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2835

Dated: 22.10.1887

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GOVERNMENT OF MADRAS.
PUBLIC WORKS DEPARTMENT.

General.
Establishment.

READ—the following letter from R. B. BUCKLEY, Esq., Under Secretary to the Government of India, Public Works Department (Civil Works—Irrigation), to the Secretary to the Government of Madras, Public Works Department, dated Simla, 30th September 1887, No. 192 I. :—

I am directed to acknowledge the receipt of your letter, No. 2315 W., dated 29th August 1887, requesting sanction to the grant to the staff employed on the Periyár project of the extra allowances detailed in paragraph 245 of Lieutenant-Colonel Pennycook's report forwarded with your endorsement, No. 356 I. of 27th April 1883.

2. In reply I am directed to state that no allowances beyond the ordinary ones allowed by rule can be given. If it is desired for special reasons, such as unhealthiness or expensiveness of locality, to recommend the grant of special allowances, the case must be separately submitted for orders with full and complete explanations. No additional allowances must be given without the sanction of the Government of India.

ORDER—dated 22nd October 1887, No. 2834 W., Public Works.

Ordered that the following letter be addressed to the Government of India.

(Here enter No. 2835 W., dated 22nd October 1887.)

(True Extract.)

(Signed) J. O. HASTED, Colonel, R.E.,
Secretary to Govt., P.W.D.

To the Chief Engineer for Irrigation.
" Superintending Engineer, VI Circle.
" Examiner, Public Works Accounts.
" Public Department.

Exd. L. Passaigne.
Spare Copies

GENERAL
ESTABLISHMENT.

Govt. of (1887) Madras.
PUBLIC WORKS.

Dated October, 22nd.

Recd.

Encl.

G.O., 22nd Oct. 1887, No. 2834 W.

OCTOBER.

Special Allowances to the Staff
employed on the Periyar
Project

The Government of India to be addressed
with regard to the grant of —.

22ND OCTOBER 1887, No. 2835 W., PUBLIC WORKS.

2834
2

PUBLIC WORKS DEPARTMENT.

General.
Establishment.

LETTER—from

COLONEL J. O. HASTED, R.E.,
*Secretary to the Government of Madras,
Public Works Department,*

To

THE SECRETARY TO THE GOVERNMENT OF INDIA,
PUBLIC WORKS DEPARTMENT.

SIR,

I am directed to acknowledge the receipt of your letter, No. 192 I., dated 30th September 1887, in which it is stated that no allowances beyond the ordinary ones allowed by rule can be given to the staff employed on the Periyar project, and that if it is desired for special reasons, such as unhealthiness or expensiveness of locality, to recommend the grant of special allowances, the case must be separately submitted for orders with full and complete explanations.

2. In reply, I am to say that the Government are satisfied that the conditions of life at the head works of the Periyar are quite as unfavorable, whether as regards cost of living and locomotion or risk to health, as those prevailing in other districts of the Madras Presidency where special allowances are granted.

3. In proposing the scale of allowances recommended in my letter No. 2315 W., dated 29th August 1887, the Superintending Engineer pointed out that special allowances had always been given at the Periyar, but that they had hitherto taken the form of double travelling allowance *plus* a personal allowance; but as the former appeared objectionable as being opposed to the principle that travelling allowances should not be looked to as a source of emolument, he recommended certain fixed allowances.

4. The following statement shows how these allowances compare with those drawn by officers and subordinates employed in the Wynaad and other hill tracts:—

STATEMENT comparing the estimated cost of fixed allowances recorded in Part III of Colonel Pennycuik's report, with the extra allowance permissible under the existing rules for Hill tracts.

2

22ND OCTOBER 1887, No. 2835 W., PUBLIC WORKS.

