to effect some economy by employing the aid of the Civil authorities to obtain workpeople and to provide supplies of food and other necessaries for the gangs.

51. Section 6 of the Report relates to works at the 2nd barrier, and comprises professional criticism on the plans proposed by Major Haig. Colonels Anderson and Fife express general approval of these plans, with certain modifications and additions. I have no observations to offer, save that this criticism seems to be very sound and useful.

52. In para. 104 they observe that some charges may possibly be largely reduced in the case of the 2nd barrier works especially, if the Deputy Commissioner of Seroncha can induce merchants to establish shops to supply the workmen with food. Every effort, if needed, shall, of course, be made by the Civil authorities for this purpose.

53. Section 7 of the Report refers to "Improvements to the river bed between the barriers." In the previous estimates (of a general character) for these works, groins were included. Colonels Anderson and Fife now "deprecate any outlay whatever for groins." On this I have no remark to offer.

54. Section 8 of the Report contains "general remarks on expenditure." A very good classification of all the past expenditure is given in para 121, on which I have to remark

as follows. It thereby appears that the total expenditure from the outset in 1853 to the end of 1865 has amounted to 28½ lakhs of rupees, or £280,000. Of the above, 4½ lakhs have been spent on the tramways, which are pronounced to be for the most part "unprofitable works" (see para. 87). This is no doubt true, though the tramways have been of some use at times. As the Government of India will remember, their abandonment was recommended in my Report of January 1863. Their construction must be attributed to the urgency of the anxiety which was naturally felt in 1861, both in England and in India, for the immediate opening out of routes for the transit of cotton from the interior to the coast.

55. The cost of actual work may be sent down thus:—

	Lakhs.
Actual work in canal and river bed ..	8¾
Recruiting, hutting, &c. (of labourers) ...	2½
Materials, &c.	1¼
Total ..	12½

For this, it may be asked, what is there to show? There is indeed much to show, though not perhaps quite so much as there ought to be. There are a massive anicut or dam right athwart the main stream of the river; a large lock for steamers; some scouring sluices; some twelve miles of canal; some blasting and other work in the river bed. If even for the above considerable outturn of work, the cost, as abstracted, seems high, it is to be borne in mind that these structures are raised, not in an inhabited part of the country, but in a remote and desolate part, whither labour and stores and materiel, and even food for the workpeople, have to be transported from a distance.

56. But the 12½ + the 4½ lakhs only amount to 17 lakhs, leaving a residue of 11¼ lakhs out of the 28½. How then has this residue been expended? Of this, 1¼ lakhs have been expended on boats and steamers—and the small flotilla is still on the river; and some 2½ lakhs on tools, plant, and machinery—all which is still in the yards and sheds. There has one lakh been spent at Doomagoodium, the head-quarters of the engineering staff, in this way,—"station improvement and accommodation for establishment ¾ lakhs; buildings for grain and transport Department ¼ lakh; in all one lakh. And there are sundries to the amount of ¾ lakh. The above items aggregate 5 lakhs. This expenditure really represents the setting up, so to speak, of the general

been thrown on things previously unknown; that foundations, broad and deep, have been laid; and that the opposing difficulties have been to a large extent measured, and to some extent surmounted. But besides the actual outlay of treasure, there has been a sad expenditure, of what cannot be exhibited by figures, namely human stamina and energy. When it is remembered how many talented and gallant men have within the last few years served on these works, have faced the inclemency of the climate and country, and have been constrained to depart in shattered health,—then the entire cost, in the higher sense, of this great project can be appreciated.

These remarks are meant to explain, rather than to justify the high rate of expenditure. This rate is indeed becoming so high as to necessitate the strictest economy, for the furtherance of which this Administration will always do its best.

58. The general establishment, and the amount of plant, machinery, and the like, are deemed to be too high in para. 127 of the Report. There does not seem, however, to have been any undue strength of engineering establishments, especially when the insalubrity of the country and the difficulty of repairing losses and casualties are considered. There may have been too much of establishment in the transport agency; but that department was a peculiar one. By mention of the large amount of plant, allusion is made to the purchase of machinery. This point has been adverted to in the preceding para. 9 of this Minute. The general remarks in this section, however, will be useful for the further enforcement of economy.

59. In their 126th para., Colonels Anderson and Fife remark that "every opportunity should be taken by the "executive officer to place the laborers on a footing more "nearly corresponding with that which obtains on other public "works. At the 2nd barrier works, the ordinary plan should "be tried—of giving the people liberal wages, and trusting more "to their coming to the works without other inducement."

I quite acknowledge the truth of all this; and at the 2nd and 3rd barriers effect may be given to this view. But still it may be observed that at the 1st barrier, unless the engineers had recruited their working gangs, by a special agency, in the Coast districts, and then conveyed the men to their destination, and when there, fed and lodged them,—thereby adding much to the cares and troubles of the Administration,—the

execution of these fine structures at the then stage of the operations would not have been possible in so wild a country. But it is a method only to be adopted under pressure of necessity, and to be altered or given up as soon as practicable.

60. After Section 8, just noticed, which is the concluding Section of the Report, there follow two appendixes. Appendix A contains Notes of a journey up the Godavery River. This is highly interesting, but does not demand comment here, except, perhaps, to observe that it is satisfactory that Colonels Anderson and Fife were able to proceed so far up the river, with comparatively so little difficulty, at so dry a season of the year.

61. Appendix B is a memorandum by Colonel Fife alone, "On storing water to increase the natural stream on the Godavery during the dry season, and to extend the navigation up the Wyngunga." The remarks about storage seem to be generally sound. There has indeed been much generalizing already on this subject. The particular and practical question is, and has for some time past been, this—*Can* suitable sites be found? I have for the past two years been causing professional search to be made, and no site suitable for the river above the 3rd barrier has been found. For the river below that barrier there are really remarkable sites for storage. These were fully adverted to in my Minute on the river Pench Reservoir in 1864. Colonel Fife's remarks on the Wyngunga River touch upon a very large subject, which I will endeavour to treat in a separate Minute.

62. In his para. 10, Colonel Fife remarks:—

"I should deeply regret if Major Haig's views (in respect "of storage of water in reservoirs) did not receive the attention "they deserve."

In point of fact, these views *have* received such attention from the Administration. For during the past three years an engineer of special qualifications (Mr. Hanna) has been employed in searching for sites for reservoirs, and two, if not three, first-rate sites have been found and reported on.

63. Colonel Anderson, adverting to Colonel Fife's Memorandum, observes that it is not necessary to discuss any extension of the navigation project to the affluents of the Godavery. I do not quite follow him here, because it seems that if

work at the 3rd barrier be undertaken (and virtually Colonels Anderson and Fife do in their 20th para., Section 1., recommend this), then the navigability of the Wyngunga ought to be taken into consideration.

64. He then goes on to remark as follows :—

"I would still advocate the entire completion of the works "at the 1st and 2nd barriers, and the clearance of works at the "other parts of the river, before the 3rd barrier canal is com- "menced. When the navigation is once open as far as "Seroncha, and the passage of boats between that place and "Seroncha becomes an established fact, the Government will "then be able to calculate with some degree of certainty what "improvement of traffic may be expected from continuing the "navigation to Chanda;" and again, "If the work within the limits "above recommended yields satisfactory results, the Govern- "ment will have facts to guide them to a conclusion as to the "merits of any extension that may be recommended."

This passage may be deemed hardly to consist with Section 1 of the Report, which at first sight seems to convey a recommendation for extending the navigation up to Chanda. In para. 12, Colonels Anderson and Fife say that "the "formation of a line of water communication from Seroncha to "Chanda should not be definitely abandoned, until it can be "ascertained for certain whether or not it is really practic- "able at a reasonable cost."

That sentence, perhaps, hardly involves an actual recommendation. But further on para. 18, after pointing to the advantage of "selecting Chanda as a terminus for the navigation," they proceed thus :—"If the arrangement we have "recommended be found worthy of execution, the merits of "the Godavery route would be put to a fairer test." And in para. 20, thus, "Should these views be accepted, the "river will be rendered navigable for five months in the "year," * * "from the Godavery to Chanda boats could ply "throughout the year. The total length of the line of navi- "gation would be 400 miles, divided as follows :—

"Cocanada to Dowlaishwaram	30	miles.
"Dowlaishwaram to foot of 3rd barrier	285	"
"Canal round barrier	30	"
"Wurdah to Chanda	55	"
Total.....	400	

Again, Conclusion 5 in the Introduction to their Report (already noticed) is of the same tenor.

Now all this does seem distinctly to imply a recommendation for extending the navigation to Chanda, and so I have treated it in the preceding paras. of this Minute.

65. Be that as it may, however, the passage last extracted from Colonel Anderson's Memorandum, to the effect that the 1st and 2nd barriers should be done first, and the 3rd barrier and works beyond that should be kept apart to be, or not to be, taken up afterwards has my entire concurrence. This indeed substantially accords with para. 122 of my Report of January 1863, which for facility of reference is transcribed below :—

"Thus the opening of the navigation to the foot of the "3rd barrier would, at an expenditure of half the aggregate "sum ultimately required, secure at least a part of the advantages "of the entire project. This moderate expenditure would, so "far as it goes, be remunerative. It would also apply a definite "practical test to the whole project, and would show conclu- "sively whether it would or would not be expedient to proceed "with the remainder of the work. Moreover, it seems especially "desirable that the efficiency of the work on the 1st and 2nd "barriers should be ascertained before the works on the 3rd "barrier are undertaken. To all this it might be answered, "that to leave the works of the 3rd barrier undone, would be to "forego a part of the benefit which would otherwise arise from "the works of the 1st and 2nd barriers. This is so far true, "inasmuch as the river would obtain a larger traffic if the 3rd "barrier were open, than if it were not. But then it may be "better to execute works regarding which there is a compa- "rative certainty, and which will secure a moderate benefit, "rather than to undertake further works of a less certain "character, in the hope of securing a larger benefit."

66. The only point of detail to be added, is that whereas Colonel Anderson contemplates that the opening of the 1st and 2nd barriers would afford navigation up to Seroncha, I say that navigation would be afforded to a point beyond Seroncha, namely to the foot of the 3rd barrier. And as that brings the navigation so near to Chanda, it would be well to open the land route on to that place. With this view I proposed in 1863, and the Government of India sanctioned, the road from the 3rd barrier to Chanda at a cost of about 7 lakhs of rupees.

If Colonel Anderson's opinion as last quoted find approval, then I still urge that the above section of road should be opened, and improved at least, if not actually made. Otherwise the opening of the 1st great section of the navigation, from the coast to the 3rd barrier, will not get the Chanda traffic, which might fairly be gotten, and the project will not have, so to speak, quite a fair start. In 1863, when this road was sanctioned at a full outlay for construction, the opening of the 3rd barrier and onwards was regarded as distant. But since the receipt of the Secretary of State's Despatch of February 1866, it seems that the 3rd barrier will after all be undertaken, and that its commencement may be nearer than has been heretofore supposed. Looking to this then, I could hardly now recommend a full outlay for construction of this road. But still, regarding it as of much subsidiary importance, I would propose to improve it and make it passable for country-carts as a fair-weather track. Thus laden carts would be able to take produce during the dry months down to the 3rd barrier, which produce would be shipped on board the boats as soon as the river had risen. If then (the former proposal of seven lakhs being abandoned) one lakh of rupees were placed at the disposal of this Administration, the road could be rendered practicable as described. The line has already been surveyed and indicated by bench-marks, and the Company of Sappers in orders for Seroncha might be employed on the work during the ensuing cold season.

67. The Report by Colonels Anderson and Fife having been thus reviewed, the main recommendations on my part, which have been elicited thereby, may be thus summarized (details being omitted) :—

1st.—That the canal from Doomagoodium to Golagoodium already in progress at the 1st barrier be completed according to the designs and estimates prepared by Messrs. Schmidt and Isaac, according to Major Haig's original project.

2nd.—That if the major project, above described, be carried out, the minor project canal, from Doomagoodium to Gongole, with blasting in the river bed, will not be required.

3rd.—That the works at the 2nd barrier be sanctioned on Major Haig's designs, as modified by Colonels Anderson and Fife.

4th.—That the works at both the 1st and 2nd barriers be prosecuted simultaneously.

5th.—That at the 1st and 2nd barriers (and at the 3rd barrier also, if that shall be taken in hand) the locks be of such dimensions as will admit steamers of sufficient size to tug convoys of boats and transport troops and stores.

6th.—That the road from the foot of the 3rd barrier to Chanda, already sanctioned by the Government of India (in 1863), be only opened as a fair-weather line at a cost not exceeding one lakh of rupees, instead of being regularly constructed at a cost of seven lakhs.

7th.—That a sufficient engineering establishment be deputed at once to prepare a design for the opening of the 3rd barrier, such design to be compatible with the future navigation, not only of the Wurdah, but also of the Wyngunga.

68. Finally, in submitting the Report by Colonels Anderson and Fife for the consideration and orders of the Government of India, I would observe that though I am not [illegible] to agree with all the conclusions and recommendations by those officers, I am fully sensible of the value of the information and suggestions which they afford. Indeed I believe that their Report to have been drawn up with discrimination, impartiality, and with moderation, and that the care and completeness with which they have fulfilled a difficult duty will be found deserving of every commendation.

NAGPORE:
The 11th September 1866.

R. TEMPLE.

(Appendix No 4)
122

MINUTE

ON THE

RIVER WYNGUNGA AND ITS AFFLUENTS:

THEIR

NAVIGABLE CAPABILITIES;

THE

RESOURCES AND TRADE OF THE ADJACENT DISTRICTS

AND THE

PRACTICABLE MEANS OF OPENING THE NAVIGATION.

BY

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SECTION I.—INTRODUCTORY.

1. In para. 4 of my Report of January 1863 on the Godavery, I remarked in reference to one of the affluents of the Godavery, namely, the Wyngunga as follows :—

"The Wyngunga rises in the Sautpoora Hills north of Nagpore. Emerging thence, it runs south, through the heart of the Nagpore Province, to its junction with the Wurdah (or more strictly, the Pranheeta,) a distance of 430 miles. This river has been examined carefully by Messrs. de Gronsilliers and Farley in 1861, and must, I fear, be pronounced utterly unnavigable. This is a very unfortunate circumstance."

Present condition of the Wyngunga.

This opinion was based on the report of those gentlemen, whom also I had had the advantage of consulting personally. And with all the knowledge that has since been acquired, there is nothing to shake the correctness of that information regarding that river, in its present state. Accordingly, in my Godavery Report of 1863, no reference was made to the practicability, or otherwise of constructing navigation works on the Wyngunga.

2. Since that time, the professional investigations made under the directions of this Administration, respecting sites for reservoirs for storing water to increase the supply of the rivers, have shewn that, while there are no sites yet found that would suit the above purpose for the Wurdah, there are some remarkably fine sites where water could be stored for the Wyngunga. The subject is unfolded in my Minute on the river Pench (an affluent of the Wyngunga), prepared in 1864.

Colonel Fife's opinion.

3. In March 1866, when Colonels Anderson and Fife passed up country, after their examination of the Godavery,

Colonel Fife suggested to me, verbally, that the works at the 3rd barrier of the Godavery might be so arranged as to fit in with a combination of works on the bed of the Wyngunga. In a separate memorandum, which Colonel Fife has attached to the joint report of himself and Colonel Anderson on the Godavery, he writes thus (para. 11):—

"The valley of the Wyngunga is fertile and populous, and it is almost destitute of means of communication to the eastwards, while to the westward it does not possess the same advantage as the Wurdah Valley, in proximity to the Railway. Under these circumstances, I cannot but regard the opening of the Wyngunga as of greater importance than that of the Wurdah, now that the Railway already passes through the valley of the latter; and that its opening is necessary for the proper development of the Godavery navigation."

Then, in para. 13, he proceeds to say:—

"If a weir were constructed across the 3rd barrier (of the Godavery), at the point where the Wyngunga enters it, * * * we should secure * * the connection of the Wyngunga and the Wurdah navigation."

In the same memorandum there are further remarks in detail on this river, which may be noticed in the subsequent parts of this Minute.

The several foregoing considerations have directed special attention to the Wyngunga.

Despatch from the Secretary of State.

4. Meanwhile, in July of this year (1866), was received from the Government of India, copy of the despatch from the Secretary of State of 8th February 1866, prescribing in general terms the prosecution of works at the 3rd barrier of the Godavery, and observing that "Navigation must be made to commence at the nearest practicable point to the great cotton fields of Nagpore." Then, after adverting to the probable outlay, the despatch lays down that this sum "would still appear to be not too high a price to pay for between four and five hundred miles of river navigation open during the greater part of the year." Due regard to these views renders it desirable to see whether the heavy works which will, under any circumstances, be necessary at the 3rd barrier of the Godavery, cannot be made to subserve the future navigation of the Wyngunga, as well as of the Wurdah; and whether, when navigation is to be extended into the heart of the Nagpore country, the Wyngunga does not afford at least as good a natural highway as the Wurdah, perhaps, even a better one; and does not equally offer powerful inducements for its improvement.

Tour on the Wyngunga.

5. Since 1863, I had at various dates seen parts of the Wyngunga. But after meeting Colonel Fife in March last, I marched, in May and June last (1866), along the banks of the river, past all its more difficult and unnavigable sections, and right down to its junction with the Godavery at the 3rd barrier of the latter, and further examined all the rocks of the barrier itself, as they are to be seen in the driest season of the year. I now proceed, briefly, to record the result of these enquiries, which are, of course, only of a general character.

SECTION II.—THE WYNGUNGA AND ITS TRIBUTARIES.

Source of the Wyngunga.

6. The Wyngunga* rises at a point about 10 miles south of the town of Seonee, near the southern ridge of the main Sautpoora Range, which runs from

* Within the Sautpoora hills, the stream is called by the natives "Bhingunga," "or Ganges of the Bhils;" below the hills it is called "Wyngunga," or "Ganges of the Bhils;" Wyn, being in the Bhilwaldee the same as [illegible], or [illegible], meaning woods.

[illegible] to west across the Peninsula,* and a little to the north of Nagpore. From that point it runs through rugged table lands due north for some miles, then turns eastwards, and then again southwards, passing through wild and marshy ground till at length, cutting through a mass of basalt, and then tumbling over a marble ledge, it finally debouches from the hills and enters on the plains. To illustrate the rapid accumulation of drainage in the hilly regions, it may be noted that just after its source the Trunk road crosses the Wyngunga with a bridge of two openings of 12 feet span. Thirty miles further on, the same road crosses the same river by a bridge with twelve openings of fifty feet span each. The river's course within the hills is about one hundred miles long. Thus far its stream will, of course, never be navigable; but it is at, or near, the debouchure that excellent sites for reservoirs are to be found.

7. At first, on quitting the hills, the river flows for some twenty miles through a valley, with deep bays as it were running up into the hills and highly cultivated. Then the valley opens out and forms one of the richest and best cultivated tracts in the country; and it continues to be fine, broad and populous, on one side, or the other of the river, for about 60 miles, to a point a little below the junction of the Kunhan. Thereafter this valley becomes of a variable character, sometimes broader, sometimes narrower, sometimes rich, sometimes jungly; but becoming more and more encroached on by hills and forests, and less and less inhabited, for about 92 miles, to a place called Chamoorsee. By this time the cultivation has become contracted to a narrow strip on each side of the river, and so continues

Its course inside the Sautpoora Range.

* The whole range has been for some time called by Europeans the Sautpoora, for convenience sake. The real Sautpoora, however, are only a portion of the range further west between Hoshungabad and Kasur.

for some 40 miles more to the confluence of the Wyngunga with the Wurdah; from which point the joint stream bears the local name of Pranhoota. It will thus have been seen that the Wyngunga has a course of 100 miles within the hills not navigable at all; and of 223 miles below the hills. Of the course below the hills, the greater portion is more or less navigable at one season or other; except at certain points where serious breaks and obstructions occur, which will be noticed hereafter. Within this distance there is already some country boat traffic on various sections of the distance, but merely of a local and isolated character. Owing to the breaks and obstructions, there is not any through navigation whatever.

8. Below the Sautpoora Range, the first affluent which joins the Wyngunga, on the right bank, is the Choonee, which is partially navigated now, from its junction to the town of Rampoles, a distance of about 10 miles. The next affluent (on the left bank) is the Bang, now partially navigable with the exception of one break, to be noticed further, to a point east of the town of Kampta, a distance of 30 miles. Below this, the Bhawuntharree joins in at the right; it drains an area of country which, though extensive, is wild and wooded; and it can hardly be counted as a navigable stream. Further down, on the right bank also, the Kunhan joins the Wyngunga. This rises in the southern ridge of the Sautpoorus, and has a course of 100 miles. Its valley above the town of Saonair encloses a site suitable for a very large storage reservoir. A little above the town and station of Kamptee, the Kunhan is joined by the Pench, which also has a site for a similar reservoir. From Kamptee, the united stream of the Kunhan and Pench would be navigable for about 30 miles, till they join the Wyngunga. Above Kamptee, the Kunhan might be made navigable for some thirty miles; but there are some shoals and rocks; and this section is, on the whole, of a doubtful character. Further

Its several affluents.

south, on the right bank, the Wyngunga is joined by the Amb; and further down, on the left bank, by the Choolbund. This stream flows through a splendid rice tract, but is hardly navigable. Both the Choolbund and the Amb have very little water after the rains are well over; and though perhaps, in the event of the main river being largely navigated, a portion of these lesser feeders might be navigable, yet at the present time their navigability can hardly be counted on.

Its total navigable length.

9. Now, if certain breaks and obstructions, to be adverted to hereafter, could be overcome, the navigable lengths included in the sketch may be summarized thus:—

	Miles.
The Wyngunga below the Sautpooras ..	223
The Choonee	10
The Baug	30
The Kunhan	30
Total miles ..	293

It will now be desirable briefly to examine the resources of the several territories through which the above channels run, in order to see whether any projects for opening the navigation of them throughout are worthy of consideration.

Compared with the Wurdah.

10. Before proceeding further, I may note that the above river-system (omitting all lesser feeders of doubtful capacity) of 293 miles, is really considerable. It greatly exceeds, of course, the mileage of the Wurdah above the 3rd barrier, which may be set down as:—

	Miles.
From Crest of 3rd barrier to confluence of the Wunna	110
From mouth of the Wunna to Hingunghat	20
Total miles ..	130

SECTION III.—THE COUNTRY OF THE UPPER BASIN OF THE WYNGUNGA.

11. The valley of the Wyngunga may be best considered in two divisions: 1st, the country of the Upper basin; 2nd, the country of the land basin. Each of these will be adverted to separately.

The Upper Valley.

12. The country of the Upper basin was, for the most part, described in my Report on a proposed tramway to run eastwards from Nagpore. From that the following extracts may be made:—

"The Wyngunga river, after the valley opens out, as above shewn, runs through the extensive plains, and the rich rice-fields of Warra Seonee, of Hutta, and of Kampta. Here the country is flat. The soil is well suited for those crops which require artificial irrigation. The richest portions of the plains are those which lie nearest to the skirts of the hills, towards the eastern extremity near Kampta. On the western extremity, near the Wyngunga itself, the country is flat, yielding fine harvests of rice."

"The eastern portion forms the valley of the Baug river, which rising far down to the south, flows nearly due north till it joins the Wyngunga near Kampta. This valley is in a few places fairly cultivated, and has generally a fertile soil. But it seems to have been neglected for many years, and has now become much overgrown by jungle; while its climate has a bad repute. By the superstitious people the waters of the Baug river are supposed to be poisonous to drink."

Its features and resources.

"It is next to be observed that, below the main range, a broken series of hills, stretches southwards. And then sweeping round to the westwards, culminates near the Nowagaon lake, and thus forms the southern limits of the tract now under description. This tract is remarkable for its tanks, many of which assume the proportions of lakes. This is the lake region described in para. 12 of the Administration Report of the Central Provinces for 1861-62. These tanks are formed among the hollows and deep vallies, advantage being taken of the spurs and offshoots of the hills, for the construction of the dams. In this manner, a vast reservoir can be obtained at a comparatively moderate expense.

Among these the most notable has a circumference of above twenty miles.

"This Lake region is bounded on the west by the Choolbund river, which joins the Wyngunga far down to the south. The country enclosed between the Choolbund and the Wyngunga teems with rice harvests."

"It will have been seen then that, over the whole of the country between the Bang river and the Wyngunga, the cultivation is more or less, carried on by irrigation. From the base of the Santpoora Range, all down the Wyngunga valley, there are splendid crops of rice, and some of the very finest descriptions of this product are cultivated. For the culminating tract Warra Seonee is the principal mart for rice, which is exported thence to Nagpore. South of this, in the valley of Ramgyle and Huita, there is a mixed cultivation, and in places along the Wyngunga and its tributaries there are to be met with rich soils, fine villages and excellent crops of wheat, grain, millet and oilseeds. During the dry season, in the very beds of the rivers, where the higher floods and back waters leave an annual cutting of alluvial deposit, rich crops of the castor oil plant, and fields of sugarcane are to be seen. The cultivation of rice and sugarcane is carried on principally from banks. The best descriptions of rice here cultivated require more or less artificial irrigation. The more common descriptions, ripen earlier and require little aid in this way beyond the water which is retained by forming small dams across the fields during the monsoon. The next most important branch of cultivation is the sugarcane, which is carried on most extensively below the large tanks in the southern tracts. At present the cane is generally poor, and the cultivation carried on in a slovenly manner, no attention being paid to thinning out the canes which seldom attains any great size. It is, however, an exceedingly profitable crop. Besides the above crops, wheat, gram and oilseeds are cultivated, but principally in the beds of the shallow tanks, which are drained after the rice crops are off the ground."

"The next tract of country to be considered is, that situate below the hill ranges above described between the Wyngunga river and Nagpore. The finest portions are those which are enclosed by the Wyngunga itself, and by its affluent the Kunhan. This a tongue of land with a fertile soil, in some places bearing a double crop during the year, generally well tilled, thickly populated, and abounding with large villages."

"The principal crops raised all over this tract are wheat, gram, oilseeds and millet. On the poorer soils near the hills, rice and some sugarcane is cultivated in places where irrigation is procurable; it might be cultivated to any extent. Cotton is not as yet raised to any great extent, but its culture is increasing, and may still further increase."

"There is really no waste worth mentioning, not even grazing ground for cattle; and at certain seasons the animals have to be sent to great distances for pasturage."

Towns on or near the river.

13. In the immediate valley of the Wyngunga, there are the following towns:—

Hutta	..	7,335 inhabitants.
Kampta	..	6,000 "
Toomsur	..	8,263 "
Moharee	...	8,738 "
Bhundarah	...	16,440 "
Pohonee	....	19,476 "

Of these, Pohonee has long been the seat of the manufacture of fine cloth fabrics, which have heretofore been exported to great distances. These may be supplanted by English made fabrics, meanwhile they form an important branch of industry. The other towns are chiefly grain marts, though they have manufactures of cloths and of metals.

Right bank of the Kunhan.

14. In addition to the above there should be mentioned here, the territory from the right bank of the Kunhan to the base of the hills which form the water shed for the rivers Wyngunga and Wurdah, respectively. This tract contains the two sister towns of Nagpore and Kamptee, which with their suburbs have 170,000 inhabitants; and most of the finest villages in the whole country. In such villages all known Indian products are reared. In one of them Mohpa for instance, there are no less than four hundred wells at work. It is well indeed to bear in mind that Nagpore and the tracts around it are situated in the valley of the Wyngunga. From the Nagpore Fort (Seetabuldee) the eye, looking westwards, sees the various ranges of hills shutting out the cotton country of the Wurdah, but looking eastwards, sweeps over the unbroken plain stretching away for forty miles to the Wyngunga, and cultivated almost to the last rood. This very productive area, from Nagpore to the Wyngunga, is indeed the "plain of Nagpore," described in para. 12 of the Administration Report of the Central Provinces for

1861-62. This tract used not to be a cotton-producing tract. What is commonly called "Nagpore cotton" does not come from around Nagpore itself, but from the valley of the Wurdah, from 30 to 50 miles distant. But this tract has begun to produce cotton since the springing up of the new demand in 1861-62, and now yields a considerable quantity of that article. In all other respects it is much superior to the Wurdah valley, being better inhabited, better tilled, and better endowed with resources, and (as a certain test) paying a fifty per cent. higher rate of land revenue.

15. In this tract, besides Nagpore and Kamptee, there are the following towns:

Towns in the interior.

Oomrair	..	17,010 inhabitants.
Ramteak	..	12,696 "
Khappa	..	9,116 "

Of these, Oomrair has some celebrity from its cloth manufactures, which are even superior to those already mentioned at Pohonee.

16. The husbandmen of the Upper basin of the Wyngunga deserve a passing notice, as they are beyond all comparison the most hardy, industrious and enterprising of all the agricultural classes in any part of these Provinces. The culture seen here in these times is not, as in many parts of India, of really ancient date, but is of quite a modern age. Without any attempt at an historical retrospect, it may be noted that the country was originally reclaimed under the auspices first of a pastoral Hindoo dynasty (still dimly remembered as the Cowherd "Gaolee" Kings), and then of the Gond dynasty. It is not, however, probable, that much was done for agriculture. The real strides were made when the Powârs and Koirees immigrated from the north, and the Koombees of Mahratta races from the west. The results which these three

Character of the agricultural classes.

tribes, Powârs, Koirees and Koombees, have accomplished within the last two centuries are perhaps surprising; and much of the most remarkable reclamation has occurred within the last century, and some even within the last half century. Within these periods, these people have felled forests over miles and miles of country (the stumps of the primeval trees are still visible inside the houses of some villages); they have constructed wells and small tanks by thousands; tanks with broad sheets of water by hundreds, and lakes by scores. They have reared a breed of cattle not tall nor showy, but braced and knit together with sinew and muscle; and able to drag the light little carts literally almost any where. With these, they have penetrated the roughest localities, got across tortuous ravines and scaled steep flanks of hills, in order to reach and break up the rich table-lands beyond, and to carry away the produce of the jungles. Even horsemen, toiling up and down these places, often wonder at finding the ruts and marks of the cart wheels.

Remarkable instances of enterprise.

To illustrate this further, a few sentences may be extracted from an address I delivered to the Chiefs of these tribes at an agricultural durbar in May last (1866):—

"The Settlement records now showed how tens of thousands of acres of culturable land, in good situations too, were still lying waste. But the past history of the district raises the hope that the remaining waste may yet one day be reclaimed. For it is scarcely more than a century ago that all the broad flat territories below the hills now waving with harvests, were covered with forest. The work of reclamation, the beginning of which was, so to speak but of yesterday, should still be carried on with fresh vigour."