Number.	Rank.	3	4	HILL ALLOWANCES PERMISSIBLE UNDER EXISTING RULES.			DIFFERENCE BETWEEN 4 AND 7.		Remarks.	
				50 per cent. on salary under paragraph 237 of the Public Works Code.	5	6*	Total.	More.		Less.
1	2	RS.	RS.	RS.	RS.	RS.	8	9	10	
HEAD WORKS.										
Preliminary year.										
1	Assistant Engineer	450	900	2,025	360	2,385	...	1,485	*The figures in column 6 are calculated on the assumption that an officer claims travelling allowance for no more than 10 days in each month.	
2	Overseers	160	540	720	270	990	...	450		
3	Clerks	150	450	675	270	945	...	495		
1	Hospital Assistant	80	270	350	56	416	...	146		
Total for 1 year				...	2,160	3,780	956	4,736		2,576
Years of regular construction.										
1	Superintending Engineer	1,600	2,700	7,200	540	7,740	...	5,040		
1	Executive Engineer	650	1,800	2,925	450	3,375	...	1,575		
2	Assistant Engineers	800	1,800	3,600	720	4,320	...	2,520		
1	Sub-Engineer	400	900	1,800	270	2,070	...	1,170		
1	Supervisor	200	540	900	180	1,080	...	540		
5	Overseers	400	1,350	1,800	675	2,475	...	1,125		
2	Accountants	200	600	900	90	990	...	390		
7	Clerks	350	1,050	1,575	630	2,205	...	1,155		
2	Draftsmen	100	300	450	180	630	...	330		
3	Storekeepers	120	360	540	270	810	...	450		
2	Medical subordinates	200	600	900	90	990	...	390		
Total for 1 year				...	12,000	22,590	4,095	26,685		14,685
Total for 5 years				...	60,000	...	...	1,33,425		73,425
Grand Total including Preliminary year.				...	62,160	...	...	1,38,161		76,001

22ND OCTOBER 1887, No. 2835 W., PUBLIC WORKS.

3

5. It will be seen that the amounts are considerably less than would be granted under the usual rules for expensive and unhealthy localities, the difference in favor of the proposed scale being no less than Rs. 76,000 for the whole period.

6. I am, under these circumstances, to request that the sanction of the Government of India may be communicated to the very moderate proposals put forward by the Superintending Engineer in charge of the works.

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

FORT ST. GEORGE,
22nd October 1887.

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

Exd. L. Passaigne.
Spare Copies

GENERAL
ESTABLISHMENT.

Govt. of (1887) Madras.
PUBLIC WORKS.

Dated October, 22nd.

Recd.

Encl.

G.O., 22nd Oct. 1887, No. 2835 W

OCTOBER.

Special Allowances to the Staff
employed on the Periyar
Project

The grant of — recommended to the
Government of India.

27TH APRIL 1883, No. 355 I, PUBLIC WORKS.

GOVERNMENT OF MADRAS.

PUBLIC WORKS DEPARTMENT.

Irrigation.

REAR—the following papers :—

Letter from Major J. PENNYCUICK, R.E., Superintending Engineer, on Special Duty,
dated 14th September 1882, No. 92.

Letter from Major J. PENNYCUICK, R.E., Superintending Engineer, on Special Duty,
dated 6th November 1882, No. 1434.

Office Note from Deputy Chief Engineer, Public Works Department, dated 31st March 1883.
G.O., No. 1193, dated 30th April 1875.

G.O., No. 115, dated 10th March 1877.

G.O., No. 159 W., dated 20th January 1881.

No. 44 I.

Note by the Acting Chief Engineer for Irrigation.

In G.O., No. 1164 W., 8th May 1882, Major J. Pennyuck, R.E., was appointed to revise the designs and estimates for the Periyar Project, and with the above letters that officer has submitted his report with complete estimates. These estimates have since been discussed, and Major Pennyuck has forwarded the notes above referred to in consequence, with alternative estimates for part of the works. The forecast statements have received the approval of the Revenue authorities, and have been revised in accordance with the latest instructions, and the estimates are therefore now submitted in a complete form to be forwarded to the Government of India.