"They should never forget the example of those who founded the prosperity now witnessed. First, Kolhoo Patel, broke in upon the wilds and wastes of Hutta and Kampta, then scantily occupied by Gonds. He and his people cut down the massive teak and the tall bamboos to form the fields. He was followed by his son Gondee Patel who enlarged all the villages his father had founded, and set up many new ones, and left to his heirs a really fine patrimony, stretching over many square miles, and containing hundreds of villages equal to half a modern district—all the work of himself and his father. Though they died as rich and powerful agricultural Chiefs, they started with very little,—their original

capital really consisting for the most part, of their strong hands, their resolute wills, and their influence over their brethren."

"Again, Lushmun Naik, the Mahratta, was a man of the same stamp as those already mentioned. He, too, left to his heirs an inheritance of several Talooks, established entirely by his own exertions. Many of his people are still living, now prosperous landholders, though originally mere settlers, who can recount the hardships and distresses they underwent in founding their villages."

Much waste still to be reclaimed.

17. Still, however, there is in some places a vast field for increase of culture. The settlement of landed tenures and the demarcation of private from State property, being now completed, it is found, from the Register of waste lands available for lease or purchase, that there are some 400 lots with an aggregate of 427,895 acres in the Nagpore district; and some 550 lots with an aggregate of 551,923 acres in the Bhundarah district—much of this area is sterile of course; but much, on the other hand, is quite fit to be reclaimed. In some parts of the country there are traces of desertion of the villages by their inhabitants in a former period, probably by reason of sickness or other failure. This may be illustrated by an extract from my Report on the Tramway, above alluded to. In reference to the banks of the Baug river already mentioned as one of the affluents of the Wyngunga, where the localities being unpromising and the climate insalubrious, settlers will not now venture.

"There are large tanks, dry and ruined. Expanses of ground now covered with scrubby brushwood, were evidently once covered with bandey and tillage. As a remarkable instance may be mentioned the remains of a noble tank, once several square miles in extent. The massive dam (seventy feet high) was breached many years ago; but its remains are still considerable, and its masonry sluices are still almost perfect. The history of its construction is unknown, even to tradition."

18. In the same neighbourhood also, there is a remarkable site for the storage of water, close to the alignment of the eastern trunk road from Nagpore to Chuttcesgurh. This spot was described as follows, in my Administration Report for 1862-63.

"There is a basin where a large reservoir of many square miles in area might be formed, at a comparatively trifling cost, by blocking the one outlet by which alone the waters can escape. From such a reservoir a valley containing twenty-two villages might be irrigated. The project has not been matured, but it is pronounced practicable by Engineer officers who have seen the place. On the spot there are the remnants of materials of an unknown period, which must have been collected by some former proprietor with a view to constructing this very work."

Capabilities of the country for irrigation.

19. In other parts of the country there are promising projects for irrigation. In my Minute on the river Pench, it was shown how (irrespectively of the storage for supply of the navigable channel of the great rivers,) a canal might be conducted down the fertile tongue of land between the converging streams of the Wyngunga and its affluent, the Kunhan, for a distance of 40 miles. This proposition was made on professional information obtained by Mr. Hanna. It has not yet been fully estimated for. Colonel Fife writes of it in strong terms of advocacy in his memorandum already adverted to.

The Pench project.

20. Then there is a project now professionally designed and matured, for the storing of water near Saonair, a town twenty miles to the north-west of Nagpore, with a view to conducting an irrigation canal down the valley of the Kunhan, close up to Nagpore and Kamptee, calculated to fertilize an area of some 128,000 acres. In the Kuttungee valley alluded to in the foregoing paragraphs of this Minute, there is a fair field for irrigation. It was thus mentioned in my Administration Report for 1862-63, para. 236. "The Kuttungee valley has been chiefly reclaimed within the last thirty years; is fast increasing in cultivation and population; sending its surplus strength of men to labor in the public works. Its products are chiefly grain and sugarcane. It has many small tanks, but these do not suffice to provide the permanent irrigation which is required. Now two gorges have been found with streams running down from the hills and capable of being dammed up and formed into large reservoirs, from which

The Saonair project.

The Kuttungee project.

irrigation might be easily conducted over hundreds of villages." Since then the Kuttungee project has been matured by Mr. Hanna; a series of irrigation works can be carried on in connection with each other calculated to fertilize ultimately some 128,000 acres.

The forests in the neighbourhood.

21. Immediately to the north of the Upper valley, lie all the best and most accessible forests of the Central Provinces; abounding in saul, saj, and other useful timber trees; which have supplied the sleepers for the railways. In the north-east are those lofty tapering bamboos (rising from 50 to 80 feet high) which love the margins of streams whence they are floated down by water to market. On the south-east are the once abundant teak forests of Pànabúrus, which though now carefully preserved, are for the present at least well nigh exhausted, from the devastating expenditure which occurred years ago. These teak-logs can be floated down the Baug into the Wyngunga.

The existing trade.

22. The Trade, partly local and partly general, in the several tracts above mentioned, is large. In my Tramway Report of 1863, it was shewn to be (para. 48) as follows :—

	Imports. Bulk Tons.	Imports. Value £	Exports. Bulk Tons.	Exports. Value £
Aggregate Imports from Eastern Districts to Kamptee and Nagpore	46,008	573,073	"	"
Exports from Nagpore and Kamptee towards Eastern Districts	.. .. ..	.. .. ..	3,115	136,598
Trade between Eastern Districts and the West not passing through Nagpore and Kamptee	7,611	251,456	6,227	226,697
Total Tons	53,619	£824,522	9,342	£363,295
	Tons.			£
Grand Total Imports	53,619			824,522
Exports	9,342			363,295
	62,961			1,187,817

Besides this, there is an exportation of rice from Kuttungee to Nagpore of 13,000 tons annually. Thus the total bulk must be nearly 76,000 tons annually. The excess of imports over exports is partly made up by the large exportation of bullion from Nagpore eastwards, which is known to amount to many lakhs of Rupees worth annually. The articles entering into Nagpore from the eastwards, or passing by or near that route towards Berar, are chiefly grains, rice and wheat, together with some cotton. The articles going from Nagpore eastwards are English piece goods, cutlery, metals, oilseeds. Now all this trade passes through the upper basin of the Wyngunga, crossing both that river and the Kunhan, and is now carried by pack bullocks or country carts. The cost of such carriage was set down in 1863 at from three to four annas per ton per mile; since then, with the universal rise of prices, the rate has increased. Besides this through trade, there is a great local traffic between the towns and villages, which could not well be exhibited in returns. It may give some idea of the resources of the country to note, that the Municipal dues for the two neighbouring towns of Nagpore and Kamptee amount in all to $2\frac{1}{4}$ lakhs of Rupees, or £22,500, net per annum (that is, the amount paid without any deductions by farmers who defray their own establishment for collecting). These are calculated at about 2 per cent all round on articles of all sorts brought in for consumption. Thus, they must represent an import trade of about 200 lakhs or two million sterling per annum into these two cities, lying close together.

23. The through traffic runs, at present, due east and west, that is, at right angles to the main line of river communication running from north to south. Whatever trade there is up and down the river, is of the merest local character, and there are no lines of land traffic running parallel to the river. It were vain to speculate as to how much of the trade now flowing east and west, would be diverted in a north and south direction, if the

river route were opened. The above facts are offered merely to show the capacity of the country for trade, and the high proportion of its surplus produce.

Statistics of the upper valley.

24. The statistics of the upper basin of the Wyngunga may be thus abstracted :—

	Revenue including Local Funds.		Population.	Total area square miles.
	Rs.	£		
District of Nagpore...	15,50,000	155,000	945,600	3,750
District of Bhundarah ...	6,95,172	69,517	711,100	5,345
Kuttongee in Seonee District.	76,747	7,675	87,900	1,376
Total ...	£3,21,919	£232,192	1,744,600	10,471

It will have been seen that this tract is already fertile, and comparatively wealthy: and is in many respects highly improveable.

SECTION IV.—THE LOWER BASIN OF THE WYNGUNGA.

25. The lower basin of the Wyngunga may appropriately be divided into two parts: 1st, that lying on the right or west bank of the Wyngunga; 2nd, that lying on the left or east bank; each of these will be separately noticed.

The west part of the lower valley.

26. The tract on the right or west bank is formed thus. Commencing slightly below Nagpore there is an irregular range of hills, chiefly sandstone, which runs southward. This is a perfect backbone to the country enclosed between the rivers Wurdah and Wyngunga. On the west of the ridge is the proper valley of the Wurdah, with its well known cotton field and its mart of Hingunghat; which require no further notice in this Minute. To the east of the ridge is the rice-growing valley of the Wyngunga. For some

distance, the two rivers run comparatively parallel. But further on the Wurdah bends eastwards a little below Chanda, to join the Wyngunga. Near the junction, the ridge above mentioned is met with. The tract now to be briefly noticed is that lying on the right or west bank of the Wyngunga.

Its tank system.

27. This tract as already seen, lies between a low range of hills and a river, having an average breadth of thirty miles. Though partly champaign, it is yet much broken up and diversified by hills and jungles. Advantage has been taken of the undulations in the ground, and the streams permeating it, to construct a regular tank system. These are not so large as the lakes mentioned in the upper basin of the Wyngunga; but are second to them alone. It has been said in the foregoing paragraphs of this Minute that the Gond dynasty of Deogurh (Nagpore) did not effect much for material improvement. But this tract belonged to the Gond dynasty of Chanda, who, probably, established at a later period, were comparatively more civilized; and these have left behind them a noble mark on the land. In 1865, after visiting these tanks, I caused a letter to be written to the local authorities, which, as it conveyed impressions on the spot, may furnish a few extracts to make up the description, as follows :—

"The number and size of these Tanks is certainly remarkable. In some parts, they even cluster thick round the feet of the hills. From the summit of the hill, called "Perzagurh," by the Gonds, and "The Seven Sisters" by the Hindoos, no less than thirty-seven tanks were counted as distinctly visible."

"These tanks are indeed the pride and ornament of the District. They are, as the people themselves told the Chief Commissioner, the very life of the place. They are the object to which much of the industry and capital of the people are devoted; and are the main source of agricultural wealth. The two staples are rice and sugarcane. And both are entirely dependant on the water supply for irrigation from the tanks. Not only have large, indeed sometimes very extensive, sheets of water been formed by damming up streams by heavy earthwork dykes; but

savages live up in trees. It has, of course, boundless forests of the usual sorts of timber trees, but not any forests of very marked character, save those of Pânabârus already mentioned in the foregoing paragraphs of this Minute. Its chief value at present arises from that large class of miscellaneous articles—drugs, dyes, pigments, fibres, and the like, ordinarily classed as "jungle produce." These are collected in quantities at the marts, and thence exported to great distances.

31. The only other place worth noting is the hill of Soorjagurh, recently described by Lieutenant Brooke, of the Settlement Department, from whose report the following extracts may be made :—

The Soorjagurh hill.

"Next morning, the 21st, guided by two Maree Gonds, I started to climb Soorjagurh. After crossing two smaller hills we arrived at the low hill, and commenced the ascent. On the top comes a cluster of huge boulders. This is cut into two parts in the middle cleanly as if with a knife. On getting to the foot of the rock, the Gond guides refused to go any further, dreading the vengeance of the god, and swore most lustily that there was no road or way up, and that no one ever went there. However, I began to climb, and in about a quarter of an hour of hard scrambling up the face of the rock, reached the summit. The day was unfortunately cloudy, rather restricting our view, which must in clear weather be very fine; as it was we could see an immense distance,—all, however, an ocean of the jungle, dotted at long intervals with Gond hamlets. My aneroid gave the height as 1,685 feet above the village, which itself is 375 feet above the level of the Wyngunga. This would make the mountain more than 2,000 feet higher than the plain. On the top is a Gond god, and the remains of an old building or fortification round the edge of the rock."

32. In the cultivated strip along the river-bank, the following towns deserve to be named, as being of either past or present importance; though the utter inferiority of the dwellings, constructed entirely of poles (they cannot be called wood,) and grass, show the low state of the civilization in this locality. First comes Armoree, a town of some ten thousand inhabitants, and is the entrepôt for the trade between the

The towns of Armoree and Wyragurh.

wild states, and the rich districts of the west. Here are collected the articles already explained as jungle products from Bastar, and all the intermediate states; and the small supplies of Foreign (even English) piece goods, of cutlery, of cotton thread, and the like. Near this is Wyragurh, a fine estate but a broken down place: with a large ruined masonry fort, erected and kept up by the Mahrattas to overawe the Chiefs already mentioned; but now quite abandoned; and no longer wanted under the altered aspect of the times.

33. Lower down the bank there is the iron hill of Khandeshwur which, rising from a broad basis of ferruginous rock, lifts up its peaked head, black and

The Khandeshwur iron-mines.

of two hundred feet. From the foot of this remarkable rock, impregnated with excellent iron ore, the people have for ages past, dug and carried the materials for the smelting furnaces in the neighbouring villages. The ore is not worked up on the spot, but is sent in crude lumps to many places all over the country. The late Mr. Hislop (an excellent authority) examined this place in 1860-61, and considered it to be quite the best, and richest in the requisite ingredients, of any ores he had seen in these Provinces, and that this was quite the best place of the kind for European enterprise. The specimens sent to the Nagpore Exhibition in 1865 were highly thought of by the Scientific Examiners. It is manifest that a valuable item of traffic might spring from this place, in the event of the navigation of the Wyngunga being opened.

34. Next (following the river course) there comes Gurhchoorolee, and then Chamoorsee. These are towns of some thousands of inhabitants each. They have some trade similar to that of Armoree; but their speciality is this, that they are the depôts for the salt which comes by land routes of hundreds of miles

The towns of Gurhchoorolee and Chamoorsee.

21

from the eastern coast districts of Ganjam and Vizagapatam, first to Sirroncha and the Godavery country, and then on to this, the lower Wyngunga country. The salt is brought by carriers of the Bunjara tribe, in bags thrown across the backs of bullocks, in droves of hundreds. The wonderful organization of these bullock-caravans [second only to the camel-caravans of the north] has been described in my Administration Reports; and it will suffice here to add that, in these two places, the Bunjara system is to be seen in its natural and original state. The quantity of salt annually passing by these points amount to 30,000 maunds, or 1,111 tons.

The salt import.

The new Imperial customs cordon passes from Chanda, thence to the junction of the Wurdah and Wyngunga, and then turns northwards passing through Chamoorsee and Gurhchoorolee on to Wyragurh, and strikes off eastwards towards Chutteesgurh. The future salt trade has always been an item in the calculation of the probable traffic of the Godavery. And it will now be evident that the opening of the navigation of the Wyngunga in connexion therewith will impart an impulse and an extension to the consumption of this necessary article.

35. In the rear, that is to the east of all these places, (Armoree, Wyragurh, Gurhchoorolee, Chamoorsee), there may be seen many square miles of flat culturable waste; the soil being of a light character, but fit to produce rice and such like things.

36. At and near the confluence of the Wurdah and Wyngunga, and along the left bank of the Pranheeta (which river commences from the confluence), the tract belongs to the Chief or Zemindar of Ahiree. Here again the quantities of fair culturable waste, now clothed with luxuriant brushwood; astonishes even those accustomed to see the

The Ahiree Chiefship.

forest. Such a fair is that held, at frequent intervals, near the iron-mines mentioned in the foregoing paragraphs.* There the rude ironmongers bring their bulky wares, and take away the fine fabrics and piece goods from Nagpore, and there I have seen English cloths, with Manchester labels all correct, exposed for sale.

Statistics of the lower valley.

39. The general statistics of the lower basin of the Wyngunga valley may be thus abstracted :—

	Revenue including Local Funds.	Population. Souls.	Area. Square Miles.
Ecrhamporee Sub-Division of the Chanda District	Rs. 1,13,263 £ 14,326	142,000	1,905
Mhool Do. Do. ...	Rs. 1,52,326 £ 15,233	130,605	1,952
Total ...	Rs. 2,95,589 £ 29,559	272,605	3,857

SECTION V.—STATISTICS OF THE WYNGUNGA COUNTRY.

Extent of the Wyngunga country.

40. The statistics, then, of the whole Wyngunga country, as thus described, may be summarized as follow :—

	† Revenue including Local Funds. Rs.	£	Population. Souls.	Area. Square Miles.
Upper basin	23,21,919	232,192	1,744,600	10,471
Lower basin	2,95,589	29,559	272,605	3,857
Total Rs.	26,17,508	£261,679	2,017,205	14,328

* The precise spot is named "Jumulghatta."

† Excluding Salt Customs.

41. This represents a really considerable portion of territory already possessing strength and resources, and even some wealth; but capable of becoming much greater; traversed from end to end by a great river, by whose affluents, too, it is threaded in every direction; but still destitute of any through water communication whatever: having roads indeed in the upper portion, but devoid of any proper land communication in the lower.

Compared with the Wurdah country.

42. In comparison with the above figures, it may be well to give the same statistics for the Wurdah valley.

	Revenue including Local Funds.	Population. Souls.	Area. Square Miles.
	Rs.	£	
Wurdah Valley	8,09,881	80,988	304,600

This area comprises the great cotton field; whereas the Wyngunga produces some, but not much, of that article.

43. It will hence be seen that the country of the Wyngunga is very much larger than the country of the Wurdah: and, save in the one item of cotton, much more important. Indeed, the revenues of the Wyngunga country are nearly three times as great as those of the Wurdah country; and the population of the Wyngunga country is five times as great as that of the Wurdah country. It must be added, however, that some of the Wurdah country being in Berar and in the Nizam's dominions, does not come into this calculation. If it could be included, it would slightly reduce the balance of the comparison against the Wurdah. But even after abatement for this; the Wyngunga is far the greater river, and its basin by far the richer and larger of the two.

* Excluding Salt Customs.

44. Further it is noticeable that excluding the Pyngunga, which is an affluent of the Wurdah, and which enters the Wurdah within the last fifty miles of the course of that river, the Wyngunga is a much larger river than the Wurdah. The Pyngunga is indeed a river of some length (see paragraph 5 of my Godavery Report of January 1863); but then it is entirely, from source to mouth, within the Nizam's dominions: and however improvable it may, or may not be, still its improvement is beside the present question. Whereas the Wyngunga is entirely a British river in British territories. Exclusive of the Pyngunga then, the capacity of the Wurdah may be compared with that of the Wyngunga, according to the subjoined table which has been compiled by Mr. Hanna from generally reliable maps, and in which the quantities of volume and discharge are deduced by a formula approved by Colonel Dickens. It will be perceived that the Wurdah has, in round numbers, only one-half the length, and one-third the capacity of the Wyngunga, and drains only one-third of the area of country. In other words the Wyngunga in all respects to the Wurdah as three to one.

The capacity of the Wyngunga compared with that of the Wurdah.

Name of River.	Length of main stream from source to mouth in British miles.	Aggregate length of principal branches.	Aggregate mileage of main-stream and affluents.	Total catchment basin in square miles.	Volume of water annually discharged in cubic yards.	Approximate flood discharge near mouth in cubic feet per second.
Wyngunga ...	325	330	655	25,500	55,555 millions	1,642,700
Wurdah ..	200	140	340	8,500	18,518 millions	730,321

SECTION VI.—THE EXISTING BOAT TRAFFIC ON THE WYNGUNGA.

45. As already mentioned in the foregoing paragraph 7 of this Minute, there is already a boat traffic on the river, of a local character only, from place to place, but not any through traffic from end to end. It will be desirable to examine this point a little closer.

The boat traffic within the Bhundarah District.

46. Captain Newmarch, the Deputy Commissioner of Bhundarah in a recent report writes thus:—"There is a certain amount of local traffic on the Wyngunga in this District during the monsoon, and this is entirely carried on dongas or large logs of Teak scooped and hollowed out. This traffic tends from north to south, and is chiefly directed towards Bhundarah. It consists almost exclusively of grain, and is dependant on the comparative cheapness and greater productiveness of the northern part of the District. The Dongas employed vary in size, but the average freight is about 30 and 35 maunds ($1\frac{1}{4}$ ton). The carriage is cheap, being on an average about $\frac{3}{4}$ths of a pie per maund, (or $2\frac{1}{2}d.$ per ton) per mile, including all charges. And as at this particular time of year, transport by carts is most difficult and expensive, the river route offers great advantages. For the registration of the boat traffic this year, four posts were established; and an abstract of the traffic for July and August 1866, with an estimate for the remaining three months of the season is herewith annexed. The season commences in July and lasts till the end of November. There is no traffic upwards, against the stream, and the four places where the posts are established, are the chief points where bulk is broken. Bhundarah absorbs three-fourths of the traffic, while Pohonee has only a very small share, on account of the difficulties of the Tiddee (or Muggurdokra) barrier. The trade consists almost entirely of grain, and as the present estimate is rated low, may be fairly considered to represent an average value of 50,000 Rupees during the season."

47. The abstract statement of this traffic may be rendered thus:—

Its existing amount.

Abstract of Traffic from north to south.	Wheat.		Rice.		Other Grains.		Oil Seeds.		Miscellaneous Articles.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
	Maund.	Rs.	Mds.	Rs.	Mds.	Rs.	Mds.	Rs.	Mds.	Rs.	Mds.	Rs.
Actual traffic in July and August 1866.	188	750	4,779	14,337	2,126	6,378	63	250	184	1,811	7,315	23,539
Estimate of probable traffic in September, October and November 1866.	212	850	5,021	15,063	2,074	6,022	51	256	166	2,089	7,524	24,230
Total.	400	1,600	9,800	29,400	4,200	12,400	120	510	350	3,900	14,870	47,810

* of 82lbs. per maund.

Hence the total existing traffic may be said to be some 15,000 maunds (550 tons) valued at Rs. 50,000 (£5,000), for the season, from July to November.

The boat traffic within the Chanda District.

48. In the Chanda District, Captain Lucie Smith, the Deputy Commissioner reports:—"During the rains a few boats laden with wheat and pulses come from Pohonee past Armoree to Chamoorsee" (a distance of about 75 miles.)

49. These amounts may not be large, but then it will be seen that even the local traffic is much curtailed and restricted, by the existence of one bar in the main river, one in the affluent of the Kunhan, and one in the affluent of the Baug. And owing to the barrier near Muggurdokra and the still greater barrier down south, there can be no through traffic at all. But from the facts as they are, it is possible to conjecture, how great, how beneficial, this boat traffic might become, if the greater barriers and the lesser bars, can be removed or overcome by engineering skill.

SECTION VII.—The BED and STREAM of the WYNGUNGA and its AFFLUENTS.

Varying character of the obstructions.

50. It were perhaps superfluous to premise that obstructions in the channel are of two kinds; namely, those which hinder navigation in the wet season of high water for some five months; and those which hinder navigation in the dry season of low water during the remainder of the year. In the former case, the boatmen disregard all the lesser sunken rocks, stones and shrubs, and lose sight altogether of the little rapids; but fear the fierce current of the rushing volume of water, and the protruding tops of rocks against which they may be thrown, and the points of trees and stones rising close up even to the elevated

surface of the water, upon which their boats may capsize or founder. In the latter case, they disregard the uplifted rocks, or the large trees, which, while moving in quiet water, they can easily avoid; but they are stopped by the tangled meshes of brushwood, and the congeries of lesser stones, so closely packed or jammed together that their boats can neither pass over nor through, nor find practicable egress. Thus it is that some obstructions, which are formidable at one season, are of no consequence at another; and *vice versâ*. At the great barrier near the mouth of the Wyngunga, where in the dry season we failed to make a boat go at all, the boatmen said, that at high water they floated over securely. At the lesser barrier, near Bhûndarah, where at flood level the violence of the water is said to be so terrific, that no boat could live, we passed down, during the dry season, in a boat amidst scenes that were placidly picturesque. It may be convenient to bear this distinction in mind, during the following brief description of the bed and channel of the river.

Mr. de Grousilliers' report.

51. Most of the description now to be given is derived from what I myself saw in the driest season (the last days of May and the first days of June 1866). The local information was obtained, at the time and on the spot, from the inhabitants, by Captain C. B. Lucie Smith, the Deputy Commissioner of the District. But it should be added that Mr. E. de Grousilliers, Executive Engineer, accompanied by Mr. Farley, of the Transport Department, descended the river from Kamptee, near Nagpore, to the confluence with the Wurdah, at the end of September and the beginning of October 1861, in four "Sangadies" (Canoes) which had been hired and housed over for the purpose. Mr. de Grousilliers made an official report of this voyage, from which quotations will be given now, and which (at least that part which pertains to the Wyngunga) will be appended in extenso.

The distances of the river course are taken with approximate correctness from the old topographical Survey map prepared by Messrs. Norris and Weston, and republished by the Surveyor General of India.

The Pranheeta barrier.

52. This description may be best commenced from the lower portion of those rocks which studding the bed of the stream, from a point between Dewulmurree and Ahiree, and thence upwards to the junction of the Wurdah and Wyngunga, and beyond that to near the village of Durroor on the Wurdah, a total distance of thirty miles, are commonly spoken of as, and now officially designated, "the 3rd Barrier of the Godavery." In reality, however, the local name of the river, formed by the confluence of the Wurdah and Wyngunga, is the "Pranheeta."*

The rocks near Ahiree.

53. A short distance above Dewulmurree, there begins a series of jet black rocks, edging the main stream of the river, more particularly the left or northern side. They do not form a continuous wall; but rise up in piles, sometimes pyramidal; these separate blocks are close together, and much in the same line; they are several in number, perhaps twelve or more; and stretch for half a mile or upwards. I looked at these in company with Captain Lucie Smith, the Deputy Commissioner, and we judged them to be at their highest points from 15 to 20 feet high, above low water level. Beneath them the water flows smooth, and we passed up and down it in a boat. Behind them, to the main land, there stretches an expanse of boulder and rank brushwood in such confusion as to baffle description. This expanse must be mostly submerged in the flood season. But the points of the piles of rock above specified must protrude. As the floods come down, the people

* "Pranheeta" is the Teloogoo for "River of Life;" that being the language of this part of the country.

say that the dash of the water against the rocks, flinging and tossing the spray about, is grand. The Abiree Chief informed me that no boat ever tried to pass this place in the flood season; and that he would not try it, for fear of his life. This place, which is the first obstruction to those going up, or the last to those going down is, so to speak, the pinch of the case; and among the very worst parts in the whole barrier. It may be distinguished by name as the Dewulmurree rocks. The scene is one of interest, perhaps, even of beauty. Above this, for a short distance, up to near Choonchgoodee, (opposite Abiree, which lies a little inland,) it is possible in the dry season to go in a boat, and doubtless would be practicable in the wet season. But even the boat winds its way amidst sand and rocks, and islets; all which obstructions increase, as the village of Boree is approached.

54. Near Boree, about eight miles above Abiree, the river is quite impassable for boats of any description during the dry months; the bed of the stream is, to a great extent, blockaded with rocks, some of which are from 10 to 15 feet high. During the rains, when the floods are high, the rocks being nearly all submerged, large boats can be passed over; the only difficulty being the velocity of the current, when the freshes are at their height, which is sometimes so severe that boats going up the stream are obliged to defer their onward course until the waters have somewhat subsided. But then the points or peaks of the rocks protrude, and cause a new trouble to boats going down. Above Boree, the rocks, though very numerous, are of a less formidable character for about two miles; when near the hamlet of Teckapullee, they again increase in extent and numbers, and form an almost unbroken bar, from bank to bank, athwart the stream. This place is impassable during the dry months, but during the floods the rocks are submerged, and the passage of boats unobstructed.

The obstructions near Boree.

55. About 9 miles further up, near the village of Mareygaon, the rocks again rise to a considerable height, and form one of the most critical points even during high water season. The inhabitants give an imposing account of the collision of the floods descending upon the rocks about here, and of the eddying whirlpools.

The rocks near Mareygaon.

56. Approaching the junction of the Wurdah and Wyngunga, the Pranheeta gradually becomes wider. At the junction itself, there is a breadth of fully one mile, subdivided into a network of small streams by innumerable ridges and piles of rocks, and with several islands, the whole forming a sort of labyrinth.

57. In the Wurdah (above the confluence with the Wyngunga) the rocks continue for some seven miles, but are not of a particularly troublesome character; till the formation of rock is reached, which was proposed as a site for an anicut, as being on the upper crest of the barrier. The distance from the rocks above Dewulmurree to the confluence of the Wyngunga and Wurdah is 23 miles by river course, leaving seven miles more to Durroor, up the Wurdah; in all 30 miles, constituting what is known as the "3rd barrier of the Godavery."

58. The foregoing remarks apply to the Pranheeta, and not to the Wyngunga proper. The following remarks will refer to the Wyngunga itself.

59. At the junction, the Wyngunga is three quarters of a mile broad, with several deep pools. The water is still, and blue; the stones have varied hues, and the scene is picturesque. People are ferried across in the dry season. The banks on either side are flat, and of earth fairly well defined and 20 to 30 feet, sometimes more perhaps, above the low water level. The village here is named Koongara. Immediately

The mouth of the Wyngunga.

above the junction the rocks in the Wyngunga are not so numerous, but sometimes they rise in scattered pieces several feet high, and sometimes sunken points are met with a few inches below the surface of the water.

60. About three miles above Koongara, and a little below the village of Ashtee, the river is very shallow and blocked up by a ledge of rocks, over which not even the smallest country boat can pass during the dry months of the year, the river escaping through chinks and crannies. From Ashtee on to the village of Kurroolee the banks become rocky, but in mid-stream there is a good channel of water on which the boats of the country ply all the year round from one village to another. About a mile above Kurroolee, opposite to the village of Yenna on the right bank, the passage is again closed in the dry season by thick banks of low rocks through which the water drains in minute streamlets.

61. Two miles above the lower boundary of these rocks the river is divided by the cultivated island, on which is situated the village of Koorta.* Of the two streams running, one to the east and the other to the west, of the island of Koorta, the latter is narrow and never navigated; the former, at present the main stream, though by no means good, is just passable.

The island of Koorta.

62. To within 1½ miles of the village of Koorta the bed of this main, or east stream, is thickly strewn with rocks, the tops of which are about 8 or 10 feet above the water in the dry season. During the floods, these rocks are submerged, and country boats pass up and down the stream with some difficulty. But in other

The main stream.

* The morning I visited the lower tongue of this island, the foot-prints in the sand shewed that a tigress and cubs had just been down to the water to drink.

seasons of the year, owing to the narrowness of the Channels, it is only just possible to float a single boat, lightly laden, from above the rocks at Koorta down to Kurroolee. From Koorta onwards to Ghatkool, and for a mile or so beyond that, the stream is comparatively free from rocks; and though very shallow in places, is more or less passable at all seasons of the year. In fact, opposite Ghatkool, there is a sort of pond in the river.

63. In the lesser, or west stream, from the commencement of the open water above Kurroolee, the bottom is almost paved with rocks, which, continuing to within five miles of Ghatkool, terminate abruptly in a wall-like barricade several feet high, through which one can hardly understand how the water squeezes its way: it must percolate through crevices. Above this stony bar is a beautiful deep pool which stretches about ½ a mile northwards. The branch then, up to its junction with the main stream, about a mile below Ghatkool, becomes extremely shallow; and in some places is all but dry in the hot months.

The side stream.

64. Near the head of the Koorta island, the stream which flows past Mhool, joins the Wyngunga; but is quite dry during the hot months.

65. At Ghatkool we may pause for a moment to note that, from thence to Ahiree, country boats do now go year by year, backwards and forwards, carrying produce. The traffic is as yet small, perhaps a few boats in a month, during the high water season; and the boatmen sometimes meet with dangers and troubles; and altogether the service is one that required some nerve and skill. Again, boats and canoes are made at Ahiree (excellent timber being procurable there) and are thence sent by water in flood time to various places up the river. These go unladen and can get over difficulties where laden boats could not venture; and thus

Boat traffic between Ghatkool and Ahiree.

is so blocked up with rocks, many feet high, as to be awkward for navigation even during the floods.

69. Above the head of Larolee island, is the village of Kurrumgiron. The channel is somewhat better, though it twists about in a maze of stones at low water; yet the floods would carry boats over these troubles. But higher up, off the village of Borghat, there is a bad piece with a fall of 13½ feet in 1½ miles, according to Mr. de Gronsilliers; and further up there is a rapid marked by him, with a fall of five feet in about a mile, near the villages of Kowtee and Pardee.

70. From the confluence then up to Kowtee, a distance of thirty miles, (by river course) I should reckon the first, or lower barrier of the Wynganga. For all that distance the bed is almost covered with rocks, causing a continous obstruction to low water navigation, and rendering even high water navigation precarious and not free from danger. In Mr. de Gronsilliers' words, it may be called "a continuation of the 3rd barrier" (of the Godavery.)

The first or lower barrier of the Wynganga.

71. From Kowtee onwards to Chamoorsee, a distance of 8 miles, the channel is, in parts, better; there is more of sand, and the rocks are at much longer intervals. At one point near Chamoorsee, there is a low ledge of sandstone almost athwart the stream, on the high bank of which are built the fine old Markundah Temples. The rock, though known to antiquarian tradition, is not such as to afford an obstruction. There is a slight rapid, marked by Mr. de Gronsilliers, just above Chamoorsee, (six feet fall in two miles,) between the villages of Arumba and Kurrelee.

The river of Chamoorsee.

72. Above Chamoorsee there is some local navigation, as will be seen presently. But below Chamoorsee down to Ghatkool (a distance of 23 miles by river course,) there is no local navigation: indeed

The break in navigation between Chamoorsee and Ghatkool.

this section is a regular break or gap. As a competent native witness deposed at Chamoorsee, "Boats very seldom go south of Chatkoorsee in consequence of the difficulty of navigation." This statement applies only to the piece between Chamoorsee and Ghatkool. Again, another native witness deposes, "between Chamoorsee and Ghatkool the navigation is difficult, by reason of the high rocks and large trees growing in the bed of the river." Exceptionally, Government ferry boats, made at Ahiree, are brought up thence past Ghatkool, on to Chamoorsee, and thence further up the river. Captain Lucie Smith observes, that, "the passage of these boats proves that, under favorable circumstances, double canoes can be taken all the way up the Wyngunga." This is very true; but in practice, the thing is not done in the interval between Ghatkol and Chamoorsee, save with unladen boats specially despatched and cared for.

Government boats.

73. Though the crest of the barrier may be considered as beginning from Kowtee, 8 miles lower down stream, yet as Chamoorsee is a well-known place, it will be easier to count the lower barrier of the Wyngunga as being between Chamoorsee and the confluence.*

74. From Kowtee, eight miles below Chamoorsee, past Gurhchoroolee and Armoree, to Pohonee (and indeed further on to Ambora), a distance of 103 miles by river course, there stretches, what I would term, the first or lower reach of the Wyngunga. In this section, the bed is generally free and unobstructed, the average breadth being about one third of a mile, or 600 yards.

The first or lower reach of the Wyngunga.

* Mr. de Gronsilliers would apparently consider the barrier as commencing further up, that is from Gurhchoroolee, but, as enquiry shows, that there is water traffic between Gurhchoroolee and Chamoorsee, I have restricted the barrier to beginning from below Chamoorsee only; and even that makes the barrier to be little longer than it really is.

The banks on either side are of earth, fairly defined, not high, perhaps from 20 to 30 feet in height, though sometimes lower, and flat at the top; in the dry season there being a broad expanse of sand with one or more channels meandering in the midst; in the wet season an equally broad flood flushing from bank to bank, sometimes even overtopping, and causing backwaters. There do occur however some occasional difficulties (they can hardly be termed obstructions) to navigation, either from rocks or from slight rapids. One such occurs off the village of Dubgaon, another off the village of Chiklee, nearly opposite Gurhchoroolee. These were observed by Mr. de Gronsilliers at low-water in October 1861. The native boatmen also depose to there being two rocky places between Gurhchoroolee and Chamoorsee. Then near Armoree, between the villages of Soonee, Oogura and Peepulgaon; there are rocks more or less dispersed over the channel. Several of these latter I saw myself. Captain Lucie Smith also writes that, in April 1866, he went down that section of the river which is opposite Armoree in a double canoe, and he observed "several large rocks standing boldly out of the water." Immediately opposite Armoree there is a regular boat ferry, and a fine pool where fish are netted in quantities. From the village of Peepulgaon to the town of Pohonee it is plain sailing, and Mr. de Gronsilliers pronounces the river here to be "pretty clear." There is a small traffic by water carriage between the towns of Chamoorsee, Gurhchoroolee, Armoree and Pohonee, all which, as will be remembered from the previous sections of this minute, are flourishing places along the river. This boat traffic is merely local and carried on in those months when the water is tolerably high, and without difficulty, according to the depositions of the traders and boatmen. It is in this section that the river Choolbund joins in.

Rocks near Armoree.

75. Above Pohonee the river continues clear,

Obstacles between Pohonee and Ambora.

though the water is shallow for several miles, or as far as the village of Ghosee. At this point Mr. de Gronsilliers, passing down in October 1861, observed that A "ridge of rocks stretches from bank to bank, with two narrow shoots through them." A few miles further on he remarked that, between the villages of Soondur and Kurraie, "the river is literally strewed all over with rocks." This is seen at low water. At high water, boats are wafted securely over these stones. Mr. M. Low, the Deputy Commissioner of Nagpore, and one of his Assistants Mr. J. Nicholls, passed down to Pohonee in August of this year. They report that "we met with no rocks: there were some isolated peaks here and there, but not in the channel of the stream. The current ran fast and very easily all the way down."

76. A short distance further on occurs Ambora. Up to this point from below Chamoorsee the river's course has been through a flat country. But at Ambora low hills occur, with regular rocky formations in the channel, and the scenery becomes fine. The first reach reckoned already from Kowtee below Chamoorsee to Pohonee, (83 miles,) may more correctly be reckoned as extending past Pohonee or to the foot of the Ambora Hills, 20 miles further on, in all 103 miles.

77. From Ambora, to a village named Mugurdokra * occurs what I would term the second or lesser barrier of the Wyngunga, extending over a distance of five miles.

The second barrier of the Wyngunga.

78. At Ambora Mr. de Gronsilliers observed that "ridges of rocks run right across the river and leave only narrow shoots for small boats to pass through." I have myself seen this place at low water. One of these ridges has a striking appearance—at first sight it seems to be an anicut or artificial weir; on a nearer view it looks like a black hogs-back. Mr. J. Nicholls (in 1866) thus writes of the spot at high water. "We came across another ledge of rocks close under the Ambora hill, *we* had no difficulty whatever." A short distance above Ambora is the well known pond of Tiddee, where quantities of fish are caught and sent to Nagpore and Kamptee. Above Tiddee, the river winds through rocks to Mugurdokra. Of these Mr. de Gronsilliers observes:—"The large masses of rocks we encountered were near Mugurdokra; they extend for about half a mile and have at present no practicable passage between them." This was at low water. Mr. de Gronsilliers must however have got round them somehow. I certainly myself went down this part in a boat during the dry season. There was throughout a channel to be found quite navigable for small boats at that season: but we wound about among rocks, which sometimes looked like little towers and pyramids, sometimes like walls and buttresses; and often rose to a height of 20 feet. My clear impression was that, about here, the obstacles to navigation would be dangerous and critical at high water, and that any boats which might venture there in the freshes could hardly escape the alternative of either Scylla or Charybdis. Captain Fraser of the Police marks opposite Mugurdokra "great danger." Mr. Nicholls writes, "we could hear the hoarse surging of the water over the rapids of Mugurdokra, when we were two miles off the place." Just below (about two miles) Mugurdokra, the Kunhan river joins in, near the village of Gond Peepree. Here also are rapids and whirlpools, of which the roar can be heard for a long distance.

79. It is however remarkable that, breaking off on its left bank from a point just above Mugurdokra, the Wyngunga is cutting for itself a channel which goes round all the rocks and rapids of Mugurdokra and Gond Peepree, and

The side-channel.

* The meaning of the name is Alligator's pool."

runs into the Kunhan close to its confluence, thus making a sort of natural canal round the worst part of the barrier, much in the same way as an artificial canal is made. This may turn out to be a providential circumstance for navigation. Mr. Nicholls writes :—

"We avoided the danger and missed the scenery by leaving the Wyngunga and going down a very narrow but swift channel which the river is cutting gradually for itself into the Kunhan. In the channel the banks appear to be of a soft gravelly deposit and of considerable height. I have no doubt but that eventually the main stream will join the Kunhan by this way instead of precipitating itself over the rocks at Mugurdokra. This passage of the Wyngunga, till we reached the deeper bed of the Kunhan by water, could not have been less than two miles ; and I should calculate the total fall at several feet."

Mr. Low writes that, at this point (near the junction), the passage of the Kunhan was safe, without any risk. This remarkable side passage must be from comparatively recent erosions, as it is new and not marked in any of the maps. Thence, from the confluence of the Kunhan down to Pohonee, Mr. Nicholls appears to have swept along past Ambora on the flood currents down to Pohonee without meeting any obstacle whatever.

80. Above Mugurdokra, and five miles south of the town and station of Bhundarah, the second or upper reach of the Wyngunga may be reckoned. Here the dimensions of the river are imposing. Mr. Nicholls thus describes it in August 1866:—"We started about noon, not on the river itself, but from a lagoon connected with the river. As it opened out, the sight was very striking. The broad bed, full from bank to bank, and the current running with great velocity, an uninterrupted volume of water above 700 yards, or half a mile wide. We were taken by the stream at the rate of about 6 miles an hour." This reach extends, without let or hindrance, past Bhundarah ; past Moharee and Toomsur (the large grainmarts) ; past the mouth of the Bawunthurree, the mouth of the Choonee, and the mouth of the Baug; and past the town of Hutta, up to a point between the villages of Peepree and Cheezgaon. Along this length of sixty (60) miles by river course, there is already local traffic by country boats, which ply for several months of the year when the channels are sufficiently full, without meeting any obstruction whatever.

The second or upper reach of the Wyngunga.

81. At the point between Peepree and Cheezgaon there is an obstruction from rocks, probably the basement of a detached hill hard by, which, though it stops the boat traffic just now, can hardly be styled a barrier in comparison with the places previously considered in this Minute. This spot was examined by the Deputy Commissioner, Captain Newmarch, in 1865, who reports the rocks to be rugged and to extend for some little distance. He has had some experience in the blasting of rocks on roadways, and seems to consider that this obstruction might be removed with a very moderate outlay.* If it were removed he justly observes that the Wyngunga would be navigable from the limits of the Mundla District, that is from the foot of the Sautpoora Range, some twenty (20) miles further. This being counted as an intermediate obstruction only, the second navigable reach of the Wyngunga may be said to stretch from below Bhundarah to the foot of the Sautpoora Range, a total distance of 85 (eighty-five) miles.

The obstruction at Peepree.

82. To this general account of the channel of the Wyngunga ; it must be added that there is no exact information as to the slope of its bed, no complete levels having yet been taken. Major Haig supposed this to

Slope of the bed of the Wyngunga.

* He supposes that 15,000 Rs. (£1,500) in round numbers : but this must be too little.

be about 2½ feet per mile (which is much greater than that of the Godavery, generally one foot per mile.) Judging by the eye I should apprehend that the Wyngunga has a quicker stream than the Godavery. According to Mr. Hanna there is a difference of 138 feet in level between the Kunhan and the confluence of the Wyngunga and Wurdah, a distance of 200 miles, which gives an average of 2·19 feet of fall per mile. Colonel Fife in his memorandum deems that the fall may be less than this perhaps.

Previous knowledge of the river.

83. Reviewing Mr. de Gronsilliers' report in 1862 Major Haig remarked that "this report gives a very unfavourable account of the Wyngunga as regards navigation. In its natural state this river appears to be useless for purposes of communication; and such a very rocky bed affords little hope of the possibility of improvement without a considerable outlay." Now this remark about the nature of the bed is quite applicable to about 30 miles of one barrier, and 5 miles of another and to few detached obstructions at intervals. It is also true that the barrier impediments will not be removed without a considerable outlay. On the other hand several sections of the river are now actually used for local trade and communication; some more, others less, and others but little. This traffic is at present of a detached and local character. But it is an existing fact of some importance. And the sections of the river used in some shape or other for communication, though at some points more imperfect than at others, do aggregate a mileage representing four-fifths of the entire course of the river below the Sautpoora Range. Of course the circumstances of this existing communication are better known in 1866 than they could have been in 1862.

The channel of the Kunhan.

84. From its junction with the Wyngunga the Kunhan is smoothly navigable at high water. Mr. Low recently passed down it. But at low water there are three small reefs off the villages of Kangaon

Panmara and Chikna respectively, which in their existing condition, would at that season be passable for small boats only. These were observed by Mr. de Gronsilliers. Further on, off the village of Rahree (or Reddie in the old maps) there is a barricade of rocks. Mr. de Gronsilliers, at low water, writes of them thus, "a series of rocks exists which at Reddie completely bar all passage; and considering the great quantity of rocks and their unusual size, I should pronounce this part of the Kunhan impracticable for navigation even in a high fresh." That this view is very correct is shown by Mr. Low's recent experience. He recently tried to pass the spot in a boat even with the aid of the full flood, but failed. He writes thus of it:—

The obstruction at Rahree.

"This constitutes a regular fall in the river. We walked till we got to the foot of the bar. The length of the critical part is about 300 yards. When we got into the boat below, we could not see the water above the fall, of which the height must be seven feet. The water framed and curled down it with crested waves." Here then there is a bar no doubt. But from the village of Jhurool (or Jooler) where the rocks begin, there is a small bend in the river, across which perhaps a short channel of some 2 or 3 miles might be cut; or the barrier itself might be turned into a weir. At all events this impediment might probably be overcome at a moderate outlay. From Jhurool on to Kamptee (15 miles) the navigation is clear. Mr. de Gronsilliers at low water considered the Kunhan in this section as "a fine river. The bed was pretty clear of rocks; we carried also good depths of water, and found generally 36 feet." Immediately above Kamptee, the bed of the Kunhan becomes again blockaded with rocks, of which Mr. Low gives an unfavourable account, having passed over them with difficulty in a boat during the season of high water. The length of the Kunhan from the confluence to Kamptee is 30 miles.

85. The Choonee river from its confluence with

the Wyngunga up to the grain mart of Rampylee, a distance of ten miles is navigable, and may even now be used by boats.

Obstructions in the bed of the Baug.

86. The channel of the Baug river is obstructed just before its junction with the Wyngunga, and just after it has received the waters of its affluent the Deo. This bar occurs between the villages of Rajagaon and Satona. Captain Newmarch, the Deputy Commissioner, after examining the place in 1865, thus reports, "I found on enquiry from the boatmen that the bar is annually submerged when the river is in flood, but is not passable even for unladen boats till the floods subside sufficiently to allow of the points of the rocks being perceptible and thereby indicating the course of the channel between." * * * "If this channel were to be cleared and formed in a curve by keeping along close to the north bank, the rush of the water would be much diminished; but to make this passage safe for laden boats, a good number of rocks would require to be removed. But all the boatmen present seemed to think this round-about channel the most practicable scheme." Captain Newmarch proceeds to state, that this impediment might be overcome with a very moderate outlay.*

87. Just beyond this the Baug, as already stated, is joined by the Deo, rising in the southern crest of the Sautpoora Range, passing through a rich country; and navigable for some miles at high water. Further on, the Baug is joined by the Sohun or Sone, much the same sort of stream as the Deo, also flowing through a rich tract and navigable for some miles at high water. Then the Baug passes near the town of Kampta, and skirts the tract known as the Lanjee Talooqua.

* He supposes, in round numbers, that the cost would be 10,000 Rupees (£1,000), but this must be too little.

88. Writing on this subject in 1865, Mr. R. E. Egerton, the Commissioner of the Nagpore Division observes:—"The produce of the District through which the Wyngunga, and its affluent the Baug with the Deo and the Sohun, flow, is carried during the rains in boats of small burden to the landing place of Oomurwarra near Toomsur. * * * The river traffic is very extensive; and water carriage becomes available at a time when land carriage is stopped. It is therefore very important that obstructions to water carriage should be removed as far as possible. * * * * If this bar could be improved, so that laden boats could pass them during floods; the cost of carriage of produce would be much lessened; the amount of traffic increased; and the time of each voyage reduced." The navigable length of the river Baug, with its feeders the Deo and Sohun, cannot be less than 30 miles.

89. The above general description of the channel of the Wyngunga, and its affluents may be summed up thus.

Conclusions regarding the channel of the Wyngunga and its affluents.

I. Immediately below the confluence of the Wyngunga and the Wurdah that is in the Pranheeta, there is a barrier about 23 miles long; irrespectively of some 7 miles of barrier in the Wurdah immediately above the confluence. This is included in what is officially styled "the 3rd Barrier of the Godavery."

II. Just above its mouth or confluence, the Wyngunga has a barrier of 30 miles in length, the upper crest of which commences from a point a little below the town of Chamoorsee; and which may be styled "the first or greater barrier of the Wyngunga."

III. From a little below Chamoorsee to the town of Pohonee and on to the foot of the Ambora hills, there is a reach now actually navigated and having but occasional minor obstructions at about six places; over a length

of 103 miles; which may be styled "the first or lower reach of the Wyngunga."

IV. From Amboa to Mugurdokra, a few miles south of the town and station of Bhundarah there is a barrier five miles in length, which may be styled "the second or lesser barrier of the Wyngunga."

V. From Mugurdokra, up to near the foot of the Sautpoora Range, there is a reach 85 miles in length now actually navigated, save at one interruption which is of a removable character. This may be styled "the second or upper reach of the Wyngunga."

VI. The Kunhan, an affluent of the Wyngunga, is navigable from Kamptee to its mouth for 30 miles, save at one point of interruption which could be surmounted without difficulty.

VII. The Chouee, an affluent of the Wyngunga, is navigable up to Rampylee, a distance of 10 miles.

VIII. The Baug, an affluent of the Wyngunga including its two feeders the Deo and the Sohun, is navigable for 30 miles, save at one point where the obstructions are quite surmountable.

IX. If these several barriers and occasional obstructions could be overcome, there would be opened up 223 miles of through navigation in the Wyngunga itself, and 70 miles in its affluents; in all 293 miles: in the midst of a country for the most part rich and populated: and this in combination with the Godavery scheme, but in addition to any extent of navigation heretofore promised from that project.

X. Of the above 293 miles, some 163 miles, are even now partially and locally navigated, though to an extent quite incommensurate with the resources of the country: but owing to the said barriers and obstructions, there is no through navigation whatever.

SECTION VIII.—THE PRACTICABLE MEANS OF OPENING THE NAVIGATION.

90. The primary object is to connect the navigation of the Wyngunga with that of the Godavery. It has been seen already from para 3 of this Minute that Colonel Fife suggests that the weir to be built for the 3rd barrier of the Godavery should be placed just below the junction of the Wyngunga; and that the canal, already under consideration should be commenced from that point, and thence taken down, to Mogellee at the foot of the 3rd barrier. This he justly observes would connect the navigation of the Wyngunga with the Godavery project. Moreover he holds that such a weir would "answer for both rivers" (i. e. both the Wyngunga and the Wurdah). He thinks it should be 28 feet high or rather more. Doubtless it should be at least 30 feet high. Inasmuch as the combination of the navigation of the Godavery with that of the Wyngunga, or the adaptation of the Godavery project to contingent works on the Wyngunga, depend on the main weir being below the confluence, the matter becomes one of fundamental importance; and should be taken into immediate consideration, whatever view may be formed of schemes for the Wyngunga itself. Further, Colonel Fife truly remarks that a weir so placed would overcome some twenty feet out of the perpendicular measurement of falls and rapids in the lower barrier of the Wyngunga itself. He goes on to say that without a survey it is impossible to specify how many more weirs would be required to overcome the remaining falls and rapids in this part of the river; but considering that the main channel is of moderate dimensions and that stone material is very abundant, he believes that "the construction of the weir need not be a difficult or expensive matter."

Weir below the confluence of the Wurdah and Wyngunga.

Its fundamental importance.

91. It has been seen that the 1st or greater barrier

Works requisite in the 1st or lower barrier of the Wyngunga.

of the Wyngunga extends for at least thirty miles or more; and thus the size or number of weirs would largely depend on the slope of the bed within this distance. Colonel Fife seems to consider that the fall may amount to 60 feet; which would give two feet per mile. I should apprehend however that the total fall may be in excess of this, the slope in this section being probably more than 2 feet per mile. On the assumption however that there may be from 60 to 80 feet to be overcome, two weirs would seemingly suffice; perhaps they might be somewhere in the neighbourhood of the Koorta island, and the Larolee island, described in the foregoing section VII. of this Minute. Or if a short canal were preferred, then on either bank the ground is generally flat, not intersected by any considerable stream, and having nothing more than the ordinary surface drainage. Thus it would appear quite possible that (exclusive of the main weir below the confluence which would subserve jointly the Wyngunga and the Wurdah) the 1st or greater barrier of the Wyngunga proper might be surmounted by an outlay not materially exceeding that contemplated for the minor project at the 1st barrier of the Godavery, or for the approved project of the 2nd barrier.

92. This done, the navigation would be cleared to a point somewhere near Chamoorsee, and the communication would be opened into the lower basin of the Wyngunga, the country described in section IV. of this Minute. From below Chamoorsee upwards to Ambora, we have seen that there is a reach of 103 miles, interrupted only by occasional obstructions which could be removed by detached works similar to those already approved for the several reaches of the Godavery. Perhaps these detached works would have at one or two points to be somewhat larger than the detached works on the Godavery, though they might be similar in kind.

Detached works in the lower reach of the river.

93. Then at the second or lesser barrier, there are rocks, to manage which would require a work something of the same kind (though of lesser extent) as that proposed for the 2nd barrier of the Godavery. But then it has been seen, that there is a fair chance of the side-channel, which the river is scooping out for itself laterally, being regulated and made use of for navigation, to the avoidance of the crest of the barrier. In the latter case, the outlay would be of a diminished character and would not be large.

Probable work at the 2nd or upper barrier.

94. The second barrier being got over, navigation is opened right into the country described in section III. of this Minute as the upper basin of the Wyngunga. This territory, one of the finest parts of these Provinces, is permeated by the upper reach of the Wyngunga some 85 miles in length, and by its navigable affluents the Kunhan, the Choonee, and the Baug; with a further length of 70 miles. In all these reaches and lengths there are but three obstructions; one in the Wyngunga itself, one in the Kunhan and one in the Baug, all which can be overcome at a moderate cost, by detached works resembling those in the Godavery reaches.

Removal of obstructions in the upper reach of the river.

95. If it were desired to store water for the supply of the navigable channel of the Wyngunga, then (whatever be the difficulties in the case of other rivers), there are in the case of *this* river, extraordinary facilities. It is not easy to imagine more suitable sites for such a purpose, than those which have been actually found near the head of the Wyngunga and its tributaries. Colonel Fife remarks "the facilities for storing water are very remarkable * * *. Compared to one of the best tank sites we have been able to find in the Deccan part of the Bombay Presidency, the advantages are in proportion of nearly 7 to 1." He shows that in the Deccan only 114

Facilities for storage of water.

cubic yards can be stored for the Rupee—whereas for the Wyngunga as much as 900 cubic yards could be stored for the Rupee.

The Pench reservoir.

96. It has been ascertained by Mr. Hanna, that for sixteen lakhs of Rupees or £160,000, the waters of the Pench could be stored for the use of the Wyngunga, to the amount of 450 millions of cubic yards. It might not be necessary to store so great a quantity. If less were to be stored, the cost (if not quite proportionately reduced) would be less. Similarly as much of the Kunhan water as might be required could be stored for the Wyngunga. Further, there is a noble site where the whole waters of the Wyngunga during its course within the Saulpoora Range could be collected and stored in a lake formed by a dam across the gorge bed of the river at the point where it finally debouches from the hills. The dam however would be nearly three miles long, and the work, though apparently quite feasible, according to Mr. Hanna's examination, would be beyond any outlay which could be recommended in this Minute.

Effect of the Wyngunga Weir upon the Wurdah.

97. Lastly, in reference to the foregoing para 90 regarding a weir to be constructed just below the confluence of the Wyngunga and Wurdah, which it is believed would answer for both rivers—it may be well to add just one observation regarding the Wurdah. It will be borne in mind, that the Wyngunga joins the Wurdah in the midst of what is now called the 3rd barrier of the Godavery. That part of the barrier which is below the junction has been already described in this Minute. It has been seen too—that above the junction to the upper crest of the barrier, there is a distance of seven miles within which Colonel Fife observes, that between these points there is a fall of 28 feet. A weir therefore of 30 feet below the confluence would not benefit the Wurdah quite so much as a weir at the upper

crest. Still, it is clear, that a weir of 30 feet or so, just below the junction of the Wyngunga would cause all the rocks of the upper crest to be submerged and would dam the water up for a short way beyond. Then Colonel Fife remarks that "the Wurdah's bed is so flat immediately above the barrier, that the effect of a weir placed even on the lower site (i. e. below the junction of the Wyngunga) will extend a long way up the Wurdah." If the Wurdah is to be made navigable above the 3rd barrier, it must (as is well known) have weirs or some such works at intervals. Then Colonel Fife remarks that "a suitable site for another weir where the Wurdah is comparatively narrow may be found."

98. From all this it seems manifest that the principal work at the 3rd barrier of the Godavery, the opening of which has been long under consideration, and the prosecution of which is, according to the Secretary of State's Despatch of February 1866 definitely decided on—*can be so placed, and can be constructed on such a site, as to form the basis of the Wyngunga navigation works*, while subserving almost equally well the requirements of the Wurdah.

SECTION IX.—CONCLUSION.

Secretary of State's Despatch regarding the 3rd barrier.

99. The concluding part of this Minute may proceed from the starting of the Secretary of State's Despatch No. 11 of the 8th February 1866, prescribing that the 3rd barrier of the Godavery is to be opened. This barrier is to be so opened with a view of providing navigation in the rivers above that point. Now what are these rivers? They are two; the Wurdah and the Wyngunga. Firstly, as regards the Wurdah, without any depreciation of its importance, and with full recognition of its cardinal advantage, in flowing through the best cotton field, still the objections to it are,

that it is not per se a very large stream, that its main affluent the Pyngunga flows from end to end through foreign territory, that it has not a great navigable length—that it has not a very large volume and discharge, that it does not drain, or water, as the case may be, a very great extent of British territory—that it has nothing which could be called a local boat traffic. Now, secondly, the Wyngunga possesses every one of those advantages in which the Wurdah is somewhat deficient. It has a long course, mostly navigable; it has a mighty volume; it traverses a broad territory comprising the richest and strongest districts of the Central Provinces; it passes near to the two capital cities of the country; it already has a local boat traffic.

Importance of connecting that with the Wyngunga.

100. If then the 3rd barrier of the Godavery is to be opened for the sake of the rivers beyond, the Wyngunga claims attention even more than the Wurdah, and offers even a more promising field for the outlay of capital. The Secretary of State appears to consider that navigation should be conducted into the heart of the Nagpore country. The Wyngunga would accomplish this great object even better than the Wurdah. For the Wyngunga (with its feeder the Kunhan), would bring navigation almost to the very doors of Nagpore and Kamptee. One objection to the project for the Godavery with the Wurdah, has always been that the boat traffic, now non-existent, will have to be created. But for the project of the Godavery with the Wyngunga, it can be said that there already *is* a boat traffic, which may well be the nucleus of a great trade. Another objection to the river above the 3rd barrier has been, that the navigable length would not be great. But with the Wyngunga an additional length of nearly 300 miles would be afforded beyond the 3rd barrier. Further it has always been objected to the Godavery, that it flows through a wild country. But a large part of the upper length of the Wyngunga flows through fertile and

peopled territories, with a population of more than two millions.

101. If effect is to be given to the declared intention of opening the third barrier of the Godavery; then it follows as a corollary, and as an integral part of the scheme, that the channel of the Wyngunga right up to Nagpore should be professionally examined. That it can be made navigable at a comparatively moderate outlay is probable. This *prima facie* probability should be tested by full and competent examination. For, if the practicability of the works were demonstrated, it is sufficiently certain that the future results would be excellent.

Professional examination of the Wyngunga recommended.

102. On all the grounds set forth, or attempted to be set forth, in this Minute, I recommend, that when the professional designs, plans and estimates are made for the 3rd barrier of the Godavery, the combination of that work with other works for the navigation of the Wyngunga be specifically considered; and that the enquiries be extended not only up the Wurdah but also up the Wyngunga.

103. If this general view shall be approved by the Government of India, I can submit separately a sketch of the Engineering Establishments required, which will however be moderate.

NAGPORE,
The 18th September, 1866.