2. In his report, paragraphs 9 to 28, Major Pennyuck has given "a history of the Present Project," which explains all that has been done in past years. It is sufficient here to say that the project, as now submitted, agrees generally with that submitted in 1872, after careful and prolonged investigations, by Mr. R. Smith, and approved by Colonel Oakes and Colonel Mullins, with the exception that the dam which it was originally proposed to construct of earth by the silting process is now intended to be constructed of concrete throughout. The main features of the projects are the same, a dam across the Periyar on the Travancore side of the Western Ghats, a tunnel through the water-shed ridge, a series of regulating sluices for passing the water diverted from Travancore into the Madura District round the anicuts on the Sooroolly river, and tributary works; the two last named having been very carefully worked out originally, have not now been revised, but the estimates for the dam and head works have, after a careful study of the subject for years, been most thoroughly worked out by Major Pennyuck.

3. The supply is derived from the Periyár draining 300 square miles of the Western Ghâts, and is beyond question. Tables VII and VIII attached to the report give an estimate of the amount of water available, which, not taking into account rainfall on the tract to be irrigated, shows an ample supply for 150,000 acres. It has been suggested that to fill the dry bed of a river in the eastern plains will require a vast quantity of water, but it must be remembered that when the works are completed, the bed of the river will never be altogether dry, and it will be observed that to fill it up after each hot season 500 millions of cubic feet have been allowed.

4. The land commanded by the channels is about 200,000 acres, of which it is proposed to irrigate 101,000 acres with first crop and 35,343 acres second crop.

An elaborate report on the subject of revenue to be expected was made* by Mr. Clogstoun, then Deputy Director of Revenue Settlement, now Accountant-General, on which the forecast of revenue has been based, and which has received the approval of the present Collector. Attached to the forecast statements is a note explaining briefly how the figures are obtained.

5. The original project was to cost Rs. 61,20,000 direct charges without any payment to the Travancore Government for the use of the water, and the estimated return was Rs. 6,24,600. The estimates now submitted are as follows:—

Direct Charges.		Rs.
Works	...	52,00,000
Establishment	...	9,25,000
Tools and Plant	...	60,000
		61,85,000
Indirect Charges	...	2,56,463
		64,41,463

The works are expected to be completed in six years, and the irrigation fully developed in ten years after their completion. The gross revenue will then be Rs. 7,00,000, the working expenses and collection charges Rs. 1,25,400, and the net revenue will therefore be—

Including Enhanced Land Revenue	Rs. 5,74,600, or 9.29 per cent. on direct charges.
Excluding Enhanced Land Revenue	Rs. 5,31,912, or 8.92 on direct and indirect charges.

Under Works a sum of eight lakhs is allowed as compensation to the Travancore Government. The subject is not yet settled, but negotiations are so far advanced that it seems certain this provision will be more than sufficient. The latest offer† + G.O., No. 238 (Political), 21st March 1883. made to the Travancore Government is six lakhs of rupees, the cession of certain small tracts of country, and Rs. 50 per acre for every acre occupied above 8,000.

6. The works estimated for are so peculiar in character, and, being situated as they are in an almost uninhabited jungle on hills which are for a part of the year very unhealthy, require a method of construction so unusual, that it is necessary here to make some remarks on the designs submitted.

The dam, which is 155 feet in height above the deep bed of the river with a parapet of 5 feet, the level of the escape weirs being 144 feet and the probable actual maximum water-level being 153.16, is intended to be made entirely of concrete. The large dams which have been constructed in the south of France, with which the proposed dam may be compared, were made of rubble masonry, and there are no examples of any large concrete dam, but it is considered that concrete will prove in all respects a more suitable material than rubble masonry. Made of good materials, the rock on the spot and hydraulic mortar, and well rammed, it will bear the same crushing weight, and will be perfectly solid, and the construction will be simpler.

7. As regards the section of the dam, Major Pennycuik has submitted a note, which is attached to his report, in which he enters very fully into the calculations on which it is designed. In this note he gives reasons for differing from the "old method" of calculating pressures, and also from the French authority, M. Bouvier, who has lately investigated the subject, and prepared designs for dams of about the same size. The subject is one which requires special study, and it is suggested that Mr. Molesworth, whom we have for years looked to as the highest authority on the subject, should be invited to discuss Major Pennycuik's note before the section is definitely decided on. Major Pennycuik's calculations are believed to be sound, and his section to be perfectly safe, but as he has propounded a new theory, it is advisable that his calculations should be discussed by known experts. On the proposed section which is submitted the line of rear slope as calculated by M. Bouvier's method is also shown. M. Bouvier's calculations would require somewhat more material, but the excess is so small that the estimate will in all probability suffice, whatever section is determined on.