R. TEMPLE.

APPENDIX.

Extract from a letter of Mr. de Gronsilliers, Executive Engineer, referred to in para. 51.

32. Mr. Farley joined me again in Kamptee on the 24th September, and we commenced descending the Kunhan river on the 26th September in four Sangadies (Canoes) which had been hired and housed over for the purpose.

Kamptee to Jooler.

33. Thence to a village called Jooler, a distance of 15 miles, the Kunhan is a fine river, the bed being not only pretty clear of rocks, but we carried also good depths of water, and found only off Pepree and Kangaon less than 36 feet water.

Reddie barrier.

34. From half mile below Jooler to Mohoda, a distance of 6 miles, series of rocks exist, which at Reddie completely bar all passage, and considering the great quantity of rocks, and the unusual large size of the same, I should pronounce this part of the Kunhan impracticable for navigation even in a high fresh.

Bad rocks.

35. From Mohoda to the junction with the Wynganga, a distance of about 16 miles three other reefs exist, viz. of Chikna, Panmara, and Kangaon, at present impassable, except for very small boats.

Shoal off Mohogaon.

36. Mohogaon is the only place where shoal water, 1½ feet, is to be found, in all other places 3 feet is the least depth.

Current.

37. The current in the Kunhan averages about 2 m. P. H.

Junction with the Wyngunga.

38. The Kunhan joins the Wyngunga at Tiddee, about 8 miles below Bhundarah.

Departure from Bhundarah.

39. I inspected the Wyngunga from Bhundarah downwards, and left that place on the 3rd October.

Mugardokra rocks.

40. The first large masses of rocks we encountered were about 7 miles below Bhundarah off Mugardokra; they extend for about half a mile, and have at present no practicable passage between them.

Ridges of rocks off Ambora.

41. Off Ambora, ridges of rocks run right across the river, and leave only narrow shoots for small boats to pass through.

Rocks below Soonder and Kurraie.

42. Below Soonder and Kurraie the river is literally strewed all over with rocks.

Ridge of rocks off Ghosee.

43. Off Ghosee, another ridge of rocks stretches from bank to bank with two narrow shoots through them.

River from Ghosee to Peepulgaon.

44. From Ghosee to Peepulgaon, the river (40 miles) is pretty clear of rocks, at least those off Howree; above and below Lardu; above Chicholee; and above Kurkunra; are easily avoided and not in the channel. The river is in this distance in many places very broad, and also very shallow.

Peepulgaon barrier.

45. Off Peepulgaon another barrier blockades the passage, and rocks are more or less disposed over the river bed till we reach Oogara, a distance of 5 miles.

46. Off Oogara another barrier exists; another off

Oogara and Soonee barriers.

Soonee; and from Gurhchoroolee Ghat till the junction with the Wurdah at Koongara, a distance of 65 miles, I may well call a continuation of the third barrier in the Pranheeta.

Worst places in the barrier.

47. The worst places in this barrier are off Chiklee, with eight feet fall in 2 miles, between Dulhgaon and Sonapoor; between Kurrelee and Arumba with 6 feet fall in 2 miles; from Kowtee to Pardee with 5 feet fall; off Bhorghat with 13 feet 6 inches fall in 1½ mile; off Larolee with 13 feet 6 inches fall in 3 miles; and above Larolee with 8 feet 10 inches fall.

End of journey.

49. We reached Koongara on the 16th October, and went on board the "May Flower" laying off Kirmeree, the following day.

State of rivers this year by native report.

50. From what I can ascertain from the Natives along the banks of both rivers, I find that the freshes this year have been high; further that the water has fallen off very rapidly, and is considerably lower than what it used to be in other years.

No. 50 C, dated 15th December, 1866.

From—C. BERNARD, Esq., *Secy. to Chief Commr., Central Provinces,*

To—*Secretary to Government of India, P. W. Dept.*

In continuation of my letter forwarding printed copies of the Report on the Godavery Works by Colonels Anderson and Fife, and of the Chief Commissioner's Minute thereon, I am now directed to submit the following further papers on the same subject, namely:—

Major Haig's Memorandum on the Committee's Report.

The Chief Commissioner's Minute transmitting Major Haig's Memorandum.

Minute by R. TEMPLE, Esq., C. S. I., *Chief Commissioner of Central Provinces,—Dated 13th December*, 1866.

Since writing my Minute of September last, on transmission to the Government of India of the Report by Colonels Anderson and Fife on the Godavery navigation, Major Haig has returned from England, and I have had the advantage of conferring with him on the whole subject. I then requested him to prepare a Memorandum of his views after a perusal of these papers. This he has done, and I now desire to lay his Memorandum before the Government of India. He enters at some length into the points discussed in many parts of the Report by Colonels Anderson and Fife. In some passages he criticises their opinions or conclusions in a tone which may, perhaps, be regarded as too controversial, and may on that score be objected to. But as some warmth of expression is apt to occur in discussions on difficult and important subjects, I have deemed it better to transmit the Memorandum as it stands, as the substance of it, at all events, is such as the Government of India may desire to have under consideration.

2. The main topic treated of in Major Haig's paras. 1 to 17 inclusive, is the importance of steam navigation on the river in opposition to the view of Colonels Anderson and Fife, who think that steamers might be dispensed with. The Government of India will have seen from my Minute of September last that, in the above respect, I entirely concur with Major Haig. Nothing need here be added to the arguments I then offered.

3. In that Minute I observed that we ought to be sure that the lock dimensions proposed by Major Haig are fully sufficient for the class of steamers required. I find on verbal consultation with him that he, having recently had further and special means of enquiring in England, is satisfied of the sufficiency of these dimensions, and certainly he ought to be by this time in a position to judge.

4. It will be remarked that Major Haig is still confident of the efficiency of stern-wheel vessels, and certainly his printed pamphlet on American Rivers evinces much enquiry on his part into the matter.

5. When the information from Messrs. Napier, as promised in Major Haig's 6th para., is received, it shall be duly forwarded to the Government of India.

6. In his paras. 19 to 21 inclusive, Major Haig expresses dissent from certain criticisms of Colonels Anderson and Fife on the 1st Barrier design. These points being chiefly professional, do not seem to require comment here.

7. In his paras. 21 and 22, Major Haig adverts to the question as to whether the major or the minor project for the 1st Barrier should be prepared. In my Minute of September last, I expressed a decided preference for the major project, the prosecution of which I earnestly recommended. It will be seen that Major Haig fully concurs in this. Having recently conferred with him on the subject, I am more than ever convinced that the minor project, though it *might* be passably good, or barely sufficient, would never be quite good, would never perfectly answer either for the steamers in the rains, or for the boats in the dry season. On the other hand, the major project, though not free from engineering difficulties, does yet only involve such obstacles as can certainly be overcome, and, when carried out, it would, no doubt, answer well. I would therefore decidedly support Major Haig's recommendation for the prosecution of the major project, as being the one on which all the engineering authorities agree as the most [illegible]ent, and as being the one which, upon every general consider[illegible]t the fairest prospect of success. After all the delays and di[illegible]which have occurred, it is apparently most important that the pr[illegible]n should be the very best that can reasonably be had, and th[illegible]ly calculated to fulfil the objects in view.

8. Towards the close of Haig's para. 22, there are certain expressions which might at first sight be thought to mean that the anicut at 1st Barrier was not necessary for a five months' navigation, such however is not Major Haig's meaning, as is evident from the statement in the same para. that, "even for a five months' navigation, the river could not have been depended on without an anicut." In that statement, I believe, Major Haig to be quite correct.

9. From his 23rd to 32nd paras. inclusive, Major Haig replies to the criticisms by Colonels Anderson and Fife on his project for the 2nd Barrier. The points being purely professional, comment seems hardly to be required here. I would only remark that, when the project was brought forward in 1864, the designs were thought good by this Administration, and that, if Major Haig is to be relied on to carry out the work, the Government of India may, perhaps, prefer to allow him to decide the engineering details.

10. To some extent, too, the Government seems to be committed to the general scope of the project, inasmuch as it appears from Major Haig's 33rd para. that he has already, during his recent sojourn in England, ordered plant, &c., suited to the design as previously proposed.

11. Major Haig's para. 34 respecting groins, does not require special comment.

12. Para. 35 relates to past expenditure, regarding which I have nothing to add beyond what was stated in my Minute of September last.

13. Major Haig's para. 38 to his concluding para. 43 relate to the separate Memoranda by Colonels Anderson and Fife, respectively. Hereon I have only one remark to make, besides what was stated in my Minute of September last. In his para. 38, Major Haig remarks in reply to Colonel Fife's Memorandum respecting the storage of water for the supply of the navigable channel :—

"It is satisfactory to find that at last one man has been found to come forward, and recommend for investigation a scheme which has always been regarded as the wildest and most preposterous of even Godavery projects."

14. This passage might at first sight convey an impression not quite correct. For whatever may, or my not, have been the views held by some, such has not been the view held by this Administration. Doubtless such storage has always been regarded as difficult, and the scheme has been looked on as uncertain, until the specific localities for such operations should have been found. But this Administration has not only recommended investigation, but has actually investigated the scheme, and has submitted several sets of papers thereon to the Government of India. My Minute on the River Pench showed that sites for such storage *can* be found for the Godavery Proper, but not for the Wurda. What has been thought, and is still thought almost impracticable, is to supply the River Wurda from storage reservoirs owing to the difficulty of finding sites for such reservoirs.

15. Although, as already observed, some of Major Haig's opinion may be expressed in too positive terms, yet, irrespectively of that, I would solicit for them the consideration which is merited by his great ability and experience and his devoted zeal to the cause in hand.

MEMORANDUM by MAJOR F. T. E., *Superintending Engineer, Upper Godavery Circle, on* LIEUT.-COLONELS ANDERSON AND FIFE'S *Report upon the Godavery Works.*

I propose to notice, *first*, a few of the principal points in which the Report of the Committee agrees with my own views; and *second*, those in which I am obliged to differ from it.

2. It is satisfactory to me to find that the project, as originally brought forward, for opening navigation to Chanda or Hingunghât, is, in its main features, approved of by the Committee. They are of opinion that, "before the communication can be pronounced efficient, the line of navigation should be continued as far as Chanda on the Wurda," and Colonel Fife "would advocate a further examination of the river and its tributaries in connection with storage works, with a view to increase the natural supply during the dry season." This is all that I have ever maintained or asked for.

3. The Committee further consider that, "excluding the portion of the estimate which relates to the construction of a road from Sironcha to Chanda, the expenditure contemplated is approximately sufficient for the scheme as at present defined by the Government."

Whatever differences of opinion may exist as to the probable cost of particular works, it will be satisfactory to the Government to learn that, in the opinion of the Committee, the probable limits of the expenditure required for the completion of the scheme may now be defined with some certainty.

4. The Committee also consider that "the general improvement of the country, and the increase of trade which will be induced by the opening of the communication, will be sufficient to justify the outlay."

This conclusion derives increased importance from the fact that the Committee contemplate a boat traffic only without the aid of steam. If, at a trifling additional cost, the river can be navigated with advantage by steamers also, the value of the communication will be proportionately increased.

The Committee adduce figures to show the great importance of the boat traffic on the Ganges and Indus. On the former river the number of boats have increased in the last eleven years from 142,000 to 251,000. On the Indus, the boat tonnage has risen in the last three years only from 60,000 to 70,000 tons.

5. I will now notice a few of the points upon which I differ from the Committee.

6. With regard to the use of steam-power upon the river.—Upon this subject I am totally opposed to the views of the Committee, and fully coincide with all that Mr. Temple has said in his Minute upon the Committee's Report.

The Committee observe "steam navigation, though it has been long established, does not, as far as we can learn, pay [illegible] enough to enable it to compete with the Railway on the Ganges, and [illegible] pays apparently barely 5 per cent. How can it be expected [illegible] mers can be worked profitably on the Godavery, when the navi[illegible]ers with draught of 3 feet

will be open for only fo… the year, and when the only single advantage to cou… wback is the cheapness of fuel, and while there are serious dis… the heavy floods and frequency of rocks?" To this, I would…

1st.—I am not at all sa… ne inability of the Ganges steamers to compete with the …ailway. I know that up to a year ago at least one of the Navigation Companies was still paying 20 per cent. per annum to its shareholders.

2nd.—The shortest distance by river between Calcutta and the Upper Provinces is, I believe, more than one-third greater than that by rail, and during eight months of the year, when the steamers are obliged to take the more circuitous route of the Soonderbunds, about *twice* as much. This is an immense disadvantage which will not be met with on the Godavery, when the distance from Nagpoor by the river to Cocoanada is about the same as that by rail to Bombay.

3rd.—The "cheapness of fuel" on the Godavery is a most important advantage, the cost being, I believe, not above one-third of that on the Ganges. The whole of the coal for the down-trip on the Ganges has to be first sent all the way up-river from Burdwan, several hundred miles. Its first cost is much greater than that of the wood-fuel so abundant all along the Godavery, and it is further burdened with the cost of some hundreds of miles of up-stream carriage.

…working expenses of steamers know that the cost of fuel is a principal item, and upon it depends in a very important degree the comparative cost of steam transport on different rivers.

This remark applies, I believe, with nearly equal force to the Indus.

4th.—The "disadvantages from heavy floods" are not nearly so serious as the Committee appear to suppose. The flood season lasts for three months only, and the "heavy floods," when the current is at all obstructive to up-stream navigation, not above three weeks; and of those three weeks there is not above one during which even the feeble little steamers now on the river find the ascent of the stream impracticable. On the Indus, the river is in flood for six months; it rises steadily with a constantly increasing current for the greater part of that time, instead of being subject like the Godavery to only two freshes, which rise and subside in the course of a few weeks, and having a broad flat bed of immense width, and constantly shifting channel, the steamers cannot, like those of the Godavery, hug the sides of steep banks, where a current not more than half that in the middle of the stream is met with.

As far, therefore, as "frequency of floods" affects the quality of the navigation by the increased rapidity of current, the Godavery has a decided advantage over the Indus. I cannot speak with the same confidence about the Ganges, but in its case also I apprehend from the similarity of the shape of its bed to that of the Indus that steamers ascending the river have, as a rule, to contend with nearly the full force of the current, instead of, as in the case of the Godavery, only that which is met with along the sides.

I suppose that "the … of rocks" has reference to the Barriers only, as of course … scattered rocks in the open parts of the bed between the … removed. There will of course be some delay caused by … steamers through the locks at the Barriers, but this will …

the increased speed which will be attained by ascending steamers in the slack-water pools extending for many miles above each Barrier.

5th.—The above remarks have reference chiefly to the monsoon navigation, but supposing the river to be navigable, as I shall presently show, during the dry season, the advantages of diminished current and well-defined channel are all in favour of the Godavery. The Committee themselves observe:—"Except during freshes, the current of the Godavery is very much slacker than that of either the Ganges or Indus, and its channel from the heavy coarse-sand and shingle of which the bed is composed is infinitely less variable."

This is surely a most important advantage, and one to which due weight should be given in comparing the navigable capabilities of the three rivers.

6th.—The Committee admit, para. 42, that a steamer, with a draught of 18 inches, could run up to the 15th February, or for 8 months of the year, but state that "such a class of steamer would be incapable of working efficiently in the high freshes." There appears to be here some uncertainty as to the meaning of the term "high freshes." If it means such freshes as seriously obstruct the navigation of the river by a steamer having a speed of 10 miles an hour, then such freshes do not last for at most a week in the year, and do not occur every year.

If, on the other hand, it is meant that a steamer of the class referred to would be incapable of working efficiently throughout the three or four months of the monsoon, when the river is more or less in flood, then the Committee are altogether in error as to the capabilities of such steamers. Only one of the steamers now on the river has a speed approaching 10 miles an hour, the rest vary from 6 to 7½ miles, yet all of these work steadily all through the monsoon. The current which they meet with at that time of the year *along the banks* is only about 3 or 3½ miles an hour.

The banks are steep, and steamers have thus no difficulty in "hugging" them closely, and so avoiding the strong currents mid-river. But these steamers have all a draught of 2 to 3 or 3½ feet. Three new steamers are now being built upon the Clyde, which, with a draught of only 12 inches, will have a speed, as usually worked, of 10 miles an hour, and by the use of a blower for increasing the production of steam in the boiler of 12 miles an hour, whenever such speed may be required. I am not able, at this moment to quote the authority of Mr. James Napier, their Designer, for this statement, but as soon as I join my Office will submit a copy of his letter.

The Committee are aware that, if such a speed can be obtained in a steamer of only 12 inches draught, much higher can be obtained with 18 inches draught.

Double the power, which would give one-fourth more speed, could, in fact, be put into the 18-inch steamer.

This fact is decisive as to the question whether a steamer capable of navigating the river in February would be equally efficient during the flood season.

Steamers, with a speed less than 10 miles, now navigate the river effectively during the monsoon, and if a steamer, with a draught of only 12 inches, can be built with a higher speed than 10 miles, one with a draught of 18 inches will have a yet higher speed, and be proportionately more efficient.

7. For the above reasons I cannot assent to the conclusion which the Committee draw to the disparagement of the Godavery as a steam communication from a comparison of it w… th… and Indus.

Taking into consideration th… light draught steamers, the Godavery may be navigated fo… part of the year (for if 18-inch draught is practicable up to Fe… draught will certainly be

so for a longer period), it appears to me that the comparative advantages and disadvantages of the three rivers are far too nearly balanced to warrant the conclusion that steam navigation will be economically impracticable on the Godavery. On the contrary, I think, that the experience of the navigation of the river by 8 or 10 steamers for the past six years, the ascertained practicability of building steamers much more efficient in point of speed with a much less draught of water than any now upon the river, and a fair comparison of the Godavery with other rivers in regard to its physical characteristics lead to an opposite conclusion, and justify the expectation that steam-power may be effectively and profitably employed upon this river.

8. The concluding para. 43 of that part of the Committee's Report which refers to this question, does indeed appear to me to imply doubt in their own minds as to the soundness of their conclusions. They observe, "in speaking of steam-power, we have considered it in relation to the conveyance of a heavy traffic. But our remarks do not apply to the use of small steamers for conveying passengers, and a very limited quantity of valuable cargo for a few years, till the value of the navigation has become understood and appreciated by the public, and when private enterprise may be expected to take the matter." If I rightly understand this, the Committee consider that the river may, with advantage, be navigated by small steamers carrying a small quantity of goods, and look to the employment of private capital in such business. But the Committee surely do not consider that navigation by small steamers like "those now on the river" would be more economical than by larger ones. The contrary is notoriously the case. Unless then, I misapprehend the meaning of this paragraph, I must regard it as a concession of the point in dispute, and the more so, because it is evident that the Committee contemplate navigation by means of steamers which will not pass through locks of the dimensions they recommend (150'×20'), but which are to be stationed in the reaches between a mode of navigation which it does not require much consideration to see, must be much more expensive than the ordinary one by means of steamers running up and down the river from end to end. If steam transport by this expensive method, and on a small scale is, in the opinion of the Committee, likely to be both practicable and profitable enough to enlist private enterprize, much more would that be which might be obtained by the use of larger steamers than those now on the river navigating it without interruption from Chanda to the Sea.

9. This leads me to remark upon the, in my opinion, extremely objectionable plan which the Committee propose for navigating the river by means of steamers placed in the reaches between the Barriers. The Chief Commissioner has pointed out the defects of such a system, supposing the river opened to Chanda as the Committee propose, there would be four reaches between that town and Dowlaishwarum, in each of which two steamers must be placed to guard against an accident to one of them. The trains of barges must be run up and down the whole line with a punctuality which would certainly not be obtainable in practice to prevent loss from detention of steamers unemployed. An accident, a steamer grounding at any one point of the whole line, would involve the delay of the whole of the steamers for the time. These detentions are a source of considerable expense when only one steamer with her train of barges is employed. The loss would be four-fold in the case supposed. In fact, long and ruinous delays would be inevitable, and assuredly no private Company would consent to work the river upon such a system.

The Chief Commissioner has further noticed the difficulty about the repairs of steamers so stationed between the Barriers, and asks how, supposing them to have been sent down to the coast over the anicuts in freshes, [illegible] could not return the same [illegible] one fresh in the year in [illegible] certainly would not be more than [illegible] fresh seldom comes before [illegible] would be passable, and, as this [illegible] the greater part of two [illegible] manner would, in point of fact, lose [illegible] be fatal to the working [illegible] would manifestly

To obviate it the Committee suggest that the steamers might have their paddles taken off, and be passed through the locks. The locks are to be 150 feet × 20 feet—19 feet × 140 feet in length, would, therefore, be the largest dimensions of the hulls of the steamers so employed. If the Committee are of opinion that the river can be effectively navigated by steamers of this size, I am at a loss to understand the reason for their doubts as to the sufficiency of locks 200 feet × 30 feet in the chamber, which would pass steamers of just double the tonnage.

Do the Committee suppose that side-wheel steamers of 140 feet × 19 feet in the hull are safer and more effective than stern-wheelers of 180 feet × 29 feet?

10. I must next notice the objection of the Committee to the use of steamers with stern-wheels. They "entertain misgivings of their success," and further observe—"They are applied on certain rivers in America, but there must surely be some points in which they are inferior to the side-paddle steamers, or why is it that the latter are so generally used in the larger class of rivers and the lakes?" The answer to this question only brings more strongly into view the peculiar advantages of the stern-wheelers. On the larger rivers and lakes there are not the same currents to contend with that are met with on the smaller affluents which have always a greater slope, and as a stern-wheeler can, from the diminished "slips" of its wheel, ascend currents which a side-wheeler cannot stem, its peculiar adaptation to navigations of this description is at once apparent. Further, where canals and locks have to be passed, the stern-wheeler possesses marked advantages on the side-wheeler, which probably the Committee admit it being less liable to injury from collision with the lock-walls or canal banks. This is a very important consideration in a line of navigation where, supposing the river open for steamers to Chanda, a steamer would have to traverse 108 miles of canal, and to pass through 56 locks in a single trip from the coast to Chanda and back.

The Committee "believe that the side-paddles which must act as out-riggers are a source of security to flat-bottomed vessels in a strong current, or in a whirl-pool, such as is occasionally encountered on the Godavery during the freshes." I do not in the least see how they are to afford [illegible] any such security. An out-rigger is a thing that floats alongside a boat, and by its weight in some cases, or by its buoyancy in others, prevents the boat being overturned. But paddle-wheels do not float in the water, and however deeply immersed, can afford no buoyancy.

As to the "whirl-pools," these have been from the outset the bug-bear of the Godavery navigation. They sound very formidable, but are in truth perfectly insignificant A whirl-pool is met with at two points only in a distance of 450 miles, and at these two points it exists only in extreme floods, such as do not occur every year, and when they do occur, maintain the height at which whirl-pools are formed, for perhaps four days. In fact, the *existence* of one of these whirls is a very doubtful matter.

I have myself run through the worst of them in a steamer with a speed of only 7 miles an hour, and with her deck only 18 inches above water. They would not be of the slightest consequence to any properly built steamer, and even if they were, the detention they would cause would be trifling.

11. The Committee think the stern-wheel "would be liable to injury, should the steamer be accidentally swept round against a rocky bank." The Committee have evidently never seen or navigated the river in the flood season, or they would have known that this objection applies with ten-fold force to the side-wheelers. The latter *are* constantly liable to injury from striking against the banks when the steamer is running up-stream close along shore. We have frequently had our side-wheel steamers so injured, and in one instance very nearly lost one from this [illegible]e. The stern-wheel on the contrary is removed altogether from the [illegible]ch injury, and with it a steamer may "hug" the bank much [illegible]hout risk of accident.

12. The fact is, that the sid[illegible] has no advantage whatever as regards facilities for quick manœuver[illegible] wheeler, unless its wheels

are, as is the case with many [illegible] American steamers, disconnected, and worked by separate engines.

This arrangement, which however has not been found necessary anywhere in India, or indeed out of America, does give increased facilities in steering, but *these can also be had*, if *required, in the stern-wheeler*, by dividing the wheel into two, worked by separate engines, as is sometimes done on the Ohio. I do not however, after several years' experience of the navigation of the Godavery in all states, anticipate any necessity for even this modification of the ordinary arrangement.

13. The Committee further observe—"Mechanical Engineers in England can have little knowledge of nature of the currents in a river like the Godavery, and any vessel on a new plan which they may build specially for its navigation, must be regarded as an experiment." It is quite true that Engineers in England can have little knowledge of the nature of the currents of the Godavery, but when they are instructed by Officers who *have* a thorough practical acquaintance with the river derived from years of observation, the case is very different, and under such conditions the probability is that the English Engineer will turn out the class of vessel best adapted to the work.

I certainly should prefer a steamer designed in this manner to one such as the Committee appear to suggest, built upon the model of the vessels in use on the Indus, a navigation of a very different character. The steamers now being built for the Indus were designed by Engineers in England who never saw the river, but who learnt from Captain Wood, an Officer thoroughly acquainted with the river, what were the conditions which the steamers are required to fulfil. Surely a similar course should be pursued in the case of the Godavery.

14. I must here distinctly protest against the assumption which underlies all this part of the Committee's Report, that in determining the size of the locks, we have been proceeding on mere hypothesis, without any experience of the actual character and requirements of the Godavery navigation. All the information I have obtained by months of careful examination and inspection of dozens out of the hundreds of stern-wheel steamers on the western rivers of America is treated as mere hearsay—"Major Haig had *heard* such steamers well spoken of." The Committee accordingly at once dismiss all that I have said upon the subject, and proceed to recommend a totally different class of steamers without any investigation whatever, merely because they "entertain misgivings" about the efficiency of stern-wheelers.

With all respect to the Committee, I venture to ask of what importance are the "misgivings" of two Officers who have never even seen, much less been on board of, a stern-wheel steamer?

How can they possibly judge as to their fitness or unfitness for a river, which neither of them has ever seen or sailed on in flood?

Who is most likely to form a correct opinion upon the subject, if not the Officer who *has* seen, and repeatedly navigated the American rivers in such steamers, and who has an intimate practical acquaintance with the Godavery navigation in all conditions of its stream?

To what purpose will be the expense which the Government have incurred in sending me to America, if the practical recommendations which I make, based upon all that I have seen, read, and heard in that country, are to be set aside in consequence of the "misgivings" of Officers to whom the whole question of river navigation is entirely new, and whose references to "currents" and "whirl-pools" show that their notions of the flood navigation of the Godavery are of a very vague, and not very correct description, derived, as they undoubtedly [illegible] hearsay.

It is next [illegible] "on experiment," and [illegible] being built are useful result," the Comm[illegible] experiments have ended in no steamer for the Godavery [illegible] to the Indus for the model of a

When the Indus Flotilla Company ordered their last new steamers a year ago, why did they send their Superintendent, Captain Wood, home to plan the vessels in conjunction with Messrs. Napier and Laird? Why did they not go to the Ganges for a model, or to the Godavery?

Would this have been a "safe" or "practical" way of setting about the matter?

Are the vessels which Captain Wood has ordered to be regarded as merely experimental? If not, why are those I have ordered for the Godavery to be viewed in that light? I know quite as much of the Godavery as Captain Wood does of the Indus. I have navigated it for years at all seasons. I know every mile of it. Am I not then competent to state what speed a steamer must have to navigate it with effect, and what draught of water?

The Committee do not think so, so they go to the Indus, one of the "rivers of Upper India," not at all similar to the Godavery, for a type of a steamer; and what is the latest type of steamer sent out for the Punjab rivers? A *stern-wheeler*, the *Beas* built at Liverpool about two years ago. So when we get into Upper India, we find opinion there apparently undecided, or possibly inclining to the type of a steamer which the Committee are afraid of!

So, again, in para. 29, the Committee set aside all calculations as to the probable cost of steam-power on the Godavery, because "the traffic has to be created," and the "cost of working a flotilla must be matter of uncertainty." "Such hypothetical calculations are entirely unreliable." Here it is assumed that we know nothing about the cost of working a flotilla on the Godavery. Of what use then is our "Accounts" Department when steamers have been running on the Godavery since 1853. Are we still in ignorance of the cost of working them? Can we not tell the expense of the crew, of fuel, &c. &c.? The Committee must be well aware that we have full information upon all these points.

They have never investigated the question; they, in plain words, know nothing whatever about it. How can they, if they have never examined it? No wonder, then, that they have doubts and misgivings. But is it right, on that account, to represent the whole matter as in a state of uncertainty, reliable calculations impossible, and all that has hitherto been written on the subject as based upon mere "hypothetical calculations?" I distinctly maintain in opposition to the Committee that there is no such uncertainty. We do know the cost of working a flotilla on the Godavery (I except of course the cost of working on the Committee's plan by means of steamers stationed between the Barriers, as the "factor of safety" to be applied in this case, to cover the cost of delays, &c., all along the line, is at present decidedly hypothetical); and we do know the sort of steamer best suited to the navigation.

15. There are other points in the Committee's observations upon this part of their subject which invite remark, but I will only notice one other. They observe that the primary object for which the Godavery works were commenced, was the conveyance of the cotton of Nagpoor to the sea; that this object "is now accomplished by the Great Indian Peninsula Railway, and that as dealers are willing to pay a higher freight for cotton by rail from Allahabad to Calcutta, rather than send it by river, it is vain to expect that the Godavery will ever carry off any of the Nagpoor and Berar cotton;" and hence that the Government may well pause before they sanction any considerable expenditure on steamer locks." I have already pointed out the fallacy of this comparison of the Godavery with the Ganges, the distance to the sea by the one river being just the same as by rail; and by the other at least half as much again.

The Committee propose to [illegible] minus of the navigation "at a considerable distance from the [illegible], at Chanda, which they rightly observe would give a gre[illegible] to the Railway which runs right through the cotton country.

Considering, however, that there is no reason why the navigation should not be carried up at least to Hingunghât, and be connected by rail or canal with the cotton country to the west of the Wurda, I cannot believe that the Government or the manufacturing community is England, so deeply interested in this question, will consent deliberately to abandon the most important cotton tracts in India to a Railway monopoly. It is of the utmost consequence that the navigation should be placed in a position to maintain a constant check upon the Railway rates, and for this reason alone it should, in my opinion, be carried right up into the cotton country. It may not be thought advisable to do this in the first instance, but it must certainly be kept in view in planning the works on the part of the river below; whereas, to substitute boat-locks only for steamer-locks, would be at once to renounce it.

It is important, too, to remark that, even to the east of the Wurda, there is a considerable extent of cotton cultivation, of which Hingunghât is the centre, and which reaches down to Chanda. On the west good cotton is grown as far down as the head of the 3rd Barrier. There is thus a considerable tract of country properly dependent upon the river for the means of export.

16. But even if cotton took another route to the sea, is this the only staple likely to afford employment to steamers? Is cotton the only article of carriage on the Indus and Ganges?

Mr. Temple in his Minute upon the subject has pointed out what the uses of steamers upon the river would probably be, and it cannot be doubted that they would find abundant employment in traffic of a similar character to that on the Ganges and Indus.

17. The Committee make no reference to the use of the Godavery for passenger traffic, and as a military line of communication for the transport of troops and stores. The Chief Commissioner has called attention to its importance for these purposes, which would seem to have altogether escaped the notice of the Committee.

They cannot surely mean to sacrifice these important advantages by making the Godavery a mere boat navigation.

18. The Chief Commissioner has also pointed out how trifling a percentage of saving upon the whole cost of the line would be effected by the reduction of the size of the locks proposed by the Committee. There is an error in his calculation caused by the term used by the Committee for the Tail-locks at Gungole, 1st Barrier. They speak in para. 90 of the "Tail-lock," but it is in reality a double, if not a three-fold lock, and the actual saving upon a single lock would not be above Rs. 13,000, instead of Rs. 70,500 as assumed by Mr. Temple, but the result at which he arrives is nevertheless correct.

The saving, supposing the 3rd Barrier canal and locks to be made for boats and very small steamers only, as suggested in 1863, would be but £11,000, even if the 1st Barrier project is carried out on the original design, and £27,000 if the locks at that Barrier are made 200 feet × 30 feet as proposed for the other Barriers, less than 4 per cent. on an outlay of a million sterling.

19. *1st Barrier Works.*—With regard to the works at the 1st Barrier, looking only at the minor project, as it is called, the Committee appear, on the whole, to approve of the designs and general plan of the works. It is, perhaps, singular that the only part of the plan which they disapprove, the arrangement by which the river channel formed by the island on which the anicut abuts, is made to form the head of the canal, is that which above all others I hold, possess the highest merit. I claim no credit for simply having availed myself of a natural feature of the ground which presents such very unusual advantages, but it is inexplicable to me that, with the knowledge which [illegible] must have of the difficulty of dealing with the silt whic[illegible]uch enormous quantities into the canals with which they [illegible]nected, they should have failed to appreciate the [illegible]rrangement by which the silt is entirely deposited o[illegible] by the means of a scouring

sluice swept out again into the river. No paragraph of the Report surprises me more than that in which they remark upon this part of the works, and there is none from which I more entirely dissent.

The flank of the anicut may be made perfectly secure from the encroachment of the river, and, had the Committee been better informed, they would have known that the breach to which they refer in the head of the island was caused by the neglect of the Executive Engineer properly to close up an artificial cut through the island made for the purpose of carrying stone and lime to the anicut.

I entirely dissent from all that the Committee say upon this part of their subject.

20. With regard to the Committee's remarks upon the rates and cost of work at 1st Barrier, I find it impossible now in any way to check their calculations, as no rates have been deduced in the Central Office of Account, and it is impossible to say whether what the Committee give as information derived from the Executive Officers may be correct or not. This part of the report I must leave for future notice when I shall have joined my headquarters, and had an opportunity of investigating the accounts.

I will here remark upon only a few points:—

(a) The Committee state that the cost of work on the Godavery is nearly 3½ times that on the coast. They appear to me to have added 33⅓ per cent. for miscellaneous charges twice over, those charges being included in the estimate rate of Rs. 22, and therefore I should suppose in the actual cost Rs. 28, which the Committee state to have been the case. If their estimate of Rs. 30 per 100 cubic feet includes such charges, then they seem certainly to have over-stated the comparative cost of the Godavery works; for this, divided by 3½ would give only Rs. 8·6 per 100 cubic feet for the cost of rubble masonry on a large scale in the beds of rivers in the Deltas, about one-half I think what it must cost now. Even if 33⅓ per cent. is added, this would make the corresponding cost in the Delta Rs. 11·5, which, inclusive of all miscellaneous and contingent expenses is, I believe, too low.

I doubt therefore whether the comparison is so unfavourable for the Godavery as it would appear.

(b) I do not see that the cost of establishments has been "most disproportionate" to the expenditure. Taking the Committee's own figures, I find that the charges for establishments amounted to Rs. 2,21,554 out of a total expenditure of Rs. 12,73,644, or to 17·4 per cent. This rate appears to me to be extremely moderate, considering the peculiarly difficult circumstances under which the works have been prosecuted, and the necessity, owing to the unhealthiness of the climate, for extra men to supply the places of those frequently incapacitated by sickness.

(c) I quite dissent from the opinion of the Committee as to the saving to be effected by the substitution of cattle for steam-power. It is true that cattle are abundant, but the bullocks of the Godavery are very small, and, as a rule, unfitted for the severe labour of mortar-mills, &c. We have frequently had them completely disabled by this kind of work, and sometimes even killed by it; and taking into account the difficulty of supplying them with food, we are very glad to substitute, as soon as we could, steam-mortar mills, and I should be very sorry to resort now to what I believe to be the more expensive means of animal power.

(d) Of the past management of the works which the Committee consider to have been neither successful nor economical, it would be vain for me here to attempt an elaborate vindication. It would involve the review of the past history of the works to an extent which would altogether over-load this already lengthened paper, and it [illegible]ive old complaints which I am willing should be forgotten [illegible] support, inadequate and constantly fluctuating supplies of [illegible]f plans on the part of the controlling authorities, and, for the [illegible] at least of the operations, inefficient establishments. Not, ind[illegible]pose that I could even so

altogether exonerate myself from a certain amount of blame. He who supposes that he could either plan or execute amid such unparallelled difficulties works on the scale of those on the Godavery without committing some mistakes, gives at once sufficient proof of his own ignorance and incapacity. I do not suppose that it is possible for any one, who has not himself passed through the ordeal, rightly to appreciate the difficulties of such an undertaking, and any arguments I might bring forward in my own defence would for this reason lose much of their force.

It is sufficient for me that the work done is, in the opinion of the Committee, well done, and I think the reasons which they adduce for the high cost of the work are sufficient to account for it, without raising the question of defective management.

21. With regard to the alternative projects at the 1st Barrier, *viz.*, the short canal with locks at Gungole, and the long canal with locks at Gollagoodiem I could have wished to have entered into a careful calculation of their comparative cost. But the materials for such a comparison are not to be had here, there being no copies of the estimates or plans in the Central Office, and the abstracts of the estimates available being insufficient for the purpose. I will therefore only observe that the question, which of the two projects is to be prepared, is one of cost only. The larger project is undoubtedly, as the Committee observe, the most complete and certain of the two. The lesser, to whatever extent completed, will be more or less imperfect and objectionable, chiefly for the boat traffic. It would never have been brought forward had it not been, first, for the want of funds to prosecute the works on the upper part of the river at the same time with those at the 1st Barrier, and the consequent prospect of a lengthened delay in opening the river; and second, for the loss of workmen caused by the out-break of cholera last year, and increased difficulties of carrying on the works consequent thereon, which, judging from a distance (for I was in England when I suggested that the minor project should be rendered more complete by the substitution of steamer for boat-locks), I supposed would tend greatly to enhance that delay. The lesser project involves undoubtedly the navigation of channels cleared through, and lined by rocks, and in the up navigation the ascent of a current difficult for boats to overcome. Boats unaided by steam-power could not venture down this channel at certain times of the flood-season, and certainly could not ascend it. If therefore funds are now available, which will allow of the prosecution of the works at the 2nd Barrier simultaneously with those at the 1st, and of the surveys and preparatory operations for those at the 3rd Barrier, I have no hesitation in recommending that the long canal with the locks at Gollagoodiem should be completed. A considerable part of it has, indeed, been finished since the minor project was brought forward in 1863, and I should anticipate no difficulty after joining my head-quarters, and obtaining the accounts of past expenditure which are not available here, in estimating pretty accurately what amount may now be required to complete it. Lieutenant Roberts writes that he has 3,000 first-rate excavators on the spots, and under his management I should expect much better progress than has hitherto been made.

22. With regard to the question whether the anicut would have been necessary or not for a five months' navigation, which the Committee answer in the negative, I subjoin an extract from a recent letter from Lieutenant Roberts, in charge 1st Barrier works:—

"The water-level on the 1st October 1865 in the sluice-channel was 16½ or 3½ feet only above the sill of the head-lock."

We reckon that the navigation commences from 20th June.

In 1865, therefore, in the fourth month only, there were but 3½ feet water on the sill [illegible] and this, although the anicut has of course already parti[illegible] of the water above it, the Committee make no refer[illegible] whatever for their opinion. The truth [illegible] navigation, the river

could not have been depended upon without an anicut. But when the works were commenced, the idea of limiting the navigation to five months only was never entertained, and from the time that the Government of India ordered that only such works should be carried on as were necessary to a navigation of that period, no work was done to the anicut, unless it were to give employment to masons and labourers who otherwise would have had to be dismissed, or retained on batta at a heavy expense.

My orders to the Executive Officers were, that the completion of the anicut should be left to the last, as the least necessary of the works.

23. *2nd Barrier Works.*—With regard to the 2nd Barrier, the Committee object to the description of anicut proposed by me on the grounds of cost and of efficiency. First as to cost.—I observe that the Committee, para. 101, have resorted to the same return as I did (in Volume IV, Professional Papers, Madras Engineers) for the rates of work done in a similar anicut on the Kistna. They have, however, fallen into the error which that statement, apart from any explanation by the Officer, Colonel Orr, who prepared it, would naturally cause.

The *quantities* in that statement are not, as I was myself informed by Colonel Orr, correct, but only about two-thirds of the true quantities. The statement was prepared in conformity with the instructions of the Revenue Board (the controlling authority in those days) *in terms of the estimate*, and the quantities shown are those in the *estimate*, and not the true ones, which are 33 per cent. higher. The cost of stone was therefore not 14·28 annas per cubic yard, but 9·52 annas.

24. The Committee next state that the work at the Kistna could not *now* be done under Re. 1-8 per cubic yard.

As the charge for plant (3·38 annas according to them) of course remains the same (plant being no dearer now than it was then), this makes the charge for labour, &c., 24—3·38=20·62. This is what they consider this charge would amount to at present prices, instead of 10·9 annas when the Kistna Anicut was actually built. In other words, the rate is doubled. Now it must be remembered that we are speaking of the cost of the rough undressed stone, and that therefore any rise in the wages of brick-layers or masons does not effect the question. I am right in stating that the wages of the coolies and quarry-men employed on the Kistna Anicut were from Rs. 4½ to 5½ per month. Do the Committee mean that such labour cannot now be procured on the Kistna for less than Rs. 9 to 11?

We have proof positive that this cannot be the case in the fact that our workmen of the same class at 1st Barrier only receive Rs. 7 to 8, and they are much more highly paid than similar workmen on the coast.

How is this to be reconciled with the Committee's assertion that work (of *this class*, rough stone quarrying) costs three times as much on the Godavery as it does *now* on the coast. If we multiply the Committee's supposed rates for labour on the coast, Rs. 9 to 11 by 3, we get Rs. 27 to 33 as the probable wages per month of coolies and quarry-men at the 2nd Barrier! Or, if a deduction of one fourth be made on the ground that wages represent only two-thirds of the actual cost of labour on the Godavery we have still Rs. 20 to Rs. 25 as the probable rates of wages at 2nd Barrier according to the Committee. I see no room for error in these deductions from the Committee's statement upon the subject; for it must be remembered that, as regards rough stone-work, the only item of cost liable to increase is that of wages, as the cost of tools, machinery, powder-plant, remain just the same now as 15 years ago.

25. Now how immensely these calculations of the Committee are in excess of the truth will appear from the [illegible] while the tramroad was being built at the 2nd Barrier, Mr. Ma[illegible] was in charge, had never any difficulty in keeping up a body [illegible] wages of Rs. 5 per month. They provided their own food, and [illegible] own huts, and really cost the Government nothing more th[illegible] Mr. MacGregor had fr[illegible]

quently to send away numbe[illegible] applied for work, and could easily have raised his numbers to 2,000 if [illegible]ired.

What are we then to make of a calculation based upon the assumption that the wages of such men when the 2nd Barrier works are commenced will be Rs. 20 to 25?

It is quite evident that the Committee have generalized much too hastily from the fact (as they suppose, but which I strongly doubt) that work generally at 1st Barrier, including earth-work, quarrying, rubble-masonry, and cut-stone, costs three and half times as much as similar works in the Deltas.

26. The truth is, that the circumstances under which the works at the 2nd Barrier will be carried on will be much more favourable than at the 1st Barrier. At the 2nd Barrier we obtain access to a large extent of country where large and populous villages, only two to four days' march from the works, will supply all the labor we shall require *for the rough stone-work*, and though we may pay higher, perhaps 50 per cent. for quarry-men, than we did in 1862 for common coolies, I have no reason to believe that the same rate, Rs. 5 a head, or at most Rs. 6, will fail now to attract the same numbers that it did then: and those numbers will be quite sufficient, probably much more than sufficient, for the anicut works.

But in my estimate, Rs. 6-8 per 100 cubic feet, I have *doubled* the Kistna rates, which would allow for wages of Rs. 9 to 11, and have added to these the cost of rail-roads, machinery, and hutting workmen.

I adhere to that estimate, and submit that that of the Committee is enormously in excess of what a due consideration of the circumstances of the case will warrant.

27. Now as to the comparative cost of the two kinds of anicut, the Committee propose to substitute for my rough stone anicut two masonry walls, one built about 100 feet below the other, and to half its height and thickness, assuming a height of 22 feet for the purpose of comparison, and allowing for a mean thickness of 14 feet, they calculate the cost of a running foot of wall at Rs. 100 per foot. Nothing however is said about the second wall, which the Committee "think necessary," and which would have a section one-fourth that of the main wall; no addition is made for coping, always an expensive item, no allowance for excavating foundations in the rock, nor for dams, baling, &c. The Committee only omitted these, because even allowing liberally for them, the cost of their anicuts, according to their own shewing, would still be much below mine. But for the purposes of strict comparison, these items must be included thus:—

	Rs.
Cost of main wall on the Committee's data, allowing for 2 feet foundation in rock	100
Coping 20 cubic feet at Rs. 75 per 1,000	15
Excavating foundation 18 × 2 = 36 cubic feet, at Rs. 7 per 1,000	2-5
Total of main wall ...	117-5
Lower wall.	Rs.
1-4th section of main wall	25
Coping	10
Foundations	1
Total of lower wall ...	36
To this the Committee's ... of both walls ...	153-5
add 33⅓rd per ce[illegible] appears from para. 105, [illegible]arges on labor ...	51-2
without any allowance [illegible] ...	204-7

The Committee state the cost per r[illegible]ot of an anicut on my plan, 22 feet high, to be Rs. 170, but calculating without plans or estimates, which as I have already said, are not here available, and from memory I think the cost must be Rs. 221 per foot.

28. It would thus appear that in point of *cost*, the Committee's anicut would have no important advantage over mine.

It may be said that the above calculation is unfair, because while it retains my original rates for rough stone-work, in calculating the cost of my anicut, it assumes the Committee's *increased* rates in calculating theirs. But I am unable to dispute the Committee's rates for masonry. I have no access to accounts, and must for the present assume them to be correct. My own rates for rough stone-work I do maintain for the reasons above-mentioned.

29. On the other hand, I would observe, that my section from which the estimates were made for the anicut was certainly a maximum section, and might be considerably reduced if we use large sized blocks of stone. If I remember right, in the orders of the Government of India, upon the 2nd Barrier estimates, it was remarked that the section might be reduced with advantage. In calculating the cost per running foot, I have assumed a top width of 50 feet, with a down-stream slope of 8 to 1. The width on top might very probably be reduced to 30 feet, and with large stone the slope might perhaps be made 4 to 1, and less than that in the lower parts of the anicut.

30. But further the Committee appear to have entirely overlooked the great advantages which an anicut of the description I propose gives for economizing labor. These are so great, that they render any deductions as to the probable cost of rough stone-work at 2nd Barrier from the known cost of rubble masonry at 1st Barrier, quite inapplicable. Instead of having to collect a large body of laborers and masons to work in the river-bed under great disadvantages for only five or six months of the year, a small body of workmen, who may be thoroughly organized, work in the quarry all the year, and the stone may be deposited in the bed without interruption during eight or nine months. Instead of the manual labor required at every step in rubble masonry, in quarrying, breaking up, handling the stone, in quarrying, burning the lime, in excavating foundations, making dams, baling, &c., almost the whole of the work is done by powder and steam or animal power.

Much less superintendence is required, a smaller establishment will suffice, and consequently less accommodation has to be provided. The latter are items of saving which cannot be computed in such a calculation as that made above of the cost per running foot, but which are considerable in amount, and should be duly allowed for. In the case of works carried on under the disadvantages in regard to climate peculiar to the Godavery, these are very important considerations, and they have great weight in favor of a simple anicut of rough stone, instead of a masonry wall requiring such a much larger amount of labor of all descriptions, especially of skilled labor, which is the most expensive and difficult to obtain.

31. I will next notice the objections of an engineering character which the Committee urge against a rough stone anicut.

1st. *Excessive leakage.*—The Committee say, para. 106.—"We are of opinion that there are serious objections against the construction of a rough stone-weir intended to withstand the pressure of 40 feet head of water." This way of putting the case conveys a very wrong impression. No one would imagine from it that there are only 170 feet in length out of 4,050 feet which will have to withstand such a head of water, and that of the remaining part of the anicut none will have more than 22 feet head, and much of it very much less. Such however is the case. So that whatever difficulty there may be supposed to be about [illegible]ead of 40 feet, it should be distinctly understood t[illegible]ill [illegible]along the 7th part of the whole length of the [illegible]are quite satisfied that the leakage would be [illegible] quite impossible to pond

up the water to the req[illegible] when the supply in the river would be small." I am as perfectly certain that it would not. Can the Committee adduce a single instance in support of their opinion? I have seen instances in which great leakage through a bank of loose stone has been completely stopped by simply choking up the interstices with small stones and gravel, and afterwards covering the slope with pure *sand*. But in the anicut I propose not only would this method be adopted, by the interstices between the stones on the up-stream slope would be filled up with concrete rammed in as deeply as a rammer could penetrate, and the Committee are aware that our Godavery concrete does not soften under water pressure. I am satisfied that this objection is of no consequence whatever.

2nd. *The severity of the action of the falling water upon the stone-work.*—The Committee after shewing that the afflux in floods will be about the same in the case of the 2nd Barrier Anicut as in that of the Kistna, observe, "in the Bezwarra (Kistna) Anicut we should have between high and low stages of the river a difference of level in the upper and lower reaches, ranging between 1 and 18 feet, and in the 2nd Barrier Anicut a difference ranging between 1½ and 37 feet. Now, this statement, though literally true, conveys an altogether erroneous impression. In the Kristna Anicut, the difference of level between the water above and that *immediately at foot* of the work is 18 feet in summer. At the 2nd Barrier, the difference of level between the same points would be but 22 feet in the highest part of the work, and much less elsewhere, because the bed of rock, in which the anicut will rest, is itself on an average 18 feet above the summer level of the water, and maintains this level for a distance of fully a mile down-stream. I leave out the part (170 feet) in length across the deep channel, because that may be easily protected against over fall in the way the Committee propose for their anicut, and which I had previously proposed for a similar work. The correct statement of the case would, therefore, be that, while on the Kistna the head of water is 18 feet along the whole length of the work, at the 2nd Barrier it will not exceed 22 feet anywhere, and will be less than that along nearly half the whole length. The action of the overfall along half the anicut will undoubtedly be more severe than at the Kistna, but this will be far more than met by the much greater strength of the 2nd Barrier work than that at the Kistna. I have carefully inspected the latter work, and observed how rapidly the stone, which is more or less friable, wears away under the action of the water, many of the stones being not above half the size, they were when put in, and certainly not averaging above 1½ to 2 tons weight. They are not grouted, and only roughly packed together, yet that anicut is practically indestructible. The most the water ever does is to dig a hole at one spot where Colonel Anderson is aware a strong current sets on to the work being deflected from a hill above, and the stones have simply to be thrown in again every year: such repairs not costing, I believe, above 1 per cent. of the original cost. At the 2nd Barrier, we propose to use larger and *far harder and more durable* stone, not necessarily of 10 tons weight, but probably averaging 5 tons, and to have the surface carefully levelled with a concrete which the Committee state to be "of most excellent quality." There need not be the slightest difficulty about making the work perfectly secure, especially when we consider that it will rest on rock, and not on sand as at the Kistna, which will admit of no settlement or loosening of the surface stones.

3rd.—The Committee have entirely misapprehended what I have written as to the use of stones exceeding 5 tons in weight, and I am quite at a loss to understand how they can have done so. I have only touched upon the subject in one paragraph of one letter which they must have read, and I there stated most explicitly that I *did not* consider the use of stones larger than 5 tons at all necessary to the security of the work, and that I only proposed to use blocks up to 10 tons, [illegible] *to be more economical.*

The Committee, however, [illegible] ton blocks were necessary [illegible] anicut, as if the use of 10 This is directly the re[illegible] ntial part of the work.

It is surely quite possible that [illegible] be found cheaper to move and deposit a block of 10 tons, rather than to break it up into two or three pieces, which have each to be lifted, moved, and deposited separately. The number of such blocks in the whole work would be very small, and accordingly in the machinery I have sent out from England, only a small part of it is designed for lifting and moving stone of this size.

32. For the reasons above stated, I object to the Committee's design for the 2nd Barrier Anicut. I consider that the one I propose would be the strongest of the two, and would be least liable to injury from the enormous masses of drift wood which float down in floods, and which plunging over the main wall of the Committee's anicut, might occasionally be dashed with immense force upon the lower wall. I am further of opinion that the description of anicut which I proposed is best adapted as regards construction to the circumstances of the case, requiring a much smaller body of men to be employed, admitting of more perfect organization, requiring less skilled labor, and a smaller establishment, and giving much larger scope for the substitution of powder and steam-power for mere manual labor.

33. Lastly, it should be observed that the whole of the rails, cranes, and other machinery, amounting to about £12,000, required for the construction of such an anicut as I propose, have been ordered, and are now on their way out from England. A change of plans now will consequently involve considerable loss.

34. *Improvements to the River-bed between the Barriers.*—Upon this point, the Committee remark—"In the present state of knowledge of the navigability of the river,.....we deprecate any outlay whatever for groins, without a most careful survey and complete information of the river in all conditions of its stream, large sums may be entirely thrown away." This is of course perfectly true, but no one proposes to construct such works without such surveys and examination. With this remark the Committee dismiss the subject, and no notice whatever is taken of the results of the only groin that has been yet attempted on a proper scale on the river, that at the confluence of the River Sebbry below the 1st Barrier. A few notes as to the success or failure of this work, which I can hardly think can have escaped the Committee's notice on their way up river, would have been infinitely more to the point, than general considerations such as those above quoted.

Have large sums been thrown away upon this work, or has it injured the reaches above and below? It was constructed at the worst known shoal upon the river. It has only been made about half its proper length for wants of funds, yet its effect has been most striking. Previous to my going home in 1864, it had almost entirely removed the shoal, and would certainly have done so completely had there been money to extend it and to maintain it in proper order. I have so repeatedly referred to the success of this kind in writing on the subject of groins, that I am surprised the Committee should have so completely passed it over. Its effect satisfies me that such works, if constructed with the care and caution I have always recommended, will greatly improve the navigation,—they must not be carried too far. When the attempt is made to confine the stream within too narrow a channel, harm will of course be done, but if the stream is not too violently interfered with, but merely helped and directed at the few points where it has a tendency to wander, the effect will be most beneficial. This has been the experience on other rivers.

Nothing of the kind has been attempted on either the Indus or Ganges. Such works would be impracticable on rivers of their class, having constantly shifting banks, an ever-changing channel, and a light sandy bottom. The Committee admit that the Godavery is a river of a totally different character, its banks are permanent and well-defined, the positions of the shoals never vary, and the material [illegible]bed is a coarse sand with pebbles. Under such conditions [illegible]e-bed for regulating the stream may be used with advanta[illegible]t that the results hitherto obtained justify this expectation.

35. *General remarks on the Report.*—With regard to this part of the report, I would observe that [illegible] of tools, plant, and machinery does not appear to me "disproportionate to the expenditure on work." A large part of such plant must now be available. It cannot fairly be debited to the work already done only.

The Committee recommend that, "when the machinery gets out of order, it should be re-placed by the ordinary bullock-power machines." I do not know what description of machinery the Committee refer to. Our portable steam-engines have not got out of order, and the Committee do not, I apprehend, propose to discard them, and to set bullocks to work the circular saws or the punching machines, or the few other workshop machines. No one who has used a steam mortar-mill would think of abandoning it for half a dozen of the common bullock-mills, which do the same work with infinitely more trouble, more superintendence, and in a worse manner.

36. *Losses under the head of materials, para.* 125.—One of the quarries referred to in this paragraph was opened by myself in 1861, and the tramway laid to it. The other was opened, and its tramway laid by Mr. Schmidt in 1863, after careful examination.

The unsatisfactory results only shew the difficulty of finding good cutting stone in that part of the country. Quarries were, in fact, opened at at least six other places, the whole country having been searched for stone, and these two were selected as the most promising.

37. *Unnecessarily large establishments, para.* 127.—The total expenditure, as shown at page 67, was Rs. 28,47,750 up to December 1865. Deducting from this the expenditure on exploring expeditions and surveys, a large part of which was necessarily for establishments, Rs. 1,43,169, there remain Rs. 27,04,581, of which establishments amount to Rs. 4,96,457, or 18 per cent. This appears to me very moderate, considering the unhealthiness of the climate, and also that, up to May 1863, all the abstracting and booking of the accounts now done in the Central Office was done in mine.

38. *Colonel Fife's Memorandum on storing water, &c. Appendix B.*—It is not necessary to the purposes for which the present paper has been written, to follow Colonel Fife through his interesting Memorandum.

It is satisfactory to find that at last one man has been found to come forward and recommend for investigation a scheme which has always been regarded as the wildest and most preposterous of even Godavery projects.

Colonel Fife could of course only refer to past correspondence for information as to my views upon the subject, but, in so doing, he has been betrayed into one or two errors. There is for instance really no discrepancy between my rough estimates formed in 1856 and 1862 of the quantity of water required to maintain depths of 3 feet and 5 feet in the navigable channels. In the one case the quantity was estimated at 1,928 millions cubic yards, and in the other 4,089 millions, which certainly looks very probable.

Colonel Fife has, however, quite mistaken what I have written about the shoal at the top of the 2nd Barrier (paras. 3 and 4).

That shoal is altogether exceptional in character. It is, in point of fact, a part of the Barrier, and will be almost wholly submerged when the anicut is built. At no other point along the whole length of the river is any such shoal to be found. It is formed by the action of the Barrier on the river-bed above, and may properly be regarded as an adjunct, if not actually a part of the Barrier itself.

To argue from its condition on the 1st October that other parts of the river may be impassable on that date would be as great a mistake as to argue in a similar manner from the [illegible] the upper mile or two of the 1st Barrier, where there is li[illegible] same time of the year.

39. Colonel Fife p[illegible] from the upper end of the 2nd Barrier to the lower, [illegible] could only be practicable at an immense outlay. The[illegible] been carefully examined, and the levels taken: for the idea is not a [illegible] shows that the line is crossed by hills which cannot be turned, but would have to be cut through, and that for a considerable part of the 10 miles or more of canal the cutting would be through rock. This scheme was of course the first that suggested itself to me, and was not abandoned without thorough investigation.

40. I must pass over for the present Colonel Fife's remarks about the 3rd Barrier and Wyne Gunga navigation. I must, however, notice the remarks in his concluding paragraph as to the need of further information as to the navigability of the river at the close of the monsoon. "At present" he observes, "there is too little known of the shoals, and it is impossible to state with any certainty what sized boats could navigate the river at the conclusion [illegible] the monsoon." "The passage" backwards and forwards of steamers [illegible] Dowlaishwaram and Gollagoodiem, the lower end of the first pr[illegible]ual at the 1st Barrier is no criterion whatever of the state [illegible]on above. Between those two places the river has advan[illegible] Colonel Fife proceeds to specify.

H[illegible] notice that this part of the river has most serious *disadvan*[illegible] with the reaches above, 12 miles of it below the confluence [illegible]ory having a fall of 2½ feet per mile, nearly double what is met wi[illegible]where between 1st Barrier and Hingunghât, yet it is undeniable that st[illegible]mers drawing 2 feet of water do run upon this part of the river up to January and February, meeting, of course, with detentions at the shoals, such shoals being very few in number, and in part at least attributable to rocks scattered at a few points over the bed, which, more than anything else, cause the channels to silt up. It is further certain that a trip in a steamer drawing 2 feet was made from 1st Barrier to 2nd in 1863 in the sixth month of navigation, and that detention from shoals was only experienced at two points where the shoals were clearly attributable to the few rocks scattered through them. The difficulty which Colonel Fife afterwards refers to in the navigation of the few miles above Gollagoodiem is undoubtedly chiefly attributable to rocks. I have always strongly advised that all the information Colonel Fife requires about the shoals should be obtained by the actual navigation of the river in the shoal season, and this was one reason why I opposed the abandonment of the transport operations commenced by the Madras Government in 1862.

41. Colonel Anderson closes the Report with a short memorandum in which he recommends, in opposition to Colonel Fife, and apparently at variance with the advice given in the body of the Report, that, in any case, the works at the 1st and 2nd Barriers should be completed before ground is broken at the 3rd Barrier. He advises that the river should first be opened to Sironcha, and that, "when the passage of boats up and down the river between that place and Dowlaishwaram becomes an established fact," Government should then take into consideration the propriety of extending the navigation further up river. If Colonel Anderson wishes to ascertain whether boats of certain sizes can navigate the river between the points mentioned, surely this information can be obtained at a less cost than that of removing the obstructions at the two lower Barriers. Besides, he has already satisfied himself, as appears from the Report, that the river may be navigated by boats of a similar description to those plying in the Delta and on the lower part of the river.

If he wishes to ascertain what amo[illegible]t of *traffic* is likely to spring up and intends to judge from that as to the amount to be expected when the line is opened up into the populous country of Nagpoor, then, I submit, that there is obviously no necessity whatever for wa[illegible]for such experience, as it is quite certain that the traffic from Si[illegible]ards must be a mere fraction of that which would ensue we[illegible]ed into the well cultivated and populous districts above[illegible]. Either navigation must be carried into the country which [illegible]d to afford a traffic commensurate with the outlay, or the wo[illegible]ver have been commenced.