8. The escape dam is designed on the same principles as the main dam, and the arrangements for the water cushion are considered satisfactory. There will be two escapes with an aggregate length of 920, and their effect in an extraordinary flood is shown in Table IV attached to the report.

9. There has been some discussion since the report was written on the subject of the escape culverts proposed by Major Pennycuik. He proposed two culverts, one on either bank of the river, to dispose of the water during the construction of the dam, that on the right bank supplying the turbine which is to drive the manufacturing machinery. These culverts were to be closed by an equilibrium self-acting shutter very ingeniously contrived, but it was considered that in a work of these dimensions any under passage would be objectionable, and doubtful whether any self-acting machinery, such as that proposed, would prove satisfactory. Major Pennycuik has therefore designed an alternative arrangement whereby the flood-water, except in high floods, may be passed over the dam by means of siphons, one of which will feed the turbine. These designs have been very carefully worked out, and it has been considered whether the siphon tubes, instead of passing over the dam itself, could not be laid on the slope of the bank on either side; the difficulty of raising them in this position has been considered a sufficient obstacle to such an arrangement, and the proposed arrangement, which is no doubt feasible, seems the most satisfactory. The cost of the siphons would be only Rs. 12,000 more than of the escape culverts, and it has not therefore been considered necessary to alter the forecast statements. It would, of course, be possible to allow all surplus to pass freely over the dam during construction, but this, though it might safely be done, would be a hindrance to the work, and in any case it is advisable to have a siphon to supply the turbine, as it must evidently be economical to utilize the water power available. The only question seems to be whether smaller discharging power might not be sufficient, more flood-water being allowed to pass over the dam and less expensive siphons being provided. It has not, however, been considered advisable to reduce the amount of the estimate.

10. The equilibrium sluice proposed to be constructed at the entrance to the tunnel, by which the supply to Madura is to be regulated, is open to some of the objections raised to those proposed for the escape culverts. The principle on which the sluice is constructed is substantially the same as that on which equilibrium valve sluices were proposed by Mr. F. Stoney, two of which were purchased by the Madras Government. In Mr. Stoney's sluice the water was admitted to both sides of the shutter; in Major Pennycuik's it is admitted within the shutter and presses outwards on both faces, so that in both cases there is no pressure due to the head of water to deal with. The principle is believed to be correct. Major Pennycuik has further introduced in the shutters hollow water-tight cylinders of such size that the weight of the shutter becomes of little account, and the power required to lift it is very small. It is proposed that the shutters should, by an ingenious arrangement, be raised by buoys floating on the surface of the water in rear, and should thus be self-

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regulating. It is to this arrangement that exception is taken. The regulating gear is subject to rust and at the mercy of such things as logs of wood which might be sucked through the sluice. It is thought that it will be found necessary to raise the shutter by means of a screw or by chains, and it is recommended that this point should be considered in carrying out the work. It will probably be necessary also to provide grooves into which shutters could be inserted in case of its being necessary to raise the shutter for the purpose of repairing it at a time when water was not required, or could not be passed through the tunnel. The provision made in the estimate will allow for the necessary alterations in these particulars being attended to.

11. In carrying out the works, machinery has been provided for, the details of which have been very carefully worked by Major Pennycuik, and are shown in the drawings. In this situation there is no doubt but that it will be economical to employ machinery to a great extent, labor being expensive, though in some cases, as for instance in ramming the concrete in the dam, it may prove, should labor be attracted to the work, better to ram by hand. The mortar-mixers and concrete-mixers should certainly be worked by machinery, but the particular form of machine to be used may be left to be decided when the work is commenced. Improvements in machinery are being made so constantly that machine now considered the best type may, in a year or two, be superseded. The drills for rock boring are no exception to this rule. The rates entered in the estimates based on careful inquiry, in some cases in communication with manufacturers, and providing amply for carriage, will suffice. The arrangements proposed for working the machinery may be accepted subject to such alterations as further experience may show to be necessary. The wire tramway up the ghat and the traction engines above and below are also approved. Should it be decided that the works are to be commenced at once, it is recommended that Major Pennycuik, who is now proceeding to England on furlough, should be entrusted with the duty of selecting the machinery required within the sums allotted. That officer's long acquaintance with the project and assiduous study of the details of the works point to him as the best selection that can be made for starting the work.