To stop at Sironcha, w[illegible] abandon the main object of the whole scheme, for the cost of carriage by land from the Nagpoor Districts down to Sironcha would be prohibitory of any important traffic between them and the coast.

42. Colonel Anderson's illustrations drawn from the case of the irrigation works in the Delta, are inapplicable. The anicuts and main canals there were not constructed merely as an experiment to see whether they would pay, and had the Government judged from the results when the works had been only thus far completed, they would have formed the most erroneous conclusions.

It would be just as great a mistake to carry the navigation to Sironcha, and then stop there without connecting it with the populous districts of Nagpoor, as to have built the anicuts and head-works in the Delta, and then to have omitted to cut the distributary channels without which the other works must have proved unproductive.

There was nothing of a tentative character in the manner in which the Delta works were carried out. It was first of all ascertained that the scheme would be *sufficiently* remunerative, though few besides the projector were willing to admit that the results would be anything like what they have proved to be. The works were then prosecuted as rapidly as the available funds permitted. Surely, a similar course should be pursued with regard to the navigation works. The Committee are of opinion that, even if limited to the employment of boats only, the navigation will, directly or indirectly, yield a sufficient return upon the probable outlay, but in hesitating, as Colonel Anderson appears to do, about the 3rd Barrier works, he shews that he altogether fails to appreciate the essential importance of that part of the works to the whole success of the whole scheme, which, without the navigations above that point, would be like an anicut with its head-works and heavy cuttings at head of canals completed, without the distributary canals.

43. But in conclusion I submit that the question as to the capability of the river for navigation for greater or less periods of the year, is now virtually decided by the ascertained fact, that steamers with speed sufficient for the monsoon navigation can now be built with so light a draught, 12 inches, that even if they cannot run for the *whole* year in the unimproved state of the river, they may certainly do so with the aid, during the latter part of the season, of such temporary and inexpensive works as those used on the Ganges for opening passages through the shoals. Such works "bandals," have been tried on the Godavery with sufficient success. A navigation with a minimum depth of 3 feet was, by these means, kept up one year from the mouth of the Sebbry to Dowlaishwaram to, to the 5th February, and this part of the river includes the 12 miles which, as above stated, have a greater fall than any other. It is true that the shoal immediately above the Sebbry did not yield a satisfactory results under this mode of treatment, but this has been permanently removed (to the extent to which the work has been carried out) by the construction of a groin. With the aid of such temporary works, I anticipate no difficulty in securing a navigation for steamers of 15 to 18 inches draught for the greater part of the year. But I have never proposed to resort to this imperfect mode of improvement, so long as funds may be available for constructing permanent works of stone in the bed, whose effect would be lasting. The only work of the kind that has been constructed has been successful. The obvious course to pursue now is to carry out the same system at a few other places, always selecting the worst shoals for the purpose, and to judge by the result as to the extension of the same system to the who[illegible]er. But I submit that the main point, can the river be navigated by [illegible]rs for the greater part of the year, is settled; that judging from the exp[illegible]nce of several years' navigation of the river with vessels of 2 to 3 feet draught, we have ample grounds to conclude that, with steamers of t[illegible] light [illegible]ht above-mentioned, navigation will be practicable for almos[illegible] even *without* groins or works of a permanent character for d[illegible]nels.

NAGPOOR,
12*th November*, 1866.

F. T. HAIG, *Major, R. E.,*
Engr., Upper Godavery Circle.

MEMORANDUM by MAJOR F. T. HAIG, R. I
Superintending Engineer, Upper Godav
Circle, on LIEUTENANT-COLONELS ANDERSO
and FIFE's *Report upon the Godavery Work*
dated 12th November, 1866;

ALSO

MINUTE on the above by R. TEMPLE, Esq., C. S.
Chief Commissioner of the Central
dated 13th December, 1866.

Calcutta:
PUBLIC WORKS DEPARTMENT PRESS

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Nos 1-16.

Godavery Navigation Project

PUBLIC WORKS DEPT. PROCEEDINGS, SEPTEMBER, 1867.

CIVIL WORKS.
Communications.

GODAVERY NAVIGATION WORKS, 3rd BARRIER.

Pros. (C. W. / Commns.) Aug. 1867, Nos. 46—52.

No. 277/3717, dated 24th August, 1867.

[No. 26.] *From*—MAJOR C. POLLARD, R. E., *Offg. Secy. to Chief Commr. of Central Provinces, in the P. W. Dept.,*

To—Secretary to Government of India, P. W. Dept.

I am desired by the Officiating Chief Commissioner to forward, for the perusal of His Excellency in Council, copy of two letters from the Superintending Engineer,* Upper Godavery Works, giving an account of the surveys in progress, with a view of determining the best way of dealing with the 3rd Barrier, and giving some remarks and proposals on the subject of the roads referred to in Government of India's letter No. 195 C, dated 8th March 1867.

* No. 844, dated 20th July.
„ 846, „ 22nd „

2. The object of the surveys on the 3rd Barrier is to determine whether it would be preferable to blast a clear channel through the rocks, or to turn them by a navigable canal as has been done at the 1st and 2nd Barriers.

3. Owing to some difficulties in regard to the selection of the best direction for the canal and position of the tail lock, the season closed before the full data were obtained to determine the question. This, the Officiating Chief Commissioner observes, is to be regretted, as it prevents the slack monsoon season being utilised in plotting the surveys, preparing and comparing the relative values and cost of the two schemes; but looking at the difficulties and dangers which had to be faced, and the extent of work to be done, Mr. Morris thinks Mr. Sieveking and his party have turned out a full season's work creditably.

4. The estimate for the completion of the examination and survey amounts to Rs. 6,211, of which about Rs. 3,672 is for cutting jungle to allow the party to move. This has been sanctioned.

5. Major Haig takes the opportunity of pointing out that, in order to determine the best and most effective way of dealing with the Barrier, and rendering the works equally advantageous for the navigation of the Wurdah and Wynegunga Rivers, a survey of the lower 60 miles of this latter stream is indispensable.

The Officiating Chief Commissioner concurs with Major Haig, into whose views on this subject he fully enters. It may be that the navigation works may not proceed further than the 3rd Barrier, but it would, in his opinion, be a flaw in this experimental scheme, if the works were not so designed as to admit of extension of navigation up both the Wurdah and Wynegunga, should a future generation desire it.

6. This Administration has, however, a difficulty in meeting the call for establishments for this survey. Every effort will be made to do so, but the work requires special qualifications, and such as are not always met with in the Upper Subordinates of the Department.

7. The Superintending Engineer also enters on the subject of a thorough exploration and survey of the Wurdah, with a view to the extension of navigation to the cotton mart at Hingunghât, and points out very explicitly that such a survey to be fully useful must be accompanied by a report on the places likely to prove useful as feeding reservoirs. He next takes up the subject of the survey of the Wynegunga, showing that already there are 233 miles of this stream almost navigable, and even in the event of its being determined, that Kamptee is not to be joined to the sea-board by a navigable channel, he points out that the wants of inland navigation alone call for improvements to this river.

8. What Major Haig urges as to the advantage to be gained by these surveys is, perhaps, incontrovertable, and the Officiating Chief Commissioner is alive to their importance. Indeed, he would be quite prepared to recommend the explorations of these valleys could an adequate establishment be spared for the purpose, but it cannot, and Mr. Morris thinks it would be a wiser course to allow these investigations to stand over, at all events until the completion of the works of the 1st Barrier shall liberate a portion of the establishment, and which may be reckoned on about July 1868.

9. On the subject of the roads little need be said, although, objecting to land-carriage when opposed to water-communication, Major Haig will doubtless complete this alternative scheme as fully as his own navigation projects. He asks for sanction to an outlay of Rs. 966, and the services of a Subordinate for the work.

10. The estimate has been sanctioned, and his other want will be supplied if possible.

11. But the Province is now short-handed, and no suitable man can at present be provided.

No. 344, dated 20th July, 1867.

[No. 27.] *From*—Major F. T. Haig, *Superintending Engineer, Upper Godavery Circle,*
To—*Secy. to Chief Commr. of Central Provinces, in the P. W. Dept.*

I have now the honour to report generally upon the surveys required for those portions of the Godavery project which lie above the 3rd Barrier, including the Barrier itself.

2. The orders of the Government of India, No. 195 C, dated 8th March 1867, directing, para. 10, that the survey of the 3rd Barrier and Wurda River up to Hingunghât should be put in hand, were received on the 29th March 1867.

The greater part of the working season was over, but I made the best arrangements possible under the circumstances, despatching Mr. J. H. Sieveking, C. E., Assistant Engineer, to take charge of the survey with Superviser Venkatruthnum, a very competent Surveyor, to assist him, there was afterwards added to the party Corporal Hogan of the P. Company, Sappers and Miners, Mr. Spairs, Supervisor, recently appointed on the temporary establishment, and Mr. Ward, who had lately been Municipal Engineer at Chanda, and who was engaged on the pay of a Supervisor. Operations were commenced on the 27th March 1867, and ended about the middle of June. The survey party has since been broken up, as reported in my No. 789—1, dated 3rd July 1867, and Mr. Sieveking and Mr. Ward alone remain attached to it.

3. The result of the season's work was that almost half was accomplished of the Wurda survey; of what had to be done, and another full working season will be required for the completion of the survey, and the preparation of the designs and estimates.

4. The instructions given to Mr. Sieveking had in view the investigation of two alternative modes of overcoming the difficulties presented by the Barrier, one by clearing a navigable passage through the river bed, the other by a lateral canal with locks. The season, however, closed before sufficient materials had been collected to guide to a decision between these two methods, and the best way of dealing with the Barrier still remains an open question. A careful survey of the bed has, however, been made, though it has not yet been laid down on paper.

5. For the alternative, a lateral canal scheme, an extensive series of levels has been taken, sufficient to determine approximately the site for an anicut at the head of the Barrier, and the direction of the upper 16 miles of the canal, half its whole length. On the lower half of the line, however, two alternative routes present themselves, and the question of the best site for the outlet and tail locks is rather complicated. It is in this part of the line that our information at present is chiefly defective, and very close and careful investigation will be required before a decision can be formed. We are, however, now in possession of sufficient data to place beyond a doubt the practicability of forming a canal at a moderate cost. The ground generally is favourable, and there is no special difficulty of any kind. Of course as yet no attempt at any estimates, however rough, has been made.

6. With a view, then, to the completion of the plans and estimates next year, I have directed Mr. Sieveking to prepare a revised estimate of the probable cost of the surveys required, inclusive of that of the Wurdá up to Hingunghât, *viz.*, of the Wurda to the mouth of the Warna Nuddee, and of the latter stream from thence up to the town of Hingunghât.

The estimate which I now submit for sanction amounts to Rs. 6,211, of which Rs. 2,275 have already been spent. The principal item is the cost of jungle-clearing on the different lines of levels which is necessarily heavy.

7. With regard to the establishment, the following arrangements appear to be required. Of those employed under Mr. Sieveking during the past season, Supervisor Venkutruthnum has been transferred to the 2nd Barrier Division. He was originally attached to that Division, and it was only for want of an experienced Surveyor that he was sent to the 3rd Barrier. His services at the 2nd Barrier are too valuable to admit of his being removed again, and he must, therefore, continue attached to that Division. Corporal Hogan was, as reported in my No. 803, dated 10th instant, sent back to his Corps on 31st May, and is since dead. Mr. Spairs, Supervisor (temporary), will be immediately transferred to the 2nd Barrier Division, where his qualifications as a Mechanical Engineer are likely to render him most useful. At present, in conse-

quence of the above transfers, the establishment, 3rd Barrier, is in excess of that submitted for sanction with my No. 501, dated 13th April 1867, but it will not be so when one of the Subordinates is transferred to Albaca next cold-weather, to superintend the clearing of rocks there. This work was to have been commenced this last season, but was postponed for want of superintendence, as reported in my No. 470, dated 6th April 1867. It is, however, urgently required, and must be put in hand this year.

8. It appears then from the above, that of the Survey Establishment employed last season under Mr. Sieveking's orders, only one man, Mr. Ward, will remain available for next year. Mr. Ward is not on the Establishment list, having been engaged in May as a temporary measure, for want of any one else, and is paid out of the estimate. I request that he may now be placed on the temporary Establishment as a Supervisor, 2nd grade, with pay of 1st grade.

Besides him one good Surveyor will be required to complete the 3rd Barrier survey, and I request that a man of experience, thoroughly expert at levelling and compass surveying, may be appointed.

He will not, however, be required before December next, as it will hardly be safe to enter those jungles before 1st January. The two Lower Subordinates now attached to the 3rd Division, but temporarily transferred to the other Divisions, will be available, so that no additional establishment will be required in this grade.

9. The establishment above proposed, *viz.*:—

1 Assistant Engineer,

1 Supervisor 2nd grade,

1 Surveyor of about the same rank and pay,

2 Lower Subordinates,

will be sufficient for the completion of the surveys and estimates for the 3rd Barrier. Mr. Ward will commence upon the survey of the Wurda in October, and will join the 3rd Barrier party on 1st January. But I must now add that the survey of the lower 60 miles of the Wynegunga is absolutely necessary to a determination of the best mode of dealing with the 3rd Barrier. The Barrier is situated at the junction of the two rivers,—the Wurda and Wynegunga,—and as we must look forward eventually to the navigation of both, it is essential that the latter should be kept in view in planning the works for the Barrier. It is not sufficient that these should be such as to satisfy the requirements of the Wurda navigation only, they must be capable of adaptation to that of the Wynegunga also. Indeed, if the views set forth in Mr. Temple's Minute on the latter river find acceptance, and the importance of the two navigations is to be measured by their respective lengths, and the relative extent, wealth, and population of their valleys, the Wynegunga will be entitled to the first attention, and no plans for the 3rd Barrier can be considered for a moment which does not form part and parcel of a plan for connecting the Wynegunga with the rivers below. To illustrate this, I may explain that it may possibly be found that a navigable channel may be cleared in the bed of the river itself at the 3rd Barrier, and that there may be no need for resorting to a lateral canal. If so, this method would satisfy all the requirements of the Wurda navigation, but the same plan may not be found applicable to the rocky parts of the Wynegunga in the last 60 miles of its course, and if a lateral canal must be substituted there, this would be an important consideration in favour of a similar canal at the 3rd Barrier, as it might be better to go to some extra expense to carry the canal right down to the clear water at foot of the Barrier, rather than to terminate it at the head of 25 miles of rocky channel. Thus the two questions must be considered together. The problem is to devise the best method of connecting both rivers with the Godavery, and this must of necessity be worked out, even though, in the first instance only, so much of the project be carried into execution as pertains to the Wurda alone. Hence the necessity for a detailed survey with levels of the lower 60 or 63 miles of the Wynegunga. This portion of the river is all more or less obstructed by rock. To the lower 30 miles of it, Mr. Temple gave the name of the 1st Barrier of the Wynegunga, but it was subsequently found that the obstructions extend over quite 60 miles, above that for a length of 108 miles the navigation is open.

10. I propose, therefore, to add one more Surveyor for the purpose above indicated. His duty will be to make a careful survey of the bed of the Wynegunga with longitudinal and cross-sections, and to determine generally the line for a lateral canal. The expense of the clearing, &c., which will be required, has been included in the estimate.

11. I would observe that this inclusion of the lower Barrier of the Wynegunga is not intended in any way to lead on to the elaboration of a project for the navigation of that river. The preparation of such a project, and the surveys and levels required for it, form a separate scheme altogether, which I shall bring forward in the following paragraphs. If it should be decided upon, the survey of the lower 60 miles of the river might be included in it, as it properly forms a part of it. If not, this portion of the survey should, as above proposed, be added to that of the 3rd Barrier for the reasons already stated.

12. To sum up, then, my proposals for the completion of the survey of the 3rd Barrier, with the last 60 miles of the Wynegunga, we require—

1st.—That Mr. Ward should be appointed a Supervisor 2nd grade, on the temporary establishment, with effect from 1st August next.

2nd.—That two other good Surveyors of, perhaps, the same rank should be appointed in like manner to join Mr. Sieveking at the 3rd Barrier on 1st January next.

3rd.—That his establishment should be increased by one Writer at Rs. 50, as a reserve in case of the one already sanctioned falling sick; and a Draftsman on Rs. 50, to assist in the preparation of the plans and drawings, which will probably be numerous.

4th.—That sanction should be granted for the accompanying estimate for the 3rd Barrier survey, amounting to Rs. 6,211.

These arrangements, if sanctioned, should enable us to complete the surveys, and to have the designs and estimates for the works well-advanced by July next, so much for the 3rd Barrier.

13. The next question to be considered is the survey of the Wurda to Hingunghât.

This was ordered by the Government of India in their No. 195 C, dated 8th March 1867, paras. 8 and 10; but as I have already reported, the establishment available during the last season was altogether insufficient for the purpose, and the survey has, therefore, yet to be made. The intention of the Government of India appears to be that the survey of this river shall be kept altogether distinct from the question of additional water-supply. It is to be undertaken at once as a separate work, unconnected with any project for storing water. All such projects, it appears from the orders above quoted, are to be postponed until the receipt of the orders of the Secretary of State regarding the 3rd Barrier works. I must, however, point out that the question of an additional water-supply for the Wurda navigation is altogether distinct from that of the improvement of the navigations below the 3rd Barrier by the same means. In the latter case the question does not press for immediate investigation, the rivers are navigable in their natural condition (the Barrier works being supposed to be complete) for 5 or 6 months of the year, and with the new steamers will be navigable for a still longer period. This, however, is not the case with the Wurda, a steamer drawing 2 feet of water can only navigate it during 3 months of the year from July to September. It follows therefore that to place this river on a similar footing with those below the 3rd Barrier in regard to the duration of the annual period of navigation, some means must be devised for remedying the defect of insufficient depth of water during 5 or 6 months of the year. A mere survey therefore which would afford the data for estimating the cost of removing the few scattered rocks, which alone obstruct its course in the 180 miles above the 3rd Barrier, would be altogether insufficient to determine the practicability and cost of extending the navigation up to Hingunghât. The defective water-supply must of necessity be taken into consideration, and some means devised for obviating this difficulty.

14. It will be desirable to describe in more detail the actual condition of the river in regard to navigation, that there may be a clearer understanding of what is required in the way of improvement. The average slope from the head of the 3rd Barrier, to the mouth of the Wurra Nuddee, 25 miles from Hingunghât, is 1 foot per mile. From the 3rd Barrier to Chanda the slope is less than this, above that point more 1½ foot per mile. The width between banks is 500 yards at the Barrier diminishing to 200 and 250 higher up. The only obstructions are rocks which occur at three or four points, loosely scattered over the bed, and which, though troublesome and even dangerous, do not prevent navigation. Their removal will be a work of small expense, so that they may be dismissed from the mind, and the river regarded as perfectly available for navigation was there, but the requisite depth of water. With regard to the latter point, we know that a steamer drawing 2 feet of water can run during three months of the autumn, but that even then there may be interruptions arising from deficiency of depth at a few points. The effect of the anicut, if one is to be built at the head of the 3rd Barrier, will be to throw the water back on a level for about 30 miles, which would submerge the worst known shoals in the river. Above this pool there would then be 70 miles of river, respecting which we have to ascertain what would be the effect of clearing passages through the few rocks met with, and which generally cause the worst shoals, whether this alone, or with some little help from training walls at a few points would not make the river navigable for steamers of 2 feet draught without interruption for 3 or 4 months, or for boats for a longer period. We have also to ascertain for what length of time the river improved only to this extent would be navigable by steamers, such as those now on the way out, with a draught of only 1 foot. Undoubtedly it would be so far a considerably longer period than for vessels of 2 feet draught, and we have yet further to determine what addition to the natural volume of the stream it would require still further to extend this period till it corresponds with the navigable period of the river below the 3rd Barrier down to the coast. It is very evident that the stream required to give an available depth of 1 foot at the few shoals met with in a river with such a moderate fall as the Wurda must be small, and the probability is that the extra supply required to maintain the stream in that condition for the few months, during which such help would be necessary would be comparatively trifling.

15. It will appear, then, from the above that the investigations, which the case of the Wurda requires, extend much beyond a mere survey of its bed with levels. We need also careful observation of depths at the shallowest points, and discharges during several months of the year, and further some estimate must be made from the data thus obtained of the quantity of water it would be necessary to store up to supplement the natural supply; and lastly, an examination should be made of the hills on the upper part of the river with a view to selecting a site for a reservoir. I fear the mention of this last word will suggest ideas of vast lakes of fabulous dimensions, costing immense sums of money, and to repel practical minds accustomed to view all such questions with constant reference to the available resources of the Government from any consideration of the question. But I believe it will be found that that the reservoir required in this instance will be of such extremely modest dimensions that it may be classed with some of the large, and by no means the largest tanks with which India is covered. I mention this simply with a view to encouraging investigation, and to guard against any foregone conclusions on the subject, for which there are really no sufficient grounds. What is needed, and what I would now urge is enquiry; that, with a view to giving effect to the orders of Government, and determining the probable cost, and most suitable method of carrying navigation up to Hingunghât, the capability of improvement of the Wurda should be made the subject of careful investigation in the order of enquiry which its natural condition suggests, *viz.*, the improvement derivable, (1), from clearing away rocks; (2), from the use of light draught steamers; and (3), from the augmentation of its natural supply from artificial sources, and it should at the same time be distinctly understood that the question of improvement to the extent last mentioned is to be considered quite independently of that of the suitability of the same system to the rivers below, and with reference only to the very limited requirements of the Wurda itself. The alternative method of improvement, by means of a series of dams, placed at such intervals as to form a succession of still-water pools throughout the whole length of the river, has also to be considered, so that in sanctioning the investigation now proposed, the Government would be in no way committed to either system, but would merely determine the comparative merits of each.

16. The establishment that would be required for this purpose would be—

1 Assistant Engineer.

1 Surveyor, say Supervisor 2nd grade.

1 Native Surveyor.

Two years would probably be occupied in the investigation. The work of the first would consist of the river survey, and taking an extensive series of levels and profilers of the bed, both longitudinal and transverse, together with careful measurements of depths and discharges at fixed point. In the second year, the observation and record of depths, and discharges would be continued, but the examination of the hills for sites for reservoirs would be undertaken, and, perhaps, the detailed survey and levels required for estimating for one reservoir would be made. Such a careful practical investigation of the question could not fail to afford most valuable and interesting results, and important contributions to the elucidation of the subject of water-supply generally. Rain registers would be kept at suitable points upon the hills, and a complete set of data collected, upon which reliable estimate could be framed, and from which a definite scheme, which from the very nature of the case would not be very expensive, could be elaborated.

17. I would strongly recommend this mode of conducting the inquiry. It would prove, I think, quite as satisfactory to the Government as to myself, it brings within a narrow and very practicable range the investigation of a system of improvement of wide application, and would at once remove from the regions of doubt and speculation questions which have been the subject of much controversy, and which can be showed in no other way.

18. I would, in the next place, draw attention to the Wynegunga, and in proposing that a detailed survey of it should be made next season, I would distinctly disclaim any intention or desire to commit the Government in any way to any further development of the Godavery project, than that which has been determined upon, pending the orders of the Secretary of State, *viz.*, the extension of navigation to the foot of 3rd Barrier only. It may appear unnecessary, so long as the question of opening the 3rd Barrier remains undecided to consider any proposition for further examinations of the rivers above it, but I would beg to point out that the question of the navigation of the Wynegunga is independent of the decision at which the Government may finally arrive respecting that Barrier, if the navigation is to stop at foot of the Barrier, the communication with Chanda is intended to be completed by a road, and the navigation of the Wurda will be abandoned, but the same result will not follow in the case of the Wynegunga. Even supposing a road to be made instead of a canal round the lower 60 miles of that river, there still remain above that point 233 miles of navigable river, if Mr. Temple's estimate of the navigable capabilities of the Wynegunga be correct, (and it must be remembered that it was subsequently confirmed by my own personal examination of the river from near Kamptee to its mouth), now this length of navigation, traversing as it does, as Mr. Temple has pointed out a valley with a population of 2,000,000 would certainly, if improved, become the channel of an important traffic, even if the connecting limb with the Godavery below was nothing better than a road. Hence it appears plain that the question of the navigation of the Wynegunga is independent of that

of the 3rd Barrier, and may be separately considered. Whether road or canal be adopted at the 3rd Barrier, the Wynegunga above will have a distinct and independent traffic of its own. The intervention of a road, though perfectly effectual in extinguishing water-communication above on the line of the Wurda, would not have the same effect on the other river. However much it might hamper and obstruct, it would not altogether prevent traffic on the 200 miles of the Wynegunga. I would, therefore, submit that there is no need for postponing the professional survey of this river, and would recommend that it be taken in hand at once.

19. There may remain, however, an objection, which I should, perhaps, notice, *viz.*, that to set on foot a fresh scheme of the kind, would have the effect of drawing away my attention from the works now in hand, and which require all my time and energies for their effective supervision. It was on this ground that the Chief Commissioner was pleased to negative my recent proposal for a six weeks' absence during the monsoon on an exploring trip down the Godavery Proper, I would observe, however, that my own presence would not be required upon the spot for the survey in question, and there is no reason why it should engage my attention for a moment from the time that the Officer appointed to it had received his instructions, until he submits his final report, when it will rest with the Government to determine whether any further action should be taken in the matter, or the survey might be conducted under the orders of the Chief Engineer, or of the Superintending Engineer, Northern Circle, which would have the double advantage of relieving me from all the temptation to waste my time in speculating about new projects, and of placing the matter in the hands of abler and perfectly unbiased men, so that this objection may, I hope, be removed.

20. As to expense I need not allude to this as a consideration, as it would of course be utterly insignificant in comparison with the interests involved.

21. With regard to the general question whether the information we already possess furnishes a sufficient *prima facie* case for further investigation upon this point also, there is no need, after Mr Temple's Minute upon the subject, for my offering any remarks. The immense value and importance of such a navigation, if practicable at a reasonable outlay, will be conceded. I merely propose that we should now ascertain approximately at least what outlay would be required. That the river is navigable for a part of the year from the Kamptee to its mouth is beyond a question. I suggest that the extent to which the navigation is capable of improvement should be made the subject of special investigation. There is no reason for postponing such investigation. Granting that years must pass before any scheme for opening the river could be put in hand, still past experience shows that year will elapse in any case, even after the preliminary enquiries have been made, for action in this country ever follows at long and dreary intervals in the wake of discussion. Might I not also suggest that independently of the navigation question, when a great river flows down the centre of a magnificent valley like that of the Wynegunga, whose gently sloping sides stretch away in vast plains on either bank, so singularly adapted for irrigation, the determination of the longitudinal profile at least of the river of its various slopes, and the advantages which it may possibly offer at certain points for leading off its waters to the adjacent lands, is a matter of the greatest interest, and will become a fundamental necessity whenever the irrigation of the country may be taken in hand on a large and comprehensive scale.

22. With regard to the establishment that would be required for this purpose, I think that an Officer, with three good Surveyors, would be sufficient to do the work in one season, a continuous survey of the river would not be required. There are already sufficiently accurately maps of it. A longitudinal line of levels, with numerous cross-sections and detailed plans of those parts of the bed which are obstructed by rock, would be required, and for these, I think, the above establishment would be sufficient. Operations might be commenced on the upper part of the river, where it passes through an open and well-cultivated country, soon after the rains, and the lower part which flows through a partially forest and less healthy tract would then be reserved for the hot-weather, when there is least risk of fever. In fixing the establishment at this amount, I suppose the lower 60 miles of the river to be left to the 3rd Barrier survey party.

The cost of establishment might then be one Assistant Engineer, 1st class, for one year, three Supervisors, 2nd grade, for one year.

23. The establishment, which I have above stated to be required for the several surveys proposed, are as follows :—

3rd Barrier Survey, including the lower 60 miles of the Wynegunga—

1 Assistant Engineer, 1st grade.
3 Upper Subordinates.
2 Lower Subordinates.

Survey of the Wurda—

1 Assistant Engineer, 2nd grade.
1 Upper Subordinate.
1 Lower "

Survey of the Wynegunga—

1 Assistant Engineer, 2nd grade.
3 Upper Subordinates.

Of these, 1 Assistant Engineer 1st grade, 2 Upper Subordinates, and 3 Lower Subordinates are provided for under the head "3rd Barrier Survey" in the establishment lists submitted for sanction with my No. 501, dated 13th April 1867.

Owing, however, to the transfers explained in my 7th para., neither of the two Upper Subordinates, and only one of the Lower is available. These, therefore, must yet be appointed to make up the establishment already applied for.

24. The establishments required for the surveys of the Wurda and Wynegunga are in excess of those entered in the lists submitted for sanction, the total annual charge for which amounts to Rs. 1,46,096. But in the Budget-Estimate submitted with my No. 593, dated 14th May 1867, I entered an extra sum of Rs. 20,000, which I then explained to be intended to cover the cost of survey now proposed. The portion of this which would be absorbed by the establishment above proposed for the Wurda and Wynegunga Surveys would be about Rs. 12,000, thus—

	Rs.
2 Assistant Engineers, 2nd grade, for six months	4,800
4 Upper Subordinates of the rank of Supervisor, 2nd grade, for six months	4,800
1 Sub-Surveyor for six months	240
Travelling allowance	2,000
	11,840

Adding to this the salary of the extra Upper Subordinate for the 3rd Barrier Survey, not as yet provided for, the total charge for the present year will amount to Rs. 13,500, to be provided out of the Rs. 20,000 entered in the Budget-Estimate for such purposes.

25. If the above arrangements should be approved by the Government, the following additional Officers and Subordinates would have to be appointed to this Circle :—

2 Assistant Engineers, 2nd grade.
5 Upper Subordinates, of whom Mr. Ward would be one.
4 Lower Subordinates.

The whole of the Subordinates must have a competent knowledge of surveying and levelling.

26. The estimates for three surveys herewith submitted amount as follows :—

	Rs.
3rd Barrier Survey	6,211
Wurda "	4,475
Wynegunga "	2,236
Total ...	12,922

Of this Rs. 2,500 have already been expended; and of the remainder Rs. 2,500 for the 3rd Barrier, Rs. 1,950 for the Wurda, and Rs. 1,600 for the Wynegunga, would be expended within the year, making the total charge to the allotment of the year Rs. 8,550. Nothing has been allowed for this in the Budget-Estimate, but the amount is small, and might be taken from that entered in the estimate for works under Rs. 2,500.

27. In conclusion, I would beg again to draw the attention of the Chief Commissioner to the question of the defective water-supply for irrigation in the Delta. I brought it forward in my report upon the Wynegunga, dated 14th December 1866; and again pointedly drew attention to it in my No. 502, dated 13th April 1867, begging only that an enquiry into the facts of the case might be instituted. So far as I am informed, no action has yet been taken in the matter. I am not even aware whether the second letter above quoted has been received. I beg earnestly to represent that there can be no reason for postponing such enquiry. It involves questions of great importance, it will not require that any official, who may take a part in it, should be moved from his present post, and it will not cost the Government a single rupee. I would further beg respectfully to adduce this as an instance of the protracted and altogether incalculable delays which beset almost every undertaking in this country. The past history of these works, since their transfer to the Central Provinces took place, involving the reference of all important questions to Calcutta or the Himalayas, is full of them, and I would urge that this is an additional reason for pushing forward such preliminary investigations as those which it has been the object of this letter to advocate with vigour. We may be quite sure that the information so obtained will not reach us a bit too soon, and will itself furnish fresh reasons, for still more of the endless discussions and delays through which every project not of the most routine description must work its slow and tedious way to actual execution.

No. 846, dated 22nd July, 1867.

From—Major F. T. Haig, *Superintending Engineer, Upper Godavery Circle,*
To—*Secretary to Chief Commissioner of Central Provinces, in the P. W. Dept.*

I regret to observe that in my No. 844, dated 20th instant, I have omitted all reference to the *roads* for which the Government of India has ordered that surveys should be made. I would now, therefore, submit, in continuation of that letter, some remarks and proposals upon the subject. The Government desire that estimates shall be prepared for the construction of "fair-weather roads by both the routes discussed," viz., from Chanda, *viâ* Salagaum, to Neagelles at foot of 3rd Barrier, and from Chanda, *viâ* Sirpoor and Bibra, to Sironcha. The one road would be 64 miles in length, and the other 150. I have no preference in favour of either route, but must equally condemn and repudiate both as substitutes for the navigation, but I wish heartily to carry out the orders of Government respecting them.

2. Regarding the first route then, viz., that *viâ* Salagaum to the foot of 3rd Barrier, I would repeat the request made in para. 6 of my No. 457, dated 28th March 1867, to which, I have received no reply. A survey of that route was made by Lieutenant Montgomerie, Royal Engineers, in 1864-65, and I believe an estimate for a metalled and bridged road prepared, I recollect his sending me privately some information upon the subject, among other things, the total amount of the estimate. Now I suppose if such an estimate is in existence, it must furnish the means for framing another for a fair-weather road only. I would be glad to be informed upon this point, and request that the estimate, if there is one, may be sent.

3. I should like also distinctly to understand what a fair-weather road means. I suppose it is one without metal of any description or bridges, in fact the common Native cart-track slightly improved.

4. With regard to the other route from Chanda *viâ* Sirpoor and Bibra to Sironcha, it will be necessary to appoint either an Officer, or an experienced Subordinate for the survey and selection of a line. A Subordinate of some experience in road-making, or rather in *laying out roads*, would probably do, as Officer could hardly be made available for such a work. Probably the existing cart-track might be generally followed.

It is not likely that a much better route could be found. The Subordinate, say a Sub-Engineer, might be placed under the orders of Mr. Sieveking, from whom he would receive general instructions, but would have to determine and survey the line himself unassisted. The distance is not more than may easily be accomplished in the time.

5. If therefore, as I suppose, the means already exist of estimating for the one route, I would propose that for the survey and estimate of the other, an addition be made to the 3rd Barrier survey party of an experienced Subordinate, and would solicit sanction for the accompanying estimate amounting to Rs. 955.

I have received Lieutenant Montgomerie's *plans* and level books of his survey, but not his estimate.

No. 686 C, dated 18th September, 1867.

[No. 28.] *From*—Colonel C. H. Dickens, R. A., *Secy. to Govt. of India, P. W. Dept.,*
To—*Chief Commissioner of Central Provinces.*

I am directed to acknowledge receipt of your Secretary's letter No. 277—3717 of 24th August 1867, forwarding copies of letters from Major Haig, giving an account of the survey operations of last season in connection with the 3rd Barrier Godavery Works, and submitting proposals for next season's operations.

2. In reply, I am directed to state that the orders of the Secretary of State must be awaited before any decision can be arrived at as to the proposed extension of operations in connection with these works.

3. Whilst admitting the importance of the survey of the Wynegunga and Wurda Rivers, the Governor General in Council regrets his inability to augment the present surveying staff as required by Major Haig. He should therefore exercise his discretion, as fit men become liberated from the 1st Barrier works, to employ them on these surveys, commencing as he proposes with the lower section of the Wynegunga, with respect to which, it is observed, you hope to be able to provide trained assistance to aid in the work of preliminary investigation.

4. I am to express the satisfaction of His Excellency in Council at the progress made in the surveys at the end of last season.

REFERENCE TO FORMER CASES.

Pros. (C. W. Commns.) Aug. 1867, Nos. 46—52.

REFERENCE TO LATER CASES.

TAKEERS.	DATED.

KEEP-WITHS.
Office Note.

GOVT. OF INDIA. } 1867. { P. W. DEPT.

CIVIL WORKS.
Communications.

P.W. 3131/67

September.

Nos. 26 TO 28.

Godavery Navigation Works, 3rd Barrier.

LIST OF PAPERS.

No. 26. From Centl. Provs., No. 2111 of 24th Aug. 1867. Submits copies of lrs. from Major Haig, regdg. surveys in progress, with a view of determng. the best way of dealg. with the 3rd Barrier, Upper Godavery Works.

No. 27. *Encls. in the above.*

No. 28. To Centl. Provs., No. 686 C of 18th Sept. 1867. States that orders of the S. of S. must be awaited, before any decisn. can be arrived at as to extensn. of operatns. in connctn. with the 3rd Barrier works, and communs. orders with refce. to the survey of the Wynegunga and Wurdah Rivers.

PUBLIC WORKS DEPT. PROCEEDINGS, DECEMBER, 1867.

CIVIL WORKS.
Communications.

GODAVERY NAVIGATION WORKS—(SECRETARY OF STATE'S DESPATCH).

Pros. (Civil Works Comms.) April 1867, Nos. 1—16.
„ („) May „ „ 19—21.
„ („) July „ „ 35—41.
„ („) Augt. „ „ 46—52.
„ („) Sept. „ „ 3—28.
„ („) Oct. „ „ 1—2.
„ („) Oct. „ „ 12—13.

No. 86, dated 14th September, 1867.

[No. 7.]

From—*The Secretary of State for India,*
To—*The Government of India.*

Your Excellency's Despatch, dated March 8th (No. 36), 1867, together with the accompanying papers, on the subject of the Godavery Navigation Project, have received my careful consideration in Council.

2. After a perusal of the papers containing information respecting the Districts comprised in the basin of the Godavery and its affluents, I am led to concur with you in the opinion that, on the whole, the arrangements which have been made by you for the prosecution of the works is the most desirable course to pursue. A river communication connecting the Central Provinces with the sea, must be beneficial to the people of that part of India, and, if successfully carried out, must eventually prove advantageous to the State.

3. At the same time, if the Godavery Works are to be completed, all half measures should be avoided. The ultimate success of the project depends upon the adequacy of the scale on which the works are constructed.

4. I now proceed to communicate my views on the various points which have been referred to me by your Excellency for decision.

5. The works should undoubtedly be adapted for steam-navigation, and the locks should, therefore, be constructed with a view to the passage of steamers. But I cannot concur in preferring the short canal at the 1st Barrier to that advocated by Major Haig and Sir Richard Temple. The larger project for a canal 20 miles long, from Doomagoodium to G[illegible]oodium, is admitted to be more complete and certain than that re[illegible]ended by the Commissioners, while the smaller project, though less expensive, and involving the construction of a canal only 5 miles long, also includes the necessity of blasting the rocks in the river bed for a considerable distance,—a doubtful and difficult operation, both the cost and effect of which are uncertain.

6. Your orders to proceed at once with the completion of the works up to the foot of the 3rd Barrier, including the 2nd Barrier works, according to the design recommended by Major Haig, have my full approval.

7. With regard to the … opinion that there should be n… preliminary investigations in o… may be in a position to sanction … part of the Godavery system as … Your orders, therefore, for the su… be carried out at an early date, a… of the Wurda and Wunna up t… its tributaries. Sir Richard T… very desirable that the latter r… Project, both on account of the in… because the navigation would thu… of Nagpoor.

8. The storage of water in … stream of the Godavery during th… ant part of the project; and I … qualifications has been already em… success. These investigations s… be given for the survey of the … within the basin of the Godaver… determine upon the sites where s…

9. A considerable time … navigation beyond the 3rd Barri… while, a road will not only be use… may ultimately be approved, but … river immediately available for tr… an expenditure of one lakh in … Mogellee, at the 3rd Barrier, to …

10. The territories of the … opening of the Godavery as our … of the results that have attended … made by the Resident to His H… is not unreasonable to expect th… will accrue to his dominions, the … steps towards opening roads as … of duties on food and other a… people employed on the works.

No. 780 C, … st November, 1867.

[No. 8.] *From*—Colonel C. H. D… R. A., *Secy. to Govt. of India, P. W. Dept.,*
To—*Resident at Hyderab…*

With reference to the c… ondence noted o… e margin, regarding the expl… of the portion of the Go… River within the Nizam's … inions, I am directed to forward herewith the accompanying extract, paragraph 10, from a Despatch* recently receiv-

From Resident at Hyderabad, No. 122, dated 14th September 1867.
Public Works Department letter No. 726 C, dated 4th October 1867.

* No. 86, dated 14th September 1867.

ed from the Secretary of State, and to request that you will be so good as to favour the Government of India, with a report on the whole subject at your earliest convenience.

er extension of the project, I am of … lay in completing all the necessary … that your Excellency's Government … prosecution of the works on the upper … ds become available in future years. … sion of the 3rd Barrier estimate should … l as those for the survey of the line … gunghât, and of the Wynegunga and … 's interesting Report shows it to be … should be included in the Godavery … rtance of the Wynegunga Valley, and … brought into the immediate vicinity …

… rvoirs, in order to increase the natural … ry season, is stated to be an import… … receive that an Engineer of special … yed in searching for sites with some … d be completed, and orders should … s which are suitable for reservoirs … It will be for your Government to … reservoirs should be formed.

… elapse before the extension of the … can be completed, and, in the mean… during the execution of works which … also render the works lower down the … I am, therefore, willing to sanction … construction of such a road from … nda.

… zam receive as much benefit from the …, and I shall be glad to be informed … y representations that may have been … iness' Government on the subject. It … in consideration of the benefits that … zam's Government should take some … ders to the river, and relax the levy … s exported for consumption by the …

No. 787 C, dated 1st … vember, 1867.

[No. 9.] *From*—Colonel C. H. Dickens, R… *Secy. to Govt. of India, P. W. Dept.,*
To—*Chief Commissioner of Centr… Provinces.*

With reference to paragraph 9 of Public Works Department letter No. 195 C, dated 8th March 1867, regarding the Godavery navigation works, I am directed to state that the Secretary of State has intimated the willingness of Her Majesty's Government to sanction the expenditure of a moderate sum for the construction of a road from … foot of the 3rd Barrier at Mogellee to Chanda, and to request that y… report at an early date what steps have been taken in pursuance of the orders quoted above to prepare estimates for this road, and when such estimates are likely to be submitted.

2. I am to add that it is of great importance that the road should be put in hand at an early date. Measures should, therefore, be taken to hasten the submission of the necessary estimates.

No. 196, dated 29th November, 1867.

[No. 10.] *From*—*The Government of India,*
To—*The Secretary of State for India.*

We have the honour to acknowledge receipt of your Despatch No. 86, dated 14th September 1867, replying to our letter No. 36 of 8th March, on the subject of the Godavery Navigation Project.

2. In para. 5 you express a preference for the long over the short canal ordered by us at the 1st Barrier, and suggest that the blasting of the rocks, involved in carrying out the latter, will be found "a doubtful and difficult operation." With reference to this, it is only necessary to refer you to the Progress Report of these works which accompanied our letter No. 137 of 17th August last. This shows that, at the end of March last, the short canal was almost finished, and that Major Haig anticipated no difficulty as regards the blasting of the rocks. Under these circumstances, it appears unnecessary to proceed with the long canal at present.

3. In the 7th and 8th paras. the early completion of the surveys for all extensions of the project, including the formation of reservoirs for increasing the natural stream of the Godavery during the dry season, is enjoined. We take this opportunity of forwarding copies of papers regarding surveys in progress, with a view of determining the best way of dealing with the 3rd Barrier, and of the orders issued by us in regard to this, and the survey of the Wynegunga and Wurda Rivers.

4. The Chief Commissioner of the Central Provinces has been requested to expedite the submission of the estimates for the road from Mogellee to Chanda, referred to in your 9th para.

5. With reference to para. 10, the Resident at Hyderabad has been called upon to submit an early report on the whole subject. On receipt of this reply, a further communication will be made to you. Meanwhile, we forward, for your information, copies of papers lately received by us in regard to the proposed exploration of the portion of the Godavery River within the Nizam's Dominions, and the construction by the Nizam's Government of roads to act as feeders to the river.

6. Although concurrence is expressed in para. 2 of your Despatch in our views as to the arrangements for the prosecution of the works,

the general tenor of the Desp[illegible] appears to us rather to support Major Haig's views than approv[illegible] action taken by us.

7. We beg to state that on[illegible]sential point in the proposals made [illegible] us, and approved in your 2nd [illegible]ra., was, that all further surveys, in view to future extensions of the [illegible]ks, should be postponed till after the estimates for the 3rd Barrier [illegible]rks should have been submitted to us. It will be seen in the propo[illegible]eferred to in the 3rd para., that we have allowed a p[illegible]tion of the s[illegible]ys up the Wurda to be included in the project for the 3rd Barrier [illegible]eyond this we would not go. We attach much importance to this [illegible]ly procedure, and to getting one thing done at a time in works [illegible] experimental in their character as these, and would accordingly re[illegible]t a re-consideration of this part of your orders. We may add, m[illegible]er, that, unless our demands for Engineers are met, it will be i[illegible]ssible to undertake any additional surveys.

Fide para. 10 of letter No. 36, dated 8th March.

8. We must, in conclusi[illegible]mark that the prosecution of the Godavery Navigation Works was [illegible]red by the Government in England before the estimates were pro[illegible] matured. This has led to large expenditure, and we believe a[illegible]ly to much delay. We are most anxious that the remainder of th[illegible]erations should be conducted with system and order. Undue haste[illegible]d not result in ultimate success, nor even in more rapid progress. [illegible] trust, therefore, that the arrangements we have made will be all[illegible]d to stand. We cannot hold ourselves responsible for the cons[illegible]nces if the measures recommended by us for curtailing operation[illegible]nnected with the Godavery Project within reasonable limits, and f[illegible]sisting on the prosecution of works upon carefully prepared plans a[illegible]timates, are set aside.

Docum[illegible]ccompanying.

1.—Letter from the Secretary to the Ch[illegible]m-missioner of the Central Province[illegible]the Public Works Department, No. 27[illegible]47, dated 24th August 1867, with enc[illegible]s.
2.—Public Works Department letter N[illegible]C, dated 18th September 1867, } Pros. (C. W. / Commns.) Sept. 1867, Nos. 26—8.

3.—Letter from Secretary to the Chief [illegible]is-sioner of the Central Provinces [illegible]he Public Works Department, No. 32[illegible]8, dated 19th September 1867, with e[illegible]re. } Pros. (C. W. / Commns.) Oct. 1867, Nos. 1—2.

4.—Letter from Secretary to the Res[illegible]at Hyderabad, in the Public Works [illegible]rt-ment, No. 122, dated 14th Septemb[illegible]67.
5.—Public Works Department letter No[illegible]C, dated 4th October 1867. } Pros. (C. W. / Commns.) Oct. 1867, Nos. 12—13.

REFERENCE TO FORMER CASES.

Pros. ($\frac{C.W.}{Commns.}$) April 1867, Nos. 1—16.
" (") May " " 19—21.
" (") July " " 35—41.
" (") Aug. " " 46—52.
" (") Sept " " 26—8.
" (") Oct. " " 1—2.
" (") Oct. " " 12—13

REFERENCE TO LATER CASES.

TAKEN UP.	DATED.

KEEP-WITH.
Office Note.

GOVT. OF INDIA. } 1867. { P. W. DEPT.

CIVIL WORKS.
Communications.

P.W. 3/14/58

December.

Nos. 7 to 10.

Godavery Navigation Works—(Secretary of State's Despatch.)

LIST OF PAPERS.

No. 7. From S. of S., No. 86 of 14th Sept. 1867. Replies to Des., No. 36 of 1867, on the subjt. of the Godavery Navgn. Project.

No. 8. To Hydbd., No. 786 C of 2nd Nov. 1867. Forwds. extt. from the above Des., with reqst. that a rept. may be furnshd. regdg. the explrtn. of the Godavery River within the Nizam's domi-nions.

No. 9. To Centl. Provs., No. 787C of idem. Enquires what steps have been taken with regard to the prprn. of estmets. for the constrn. of a road from the foot of the 3rd Barrier at Mogallee to Chandah.

No. 10. To S. of S., No. 196 of 29th Nov. 1867. Replying to the letter from the S. of S.

CIVIL WORKS.
Communications.

GODAVERY NAVIGATION WORKS—(SECRETARY OF STATE'S DESPATCH).

Pros. ($\frac{C.W.}{Commns.}$) July 1867, Nos. 35—41.
" (") Dec. " " 7—10.

No. 109, dated 31st October, 1867.

[No. 39.] *From—The Secretary of State for India,*
To—The Government of India.

I have received and considered in Council your Despatch, dated July 11th (No. 107), 1867, forwarding Major Haig's interesting Report on the navigable capabilities of the Kanhan and Wynegunga, after a detailed personal examination of those rivers.

2. In approving of your orders to proceed at once with the completion of the Godavery Works up to the foot of the 3rd Barrier, in my Despatch, dated 14th September (No. 86), 1867, I also expressed my opinion that there should be no delay in completing the necessary preliminary investigations above it. I would add, with reference to your remarks on Major Haig's Report on the navigation of the Kanhan and Wynegunga, that these investigations should be completed, rather than commenced, when the works now in progress are approaching completion.

3. The very important statement brought to your notice by Major Haig, that the area of cultivation under the Godavery has already been extended so far as to cause a large deficiency in the present water-supply, and that it has been found necessary to prohibit second crop cultivation in three talooks, properly received prompt attention from your Excellency's Government.

4. I perceive that a report has been called for from the Madras Government on this subject. If the views of Major Haig are corroborated, and it is found that the necessary supply of water for irrigating the Godavery delta is failing, the advisability of taking immediate steps for storing extra supplies of water, either in small or large reservoirs, should at once receive very careful consideration. In my previous Despatch, I directed the completion of the survey of sites suitable for reservoirs within the basin of the Godavery, with a view to increasing the natural stream of that river during the dry season.

5. Major Haig asserts that the construction of a reservoir of a capacity sufficient to supply present wants in the delta would be a comparatively inexpensive undertaking, and be the best possible test of the question of the suitability of that method of improvement to the Godavery and its affluents. His proposition appears to me to commend itself to your early attention.

6. I look with considerable interest for the replies you may receive from the Government of Madras to your requisition for information on the condition of the delta cultivation.

No. 200, dated 14th December, 1867.

[No. 40.]

From—*The Government of India,*
To—*The Secretary of State for India.*

We have the honour to acknowledge receipt of your Despatch No. 109, dated 31st October last, on the subject of the investigation of the navigable capabilities of the Kanhan and Wynegunga Rivers, and the survey of sites for the formation of reservoirs within the basin of the Godavery River, and beg in reply to refer you to our Despatch of 29th November 1867, No. 196, conveying our views as to the manner in which the Godavery navigation works should be proceeded with.

REFERENCE TO FORMER CASES.

Pros. (C. W. / Commns.) July 1867, Nos. 35—41.
" (") Dec. " " 7—10.

REFERENCE TO LATER CASES.

Pro (Cur.) Jany/68 No 15/19
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None.

GOVT. OF INDIA. } 1867. { P. W. DEPT.

CIVIL WORKS.

Communications.

P. W. 3131/81
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December.

Nos. 39 AND 40.

Godavery Navigation Works—Secretary of State's Despatch.

LIST OF PAPERS.

No. 39. From S. of S., No. 109 of 31st Oct. 1867. Replies to Des. on the subjt. of the investigatn. of the navigable capabilities of the Kanhan and Wynegunga Rivers, and the formatn. of reservoirs within the basin of the Godavery River.

No. 40. To S. of S., No. 200 of 14th Dec. 1867. Refers to previous Des. which convyd. the views of the Govt. of India as to the manner in which the Godavery Navigatn. Works should be procdd. with.

PUBLIC WORKS DEPT. PROCEEDINGS, MAY, 1868.

CIVIL WORKS.

Communications.

GODAVERY NAVIGATION WORKS. DEFICIENCY OF WATER FOR IRRIGATION IN THE GODAVERY DELTA—(SECRETARY OF STATE'S DESPATCH).

Pros. (Civil Works / Commns.) Dec. 1867, Nos. 39—40.

No. 848 dated 13th March, 1868.

[No. 4.] *From*—COLONEL C. A. ORR, R. E., *Secy. to the Govt. of Madras, in the P. W. Dept.,*

To—Secretary to the Government of India, P. W. Dept.

With reference to your letter No. 506 C of the 11th July 1867, and to Mr. Campbell's docket of the 22nd ultimo, I am directed to explain that Major Haig's remarks, on the subject of reservoirs in connection with the water-supply of the Godavery Delta, were referred to the Superintending Engineer of the 1st Division for report, but that, in consequence of his reply not containing full information regarding the quantity of water now available for the use of the Delta during the dry season, or the area irrigated by it, a further report had to be called for. The Superintending Engineer has not yet replied to this reference, and precise information on these two points cannot, therefore, be at present afforded. It would appear, however, from the reports already received, and which are herewith furnished for the information of the Government of India, that the requirements of the Delta during the dry season are not so important nor extensive as Major Haig imagines, and that the local Officers, including the Collector of the District, are of opinion that the raising of two crops of rice on the same land in one year is not a thing to be encouraged.

2. It should be explained that the term Dalwa is used indiscriminately in the accompanying correspondence for the rice crop raised during the six months from December to May, whether it is a second crop or not. A considerable portion of the Dalwa is produced on land which is more or less submerged during the rainy season, and, of course, until such lands are drained, it is the only crop that can be raised on them. In the absence of precise information as to the area cultivated under different conditions during the dry season, it would be impossible to form a reliable opinion regarding the quantity of water in addition to the present supply of the river which could be turned to good account in the Delta at that season; but there is no question that the crop raised from June to December is a more remunerative one than the Dalwa, acre for acre, and that a large proportion of the latter will be abandoned when the Delta shall have been properly drained. The water which is used for the irrigation of swampy land during the dry season would then be set free for the irrigation of sugar-cane, garden produce, chillies, &c.

3. There is an ample supply in the Godavery, from June to December, for the irrigation of the whole Delta, and of the 1,000,000 acres said to be under command of the anicut, only about 400,000 acres are as yet under wet cultivation. There is thus great room for improvement, and it is but reasonable to conclude that money would be more profitably laid out in enlarging and extending the existing channels in the Delta, in reclaiming swamps and general improvements in the Delta itself, so as to bring the whole area within the influence of the water already available in the river, than in furnishing a supply by artificial means for raising a comparatively unremunerative crop during the dry season.

A Return for 1861-65, received from the Board of Revenue, gives the following acreage of wet cultivation:—

Government lands	199,103
Zemindary	27,644
Inams, Agraharums, &c., ...	147,429
	374,176

4. While, therefore, this Government are not prepared to assert that a gradual increase in the second-crop cultivation would not be made if the dry-weather supply of the Godavery were augmented, they consider that it would be premature to look to improvement in that direction when so much remains to be done in utilizing the natural supply of the river during the rainy season.

5. As regards the navigation, I am to remark that the defective condition of some of the channels for several months in the year is due, not so much to actual deficiency of water, as to insufficiency of locks, and to the generally incomplete condition of the Delta system. A comparatively small quantity of water would be required if still-water navigation could be kept up, but in some cases there being a considerable fall from lock to lock, or from a terminal lock to a tidal channel, a sufficient depth for the passage of boats cannot be maintained unless there is a surface fall in the canal as well, or, in other words, unless a stream is kept up.

6. It will be observed on reference to the report of the Sub-Engineer in charge o the 5th Range, that there has never been less than 4 feet depth of water in the hea sluices even in the month of May since the anicut was built, while the Officer in charge o No. 2 Range states that he had never seen the navigation interrupted in the Central an Western Deltas for want of water, except at the lowest reaches of the canal, and that he attri buted the stoppage to the bad condition of the canals, and not to want of water. Looking t the channels in their present state, it would certainly appear that there is an insufficien supply to keep up navigation, and to meet the demands of the cultivators during the month of March, April and May, but before it can be determined whether any additional supply b means of reservoirs should be sought for, it must be ascertained to what extent the efficiency of the channels can be improved by means of additional locks and other works in the Delt itself. The Superintending Engineer (Captain Ryves) is now engaged in drawing up a pro ject for the completion of the Delta system, and his attention will be drawn to these points.

7. As regards the notice which appeared in the Godavery District *Gazette*, and whic attracted the attention of Major Haig, I am to state that the Range Officer at whose instanc the notice appears to have been inserted, explains that it was not correctly worded. Th channels must be cleared out periodically, and it is customary to close the main canal and, of course, also the branches from them, in turn for this purpose, arrangements being made as far as practicable, to keep up the navigation along the principal lines of traffic. Even the river-supply were increased during March, April and May, it appears questionable to th Government whether such closures could be avoided.

No. 157, dated 17th October, 1867.

[No. 5.] *From*—*Acting Superintending Engineer, 1st Division,*

To—*Secretary to the Government of Madras, in the P. W. Dept.*

I have the honour, as requested in Government Order No. 2525, dated 19th August 186 to report the advantage to the Delta the Godavery of constructing reservoi in the Nagpoor Territory, as proposed b Major Haig, R. E. I have consulted th Collector and the Executives, and enclose copies of their Reports upon the subject.

Five Reports from Nos. 1, 2, 3, 4, and 5 Ranges of Godavery District.
One Report from Collector, Cocanada.

2. The Godavery naturally affords far more than sufficient water for raising a sing crop of rice were the entire Delta both above and below the anicut irrigated.

3. Were there more water in the river before the first fresh, usually occurring about Jun 10th, paddy might be transplanted earlier than it now is; the only advantage in this woul be that the ryots would have more time to cultivate a given acreage, the crops would not b better; and, on the other hand, if during a part or the whole of May cultivation is going on our working season would be shortened, and the condition of the channels would deteriorate as the population of the district increases, these arguments for and against early transplant ing will vanish.

4. There is ample water in the river up to the end of December for all our presen and, probably, for all our future wants.

5. The Revenue and Engineer officials are unanimous in considering that it is not advisable to raise a Dalwa crop, that is, not two crops of rice on the same land in one year, and the ryots generally are of the same opinion. The following are some of the arguments against Dalwa: it is not good for the villagers, nor for their cattle, that they should never walk upon dry land, but be perpetually surrounded by a rice swamp; the land itself will be impoverished from being over-worked, and from want of perfect exposure to sun and air; moreover, it is found by experience that from Dalwa the land produces noxious weeds and destructive grubs.

6. Were Dalwa beneficial in a revenue and general point of view, it could not for long be maintained; unless the channels are for part of the year closed they cannot be repaired, and must inevitably fall into a ruinous and ineffective state, and, moreover, to obtain labour for their repair would be a serious difficulty.

7. In some parts of the district, especially in the neighbourhood of the Colair Lake, a crop of rice can be more easily raised in the after part of the year than during and before the monsoons; there may be, perhaps, in the Delta some 100,000 acres of such land that will eventually require 200,000 yards of water per hour during the months of December, January, February and March, but much drainage has to be done before all this extent of land can be brought under cultivation at any season of the year.

8. Provision also must be made for irrigating sugar, chillies, and other garden crops long after the principal rice-crop has been reaped.

9. The whole of the canals are open and in good working order from June 10th to November 15th: then some are closed for repairs or improvements, and others gradually become less navigable as the water in the river falls. I think there can hardly be a doubt but that our navigation would materially benefit by an artificial supply of water in the river from March 1st to June 10th.

10. Not all the water that we require for the later crops need be derived from the Godavery; on the contrary, to perfect the Delta works, at least three reservoirs ought to be constructed entirely independent of the Godavery.

11. In conclusion, I beg to state as my opinion, that I consider that the Godavery Delta could, with advantage to itself, pay one lakh yearly for water that had been stored in reservoirs to be delivered at the Dowlaishwarum Anicut from March 1st to June 10th in quantities varying from 100,000 to 200,000 cubic yards per hour.

Dated 28th August, 1867.

Replies to questions circulated in the Memorandum of Captain Beckley.

Questions.	Replies.
1. Is there sufficient water for the first crop?	There is ample.
2. Would there be any advantage in having the supply augmented in May and June, so that the rice cultivation should be commenced earlier?	None. The seed beds are prepared, and the seed sown in May, there is then enough water in the river for wetting these. The seed is ready for transplanting by 15th June, by which time generally the freshes commence; transplanting should be over by end of August.
3. Would there be any advantage in having more water in November and December, so that part of the first crop might be planted later?	No. At the latest, the first crop should be transplanted by middle of September, and such crop would be cut from 15th December to 15th January.
4. Is it advisable to take two crops off the land in one year?	Certainly not. As a rule, if two crops of paddy be meant, most wet lands will stand cropping with paddy and green gram, or paddy and hemp, but two crops of paddy would scourge most of the lands too much.
5. How much water is required for the second crop; *first*, on land that has yielded a first crop of rice; *second*, on land on which there has been some dry crop; and *third*, on land on which there has been no first crop?	For a second crop of paddy the same quantity of water would be required in all the three cases specified.
6. What supply of water is hereafter likely to be required in excess of that now used?	Impossible to say until the probable number of acres to be irrigated in future, in excess of the number now irrigated, is known or stated.
7. In what months, and to what extent, does navigation suffer from want of water?	In March, April and May. These are the months in which the necessary annual repairs are made to the channels. There are always some open and some closed at this time for this purpose, and this is unavoidable. All the main canals could not be kept open (from want of water in the river) if there were no repairs going on.