12. The rates to be allowed for work have been the subject of careful inquiry. When the original project was prepared, this subject received the attention of Mr. R. Smith, Major Pennycuik and Colonel Mullins, and it was the opinion of the latter officer that the rates proposed were too low. The use of machinery will have a considerable effect on the rates; and the opening out of the work spot will make it easier to obtain labor than it hitherto has been, but the rates as now worked out are in excess of those originally allowed, and it is believed will prove ample. The principal item in the work is concrete, and this is now estimated at Rs. 20 per 100 cubic feet, the prevailing rates in the Madura District being Rs. 15 to 17. The data for rates of work are given in an appendix to the report.

13. It has been stated that the works as proposed in the Madura District are as originally estimated after having been most carefully worked out by Mr. R. Smith. After much consideration it was decided that the water now thrown into the Sooroollyaur and Vaigai should be passed round the existing anicuts and not over them. It is to be noticed that all these anicuts supply Government land exclusively, and that therefore there is no reason to anticipate difficulty from interference with the existing supply. The additional water sent down the river will of course benefit existing cultivation, but as the anicuts supply but a very few tanks and the surplus all falls back into the river, there can be but little waste of the water. The designs of some of the works may need modification to some extent, but generally they are approved and may be accepted.

OOTACAMUND,
11th April 1883.

(Signed) J. O. HASTED, Colonel, R.E.,
Ag. Chief Engineer for Irrigation.

To the Joint Secretary to Government,
Public Works Department, Irrigation Branch.

NOTE

The ultimate area of irrigation and the estimate of revenue have been arrived at as follows:—

	Number of Taram.	Estimated yield per Acre, Madras Measures.	Irrigable Area, Acres.	Rate per Acre.	Revenue.
Government Land	1	1,000	16,431	Rs. 8½	Rs. 1,39,663½
Do.	2	900	29,522	7½	2,21,415
Do.	3	800	21,905	6½	1,42,382½
Do.	4	700	5,849	5½	32,169½
Do.	5	620	2,643	5	13,215
Total			76,350		5,48,845½
Tank beds			9,196	8	73,568
Usual Wet Inams			4,356	Free.	
Inams, dry			3,400	6	20,400
Zemindari and Inam Land			15,216	6	91,260
Total			108,512		7,34,073½
Deduct Revenue due to old Irrigation, average of ten years' collections					1,52,598
Net Total					5,81,475½
Deduct Area and Revenue of land irrigated by Korambors, which it is not advantageous to bring under the project			7,538		22,849½
Net Total			101,074		5,58,626
Or, say			101,000		
Second Crop					1,41,374
Total			101,000		7,00,000

The above estimate is based on Mr. Clogstoun's report printed with G.O., Revenue Department, No. 730, of 17th February 1877, except that, in the case of second-crop cultivation, the assessment has been reduced from Rs. 2,15,648 to Rs. 1,41,374. The Collector of the Madura District has approved the estimate of revenue, and has countersigned the forecast statement as prepared by Major Pennycuik.

Mr. Clogstoun's report shows that the irrigable area of first crop is 96,088 acres, which includes only 1,000 acres under the first group instead of 5,886 acres, as pointed out in paragraph 33 of his letter, he having assumed that the water required for 5,886 acres of old cultivation would be the same as that required for 1,000 acres of new cultivation. The ultimate area of irrigation is therefore 101,000 acres. The amount of direct and indirect revenue have not been separately estimated, as the rates of assessment proposed are consolidated. The consolidated assessment has been separated into land and irrigation revenue, the former being calculated at the average rate of dry land assessment according to Rule IV, paragraph 7 of G.O., Revenue Department, No. 769, of 5th July 1880.