J. FRASER,
Collector.

Cocanada,
11*th October*, 1867.

No. 348, dated 6th September, 1867.

From—*Executive Engineer, Godavery District,*

To—*Superintending Engineer, 1st Division.*

I have the honour to acknowledge the receipt of your Memorandum No. 662, forwarding extracts from Reports by Major Haig, R. E., together with G. O. No. 2525 of the 19th August, and requesting my opinion on seven points connected with the questions raised in the above papers. I beg to state in answer to your questions—

1. I have not, during the last three years, known any deficiency of supply for the first crop in the Delta except for raising the seed beds; this deficiency, too, is owing principally to the unnatural desire of the ryots to force on an earlier crop than was usual formerly. Flooding the ground during the hot season in May causes the generation of foul grasses and worms, and, unless there is a constant change of water, hot-weather crops are constantly attacked by worms, causing, at the time that the evaporation is greatest, an extraordinary expenditure of water. The desire of the ryots to transplant their first crop in May arises, I believe, from much of the area commanded by our channels being imperfectly drained, as if the lands are swamped in October and November, the crop is lost unless it has grown very strong. On such land only does it seem any advantage to transplant before the monsoon and freshes have regularly set in. As improvements in the Delta extend, the area of badly-drained land will year by year diminish.

2. There would be an advantage undoubtedly in the water-supply for irrigation being increased in May and June to enable the seed beds to be raised ready for transplanting immediately the channels receive their monsoon supply; this advantage would be limited, inasmuch as however great the supply after the setting in of the monsoon, the deficiency of labour limits the rate at which the land can be transplanted, whatever water-supply can be thrown on to the land by us. On the other hand, it would, for this very reason, be some advantage to commence early in order that the transplanting may be got over as early as possible.

3. I have never known a deficiency of the water-supply in November and December. Major Haig's experience of the Delta irrigation was before the raising of the anicut, which not only enables the channels to be kept fuller when we get small and early freshes, but also enables us to keep a full supply in the channels after the heavy freshes are over.

4. The ryots seem now to be generally of opinion that the Dalwa (or summer paddy) crop is a mistake, *first*, because the yield is very small, compared with the expenses of the crop; and *secondly*, because land which has been cultivated with Dalwa yields much less for the first crop. In fact, land on which two crops of rice have been raised frequently deteriorates. Under the present land revenue system, land which has deteriorated would be speedily thrown up by the ryots, and the Government would, in the end, be the losers by an extensive system of over-cropping. It is, however, very desirable that there should always be an abundant supply for such summer crops as chilly, turmeric, and other garden crops, as well as for sugar-cane gardens, the revenue which now is, and which can be, derived from these crops being very considerable. Dalwa cultivation is injurious in the following respects:—it keeps the channels and drains full at the time when repairs are otherwise not easily executed; it drains the main canals of the supply necessary for navigation, and the labour required for keeping all the works in working order for the main crop is diverted for the Dalwa cultivation.

5. I cannot state accurately the quantity of water required for an acre of the various summer crops. Dalwa, however, takes a vast quantity of water, not less than 3 to 4 cubic yards per acre per hour. Chillies and cane gardens take much less, and summer *gingely* less again.

6. I should say if the summer supply of the whole river were never less than 300,000 cubic yards per hour, all requirements, both for summer irrigation and navigation, could be fully met in the three Delta ranges. I do not mean to say that every channel could be made navigable during the whole of the summer by this supply, as some of the main canals would be necessarily closed for clearances, but navigation on one of the main lines in each Delta would then be rendered certain.

7. It generally becomes difficult after the 1st April to keep the navigation good, and the difficulty increases till the freshes set in, generally about the 20th June, when water is being much drawn off for Dalwa or seed beds; it is at present almost impossible to keep the canals open for boats drawing more than 2 feet 6 inches or 3 feet of water, the increase of the river supply would be of essential service in maintaining good navigation.

No. 227, dated 14th September, 1867.

From—Supervisor in charge of No. 4 Range,

To—Acting Superintending Engineer, 1st Division.

With reference to your Memorandum No. 662 of the 28th ultimo, I beg leave to report the following points, *viz.*:—

QUESTIONS. ANSWERS.

(1). There has been sufficient water in the canal.

(2). If water be sufficient in May and June, the first crop may be commenced early, and the produce may be yielded without fail.

(3). There would be an advantage in receiving water during the months of November and December. Part of first crop can be yielded properly when planted later.

(4). Half of the land that is under the canal is fit for two crops in one year, say 12,000 acres.

(5). There are no lands used at first for dry crop, second, wet crop, but lands under wet cultivation are yielding one crop of rice, and require 2¼ cubic yards of water per acre per hour.

(6). The full supply of water from the Ellore Canal, Godavery portion, in August is 68,000 cubic yards per acre per hour, but by the velocity taken on Nundamoor Aqueduct in May, it is 54,400 cubic yards per acre per hour, the difference, 33,600 cubic yards of water, is required in May in excess of that using in that month.

(7). The navigation suffers for water during the months of April and May, and 1 foot of water* is required in excess on Nundamoor Aqueduct in these months.

* Height.

No. 604, dated 20th September, 1867.

From—Officer in charge of No. 1 or Eastern Delta Range, Godavery District,

To—Superintending Engineer, 1st Division.

I have the honour to acknowledge receipt of your No. 662 of 28th ultimo, forwarding extract of a Report by Major Haig, and G. O. No. 2525 of 19th August 1867, and will concisely reply to your queries, afterwards giving explanations:—

(1.) Yes.
(2.) No.
(3.) No.
(4.) No.
(5.) Two cubic yards per hour per acre.
(6.) None.
(7.) March, April, May, and part of June.

In giving the above answers, I intended them only to apply to my Range in particular, and at the same time to observe that they will apply more or less to the whole Delta.

2. I will now give explanations to the above replies in same order:—

(1.) For first crop, if it were three or four times as great as Major Haig mentions (which is impossible), there is sufficient water.

(2.) It is the opinion of every one here that the ryots plant too early, and that the crop is not so good when planted out early; if planting is commenced in July and finished in August, it is sufficiently early; there is, therefore, no reason why supply for first crop should be augmented.

(3.) The water in river is quite sufficient to carry the first crop through November and December, there is, therefore, no reason why a further supply is required.

(4.) My own opinion, and that of most people connected with irrigation here, including ryots, now is, that it is not advisable to take two crops off same land in one year, because, first, it impoverishes the land, and the crops are not so good; or, in other words, if two crops are regularly taken off the land, the yield is a mere trifle in excess of that given by one crop, owing to land being so much impoverished, whilst the cost of cultivation is doubled (for, mind, there is no manuring carried on), and further the second crop is generally more or less destroyed by blight or caterpillar caused by keeping land wet during hot months, instead of allowing it to lay fallow, and so recover itself.

(5.) I am not aware that a second crop requires more or less water than at other times. I am alluding to paddy only.

(6.) Requires no explanation, as the answer to (1) is sufficient.

(7.) Navigation in the months mentioned would be all the better for from 50,000 to 70,000 cubic yards per hour (I allude to my Range only).

3. Another reason for not having a second crop (4) is, that with all the canals running full, it is impossible to keep them and their branches in proper order, or the drains either, as nothing can be done to them with water in them; a very sufficient proof of which was to be seen in this Range when I took charge of it, and even in its present state, which I consider anything but satisfactory, although for three seasons I have done my best to get it into proper order.

4. The Gazette Notice, which Major Haig takes as his stand point, was not correctly worded, as the reason for forbidding Dalwa was not entirely on insufficiency of water, but in advisability of a second crop, and necessity for closing canals for repair.

No. 139, dated 24th September, 1867.

From—Officer in charge of No. 2 Range, Godavery,

To—Superintending Engineer, 1st Division.

As directed in your Memorandum No. 662, dated 28th August 1867, I have the honour to forward the following answer to your questions *seriatim*, as far as I am able to answer them:—

1. There is sufficient water for the first crop; and, as far as my observation goes, the amount at present supplied is a good deal more than sufficient, if properly managed.

2. Some of the ryots with whom I have conversed think there would, but I think their motive in wishing to plant earlier is mainly that the local labour is thereby economized. If a man has ten acres of land, and can get water in May or the beginning of June, he can go on ploughing and transplanting for a couple of months with only the one or two pairs of

buffaloes, and the few labourers who may belong to his own farm; whereas if he cannot get water till, say, August, he is obliged to hire labour for transplanting at what is, to a Native, an exorbitant rate: women sometimes get as much as 2½ annas (or its equivalent in grain) for an easy day's work in the transplanting season when water has been scarce. The difference in the time of transplanting does not make a proportionate difference in the time of harvest, for the paddy does not begin to grow healthily till the North-East monsoon begins to blow; so there will not be 20 days' difference in the time of harvest of two crops of the same kind of rice transplanted at the beginning of June and the end of August. But it is reasonable to suppose that the crop which has had time to mature will be stronger and heavier than that which has been only 110 days planted out. I think, therefore, that there would be some advantage in having enough water to begin transplanting in the end of May, as labour is so scarce in the district.

3. There would, as far as I know, be no advantage in having more water in November and December, as there is always more than sufficient during those months, and there would be no advantage in planting the Sarva crop late.

4. As the Natives in this district will not go to the trouble of systematically manuring their land, I think it decidedly prejudicial to the land to take two rice crops off it. But some of the land, especially in the Western Delta, is so low, that no early crop can be cultivated on it. Such land requires water in the Dalwa season, though it is not, properly speaking, a second crop.

5. Taking one cubic yard per acre per hour as the usual allowance for a rice crop in this district, I think that, in the first case proposed, no more would be required for a second crop, though, as stated above, I think second crops of paddy should be discouraged. In the second and third cases, the land being quite dry at the time of receiving the first supply of water, and being full of deep cracks, it will probably take three times the above allowance for the first few weeks of cultivation. I would here observe that I think the one cubic yard per acre per hour a very sufficient supply where the water is carefully managed; in the Southern Districts we allow more, nearly 3 cubic yards, but the evaporation is much greater there, and the water for the most part not so rich in silt.

6. I think if the supply were increased by 20 or 25 per cent. in April and May, it might be an advantage, chiefly on account of the heavy navigation in the Eastern Delta.

7. I have never seen the navigation interrupted in the Central or Western Deltas for want of water, except at the lowest reaches of the canal, where the heaviest traffic is sometimes stopped for a few days; but I believe that was chiefly owing to the bad condition of the canals, and not to the want of water. I believe, however, the supply in the Eastern Delta is sometimes a little short in April and May.

No. 23, dated 26th September, 1867.

From—Sub-Engineer in charge of No. 5 Range, Godavery District,

To—Acting Superintending Engineer, 1st Division.

In reply to your Official Memorandum No. 662, dated 28th ultimo, I have the honour to give my opinion on the following points as therein required:—

(1.) There is sufficient water for the first crop in the Godavery.

(2.) There will be a great advantage in increasing the supply of water in April and May for early commencement of rice cultivation; by commencing it later, the crops generally suffer from bad wind, insects, &c., in some villages.

(3.) There will be no benefit in having more water in November and December, as the cultivation cannot be commenced later, and also it is harvest time, at which time water is not required at all.

(4.) Two crops can be taken off the land in one year in this district in some parts, provided that the land is properly manured. This is generally done in the districts where two crops are made, but the ryots in this district do not know how to fertilize the soil, therefore it is not advisable to make two crops.

(5.) Two cubic yards of water are required per hour per acre for second crop on land that has yielded first crop, and nearly, on average, three cubic yards on land on which there has been some dry crop, and on that which has not yielded first crop. A greater part of Dalwa cultivation, or second crop, is not made on the land which has yielded first crop, but on that which is kept quite untouched for that purpose at the beginning.

(6.) As for the water required in excess of that now used, I consider that it is necessary in low-water season to keep the head of water at the anicut 2 feet higher than it now stands in that season, or quite level with the crest of the anicut, or 6 feet deep on the floor of head-sluices. To effect this partly, I think the water which usually stands in shape of a pool near Pooroosbotapatam, at a level of about

10 feet above the crown of the anicut, can easily be thrown in by making a passage for a distance of nearly 2 miles through the shoals, which form a barrier between Rajahmundry and Poorooshotapatam about 26 miles from the anicut. At the beginning of the Upper Godavery Works, Government had sanctioned funds to deepen the canal and to remove shoals, &c., in the bed of the river within 20 miles, for navigation between Poorooshotapatam and Rajahmundry, from which we had a better head of water at the anicut in former years.

The following sums had been sent for the above purpose:—

	Rs.
In the year 1861-62	3,017
1863	4,427
1864	3,249
1865	1,338

But no work has been done within the last two years. If these shoals are removed between Poorooshotapatam and Rajahmundry, a sufficient supply can be had from the reservoir near Poorooshotapatam.

(7.) Navigation does not suffer if the canals are kept in good repair, as the water on the floor of head-sluices has never been less than 4 feet deep even in May since the anicut was raised.

No. 3468, dated 8th November, 1867.

Order thereon by the Govt. of Madras, in the P. W. D. (Irrigation).

Before submitting to the Government of India the papers above recorded, the Government request the Superintending Engineer of the 1st Division to ascertain and report what is the approximate supply of water available for the Godavery canals during the dry months, the extent of the Dalwa crop, its assessment, and water-rate. Captain Beckley will also state what proportion of the Dalwa or second crop is really only a single crop on lands which are submerged during the rains, as, for example, those on the margin of the Colair Lake, and whether it is customary to grow a second crop of *paddy* when water is available, or whether the Dalwa crop is mostly confined to chillies, garden produce, sugar, &c.

No. 18, dated 29th February, 1868.

[No. 6.]

From—The Secretary of State for India,

To—The Government of India.

I have had before me in Council your Excellency's Despatch No. 196 of 29th November last, replying to mine of 14th September previous, on the subject of the Godavery Navigation Works.

2. In your 2nd para. you state, with reference to the preference expressed by me for the long over the short canal at the 1st Barrier, that the latter was almost finished so long ago as March last, and that no difficulty was anticipated in blasting the rocks. Under these circumstances, I do not desire that the longer canal should be undertaken at present.

3. With regard, however, to the prosecution of the surveys above the 3rd Barrier, I cannot consent that these investigations should, as you propose, be delayed until the works at the 2nd Barrier are completed. With reference more especially to the storage of water in reservoirs, which I look upon as a most important element of success in the project, I am desirous that the surveys in question should be undertaken at an early period. I request, therefore, that the instructions conveyed in the 7th and 8th paras. of my Despatch No. 86 of 14th September last may not be overlooked.

No. 68, dated 22nd April, 1868.

[No. 7.]

From—The Government of India,

To—The Secretary of State for India.

In continuation of our Despatch No. 107, dated 11th July last, and with reference to paras. 3 to 6 of your letter No. 109 of 31st October following, we have the honour to forward, for the information of Her

Majesty's Government, a copy of the reply from the Government of Madras to the reference made on the subject of the alleged insufficient supply of water for irrigation in the Godavery Delta.

2. A further report may be expected from the Madras Government, but the papers now sent will doubtless satisfy you, as they have satisfied us, that there is no sufficient ground for undertaking, at the present time, any investigations in connection with the formation of reservoirs on the Upper Godavery, either on account of the irrigation or navigation requirements of the Delta.

3. Your wishes for the early prosecution of surveys for reservoirs, as communicated in Despatch No. 18 of 29th February last, and the earlier Despatch of 14th September 1867, will be borne in mind, though the papers now sent shew that the matter is not so urgent as was supposed.

Documents accompanying.

Letter from the Government of Madras, No. 848, dated 13th March 1868, and enclosures.

No. 278 C, dated 22nd April, 1868.

[No. 8.] *From*—Colonel C. H. Dickens R. A., *Secy. to the Govt. of India, P. W. Dept.*
To—*Chief Commissioner of the Central Provinces.*

In continuation of Public Works Department No. 507 C, dated 11th July last, I am directed to forward, for information and communication to Major Haig, copy of the reply* from the Government of Madras to the reference made on the subject of the alleged insufficient supply of water for irrigation in the Godavery Delta.

2. This Report has satisfied the Government of India that there is no ground for undertaking at present any investigations in connection with the formation of reservoirs on the Upper Godavery, either on account of the irrigation or navigation requirements of the Delta.

* No. 848, dated 13th March 1868, and enclosures.

REFERENCE TO FORMER CASES.

Pros. (P. W. Commns.) Dec. 1867, Nos. 39—40.

REFERENCE TO LATER CASES.

TAKENDS.	DATED.

KEEP-WITH. —
Office Note.

GOVT. OF INDIA. } 1868. { P. W. DEPT.

CIVIL WORKS.
Communications.

P. W. 3/31/87
8

May.

Nos. 4 to 8.

Godavery Navigation Works—Deficiency of water for Irrigation in the Godavery Delta—(Secretary of State's Despatch).

LIST OF PAPERS.

No. 4. From Madras, No. 848 of 13th Mar. 1868. Submits rept. on the allgd. deficency. of water for irrign. in the Godavery Delta.

No. 5. Encls. to the above.

No. 6. From S. of S., No. 19 of 20th Feb. 1868. Replies to Des. on the subjt. of Godavery Navgtn. Works.

No. 7. To S. of S., No. 68 of 22nd Apl. 1868. Forwds. papers on the subjt. of the allgd. insuffency. of water for irrign. in the Godavery Delta.

No. 8. To Centl. Provs., No. 238 C of 22nd Apl. 1868. Forwds. papers on the subjt. of the insuffcny. of water for irrign. in the Godavery Delta.

CIVIL WORKS.
Communications.

GODAVERY NAVIGATION WORKS.

Pros. (Civil Works Commns.) April 1869, Nos. 15—18.

No. 96—1148, dated 17th March, 1869.

[No. 20.] *From*—MAJOR C. POLLARD, R. E., *Secy. to the Chief Commr. of the Central Provinces, in the P. W. Dept.*,

To—Secretary to the Government of India, P. W. Dept.

The Chief Commissioner has had under his consideration the manner in which the estimates for works on the Godavery have been submitted.

2. Although these have generally been forwarded to the Supreme Government with his recommendation, yet he observes that they appear to be sent up in a disconnected way, and not as if they formed part of one great and comprehensive scheme, and he is apprehensive that if the system is allowed to continue the Government of India may find itself committed by a series of comparatively petty sanctions to a larger outlay than it is prepared to expend on that work. Even should rigid scrutiny prevent such a result, the time has come, in the Chief Commissioner's opinion, when desultory sanctions should be discontinued, and that a clear, well-digested scheme for the navigation of the Godavery, and the junction of the Valleys of the Wurdah and Wunna with the Eastern Coast, and an estimate of cost, should now be prepared.

3. The Chief Commissioner has accordingly issued orders to this effect to Lieutenant Colonel Haig, a copy of which he now submits for the information of the Government of India.

4. These orders comprehended the preparation of two estimates, one on a scale in which the works are reduced to the smallest possible compass consistent with the object in view; and the other on a scale in conformity with Colonel Haig's own views of the navigation of the Godavery, and the works required to develop it to the utmost. This latter will probably be more comprehensive, more elaborate and more costly than the other, but Mr. Morris thinks this was due to Lieutenant Colonel Haig, whose knowledge of the river, its capabilities and requirements, is unequalled, and who has made the improvement of its navigation the study and business of his life.

It will remain for the Supreme Government, with these two projects and estimates before it, to weigh expenditure against probable results, and pass such orders thereon as may seem to it good, with a full knowledge of the subject in all its bearings.

Mr. Morris trusts that this course of action will meet with approval, and he would also solicit sanction to the extra establishments that may be necessary for the preparation of the field data within a reasonable time.

Nos. 92—1095, dated 15th March, 1869.

[No. 21] *From*—MAJOR C. POLLARD, R. E., *Secretary to the Chief Commissioner of the Central Provinces, in the P. W. Dept.*,

To—Superintending Engineer, Upper Godavery Circle.

The Chief Commissioner has had under review the whole condition of the Godavery Scheme as it now stands, and the various sanctions to expenditure that have from time to time been given.

2. This scheme has for its object the junction of the rich cotton-producing valleys of the Wurdah, the Wunna and the Pyngunga with the sea-board at Cocanada.

3. It is admitted that up to Dewalmurree, at the foot of the 3rd Barrier, and 330 miles from the coast, navigation should be employed. Above Dewalmurree two alterative schemes have been proposed; one to continue the navigation round the 3rd Barrier and into the Wurdah and Wunna up to Hingunghât, and the other to complete the chain of communication by a road from Chanda to the navigable reach of the river below the 3rd Barrier.

4. In furtherance of this project, the Government of India has sanctioned—

1st.—The construction of an anicut and short line of canal with some rock clearance at Doomagoodium, called the 1st Barrier Works, the estimated cost of which has not yet been submitted.

2nd.—The construction of an anicut at Kachampilly with a flight of three locks connecting the navigation above and below the Barrier—these being called the 2nd Barrier Works, and estimated to cost Rs. 11,34,000.

3rd.—Blasting a passage through the Allaca reef of rocks between the 1st and 2nd Barriers, estimated to cost Rs. 15,750.

4th.—The construction of training walls, groynes and pandals, to clear away shoals, and facilitate navigation in shallow parts of the river, estimated to cost Rs. 30,000.

5th.—The preparation of an estimate for turning the 3rd Barrier; surveys of the Rivers Wurdah and Wunna up to Hingunghât; and the survey of the line of road comprising the alternative project joining Chanda with the foot of the 3rd Barrier, with estimate of cost.

5. Also, with a view of facilitating traffic, three steamers with six barges have been sent out from England at a cost of about Rs. 2,25,000, and an expenditure of Rs. 20,000 also has been sanctioned for improving the build of cargo-boats on the river.

6. Looking at these desultory sanctions, and at the whole project comprehensively, it appears to the Chief Commissioner that it has no clearly defined end or limit, nor is the object to be attained to which the nature and extent of all the works should have reference, or the point to which the scheme should be elaborated plainly laid down.

The absence of any such guiding line renders it clearly impossible to see where the expenditure on this project will cease, and places it beyond the power of the Government to discern whether the advantages to the country, directly or indirectly, will be commensurate with the cost of the works.

7. I am, therefore, desired to convey to you the Chief Commissioner's orders for the preparation of a detailed project for opening a communication from the Dowlaishwarum Anicut, which is the limit of your charge, to Hingunghât.

It will be left to you entirely to determine in the first instance whether this communication shall be by a continuous line of navigation throughout, or whether navigation shall cease at a certain point, and the communication be continued by road, which may be of the 3rd class according to the standard specifications.

Should steam navigation be employed, as it most probably will be in the lower reaches, the works should contemplate and provide for the running of steamers for eight months of the year, and up to the point where navigation ceases, the river should be made navigable for boats all the year round; anything short of this, the Chief Commissioner thinks would not meet the object required.

8. I am to point out clearly that the Chief Commissioner's object in calling for this is to lay before the Supreme Government a complete project, with detailed plans and estimates, for connecting Hingunghât with the Eastern Coast, utilizing the water of the Godavery as far as this may be available for the purpose.

In this he contemplates including all the minor works for the improvement of the river channel between the barriers, as well as the heavier works for surmounting those obstacles. Indeed, it seems to Mr. Morris that in looking at the cost of the Godavery Project, the expenditure on these minor improvements has not been fully faced. Much care has been taken to get accurate estimates of the heavier works, but the cost of the minor works appear to have been overlooked either from the difficulty of obtaining data on which to base a calculation of cost, or from the fact of each work being itself insignificant when compared with the larger items of expense, and it is this pettiness of each work that leads Mr. Morris to think that their aggregate cost, which he fears will amount to a heavy sum, may be overlooked in summing up.

I am therefore to request that your estimate may be as complete in the details of minor improvement as in those of the heavier and more important works.

Looking at these orders, it will remain with you to say whether you think feeding reservoirs are necessary to carry out the end in view. If you, as the Engineer to whom the Supreme Government has entrusted the preparation of this project, think that these reservoirs are necessary, and that the success of the scheme as now desired is dependent on them, then, I am to add that the estimate for the project must include the cost of these reservoirs, not founded on sketch plans, but on reliable fixed data.

In short, this scheme for the navigation of the Godavery and its junction with Hingunghât, must be as complete as foresight and Engineering skill can make it, and Mr. Morris thinks it might be divided into the heads—

1st.—Principal works, including all works connected with the navigation proper, costing a lakh of rupees and upwards.

2nd.—Secondary works, including the minor improvements to the river generally, and costing less than one lakh of rupees.

3rd.—Auxiliary works, including all work not actually executed on the line of navigation, but which are yet necessary for the success of the project, such, for instance, as the stowage reservoirs.

4th.—Roads.

Such, then, is a short outline of the "Godavery Project" which the Chief Commissioner would wish to see elaborated. It is, you will observe, reduced to the smallest possible dimensions consistent with the end in view, and I am to add that along with this project Mr. Morris will be glad to receive a project for the work carried out according to your own views of the most efficient way of treating the Godavery and its affluents up to Hingunghât.

It will then remain for the Supreme Government, with these two carefully framed estimates before it, to decide whether the plan of operations shall be narrowed to the smallest possible limits consistent with one uniform and continuous scheme, or whether the prospects of future success and the condition of the Imperial Exchequer will permit the adoption of a more ambitious and more costly project, and a higher development of those natural advantages for navigation which undoubtedly exist.

To ensure these orders being carried out simultaneously with the works now under construction, it will be necessary to divide your establishment into two parts, one to be employed on works, the other on the preparation of field data from which to frame the comprehensive estimates now called for. It is not improbable that you will find yourself short-handed for this, and if so, I am to add that Mr. Morris will be prepared to support your application for such extra hands as may be necessary to ensure the preparation and submission of the project within a reasonable time.

Throughout all the papers connected with the Godavery Project, Hingunghât or Phoolgaon has been taken as the inland terminus.

I am, however, to add that the improved prospects of the Chanda Coal-fields render it not unlikely that a branch line of Railway may be constructed from the Great Indian Peninsula Railway to Gugoos on the Wurdah; in which case, that point will be the terminus of the navigation, and an abstract should accompany the estimate showing its cost up to that point.

No. 235 C, dated 8th May, 1869.

[No. 22] *From*—Colonel R. Strachey, R. E., *Offg. Secy. to the Govt. of India, P. W. Dept.*
To—*The Chief Commissioner of the Central Provinces.*

In reply to your Secretary's letter No. 96—1148, dated 17th March 1869, I am directed to communicate the general approval of the Governor General in Council to the instructions issued under your orders to the Superintending Engineer, Upper Godavery Circle, with the view of having more certain information as to the nature and extent of the works which will be necessary, (1), to secure navigation for steamers for eight months of the year, and for country boats during the entire year, from Dowlaishwarum to Hingunghât; and, (2), to carry out Major Haig's own views on the question to their fullest extent.

2. I am, however, to request that the instructions issued may be somewhat amplified, so as to separate more completely the projects which have for their end the increase of the supply of water in the river, from those which aim merely at improving the navigation with the natural supply.

3. In this view, Major Haig should be instructed to deal with his proposals on the following basis:—

1st.—To show the best practicable results with the natural river supply only.

2nd.—To show the best results possible with reservoirs sufficient merely for supplementing the supply in the upper reaches of the Wurdah and Wunna Rivers, that is, all above the 3rd Barrier, to the extent necessary to continue the navigation in that part of the river, as long as it would be open below the 3rd Barrier, with the natural supply.

3rd.—To give his own views as to the system which should be adopted for a permanent navigation.

4. Any surveys which Major Haig may consider to be necessary to enable him to deal properly with the second and third of these suggested projects, should be clearly specified and explained by him, and sanction obtained through you, in the regular manner, for their prosecution before they are set in hand.

5. From para. 13 of Major Haig's Report submitted with your Secretary's No. 277—3717, dated 24th August 1867, it would seem that the second of the suggested schemes, if that Officer's anticipations as to the extent of navigation below the 3rd Barrier with the natural supply be realised, will be the same as the smaller project called for by the Chief Commissioner.

6. It is thought that the project based on the natural supply of the river only could be prepared in a comparatively short time; and for the second of those named above, a good many data must already have been collected, so that this should not be very much longer in preparation.

7. The Governor General in Council views with much approbation your endeavours to obtain from Major Haig a more complete and satisfactory statement of the end to be kept in view in the operations on the Upper Godavery, of the means by which this end is to be attained, as well as of the expenditure which will ultimately be necessary. The Governor General in Council fully appreciates the value of Major Haig's services, and his earnestness and general professional ability; but it is beyond doubt that, up to the present time, no complete, clear, or definite report, or scheme, has been submitted to the Government of India, showing the whole scope of the works that will be required for opening out the navigation of the Godavery from any one point to any other, and still less has any corresponding estimate of cost been forthcoming. The Governor General in Council is constrained to remark that the long continued failure to supply this information has caused the high opinion which His Excellency in Council would otherwise have had of Major Haig's practical usefulness to be much shaken, and His Excellency in Council hopes that this Officer will take the present opportunity to put an end to all similar causes of complaint for the future.

REFERENCE TO FORMER CASES.

Prot. (C. W. / Comms.) Apl. 1869, Nos. 15—18.

REFERENCE TO LATER CASES.

TAKEEDS.	DATED.

KEEP-WITH.
Office Note.

GOVT. OF INDIA. } 1869. { P. W. DEPT.

CIVIL WORKS.

Communications.

P.W. 3131/87
9

May.

Nos. 20 TO 22.

Godavery Navigation Works.

LIST OF PAPERS.

No. 20. From Centl. Provs., No. 96—1148 of 17th Mar. 1869. Repts. havg. issued instrctns. to Col. Haig for the preprtn. of well digstd. altrntve. schemes for the Godavery Works.

No. 21. *Enclo. in the above.*

No. 22. To Centl. Provs., No. 235 C of 8th May 1869. Approves genlly. of the instrctns. issued, and reqsts. that they may be amplfd. in some respects.

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Govt. of [1881] Madras.

PUBLIC WORKS.

To

Dated

Issued

Recd.

Encl.

G. O. 25 June 1881, No. 1576 W

Nos. 89

Godavari Delta works

Specially arrangements made for the ~~preparation~~ preparing and ~~submission~~ submitting for sanction of the Govt the complete revised estimates for the —