The extent of unoccupied lands which will be brought under irrigation is 35,998 acres, as shown below:—

Dry lands	20,616
Wet do.	6,186
Tank beds	9,196
Total	35,998

The share of enhanced land revenue is Rs. 46,122 at Rs. 1-4-6, the average rate of dry assessment per acre, or Rs. 46,000. The irrigation or direct revenue will then be Rs. 6,64,000.

The question, whether the irrigation revenue should be levied on Zemindari and Inam lands at 6 rupees or 4 rupees per acre, was raised in paragraph 10 of the letter from the Director of Revenue Settlement, printed with Revenue Department G.O. No. 730, of 17th February 1877. This question has not yet been settled, but if the reduced rate be decided on, the probable reduction in the estimate of revenue may be made good by the probable increase in the extent of second crop, which has been reduced. The net revenue is Rs. 5,74,600, which would represent 8.92 per cent. on the proposed Capital outlay including indirect charges.

At the end of ten years after the completion of the works, there will be a surplus revenue of Rs. 5,92,000 over the interest charges, including interest during construction.

(Signed) J. O. HASTED, Colonel, R.E.,
Ag. Chief Engineer for Irrigation.

PERIYAR PROJECT.

No. I.

Summary of the Estimated Direct Charges to Capital Account.

Year.	Works.	Establishment.	Tools and Plant.	Total.	Remarks.
1	2	3	4	5	6
First ...	Rs. 4,00,000	Rs. 50,000	Rs. 5,000	Rs. 4,55,000	
Second ...	8,00,000	1,75,000	11,000	9,86,000	
Third ...	9,00,000	1,75,000	11,000	9,86,000	
Fourth ...	9,00,000	1,75,000	11,000	9,86,000	
Fifth ...	8,00,000	1,75,000	11,000	9,86,000	
Sixth ...	8,00,000	1,75,000	11,000	9,86,000	
Seventh ...	4,00,000	...	...	4,00,000	
Eighth ...	4,00,000	...	...	4,00,000	
Total ...	52,00,000	9,25,000	60,000	61,85,000	

No. II.

Summary of the Estimated Indirect Charges to Capital Account (excluding Interest).

Year.	Capitalization of Land Revenue shown.	Loss by Exchange on Payments in England.	Leave and Pension Allowances.	Total.	Remarks.
1	2	3	4	5	6
First ...	Rs. 17,600	Rs. 30,000	Rs. 0,050	Rs. 30,050	
Second ...	17,000	2,000	25,000	44,000	
Third ...	17,000	2,000	25,000	44,000	
Fourth ...	17,000	2,000	25,000	44,000	
Fifth ...	17,000	2,000	25,000	44,000	
Sixth ...	17,000	2,000	25,000	44,000	
Seventh ...	17,413	2,000	25,000	44,413	
Eighth ...	...	...	...	...	
Total ...	85,413	40,000	1,31,050	2,56,463	

No. III.

Summary of Growth of Irrigation and Revenue Receipts and Charges.

Year.	Irrigated Area at end of Year.	REVENUE RECEIPTS AND CHARGES.						Remarks.
		Gross Revenue due to Works.			Charges, both Direct and Indirect.	Net Revenue due to Works.		
		Direct Receipts.	Enhanced Land Revenue or Indirect Receipts.	Total.		Including enhanced Land Revenue.	Excluding enhanced Land Revenue and Collection Charges thereon at 7.2 per Cent.	
1	2	3	4	5	6	7	8	9
	ACRES.	RS.	RS.	RS.	RS.	RS.	RS.	
Seventh ..	11,000	65,400	4,500	70,000	20,040	49,960	45,601	
Eighth ..	21,000	1,30,800	9,200	1,40,000	40,080	99,920	91,382	
Ninth ..	31,000	1,96,200	13,800	2,10,000	60,120	1,49,880	1,37,073	
Tenth ..	41,000	2,61,600	18,400	2,80,000	80,160	1,99,840	1,82,784	
Eleventh ..	51,000	3,27,000	23,000	3,50,000	1,00,200	2,49,800	2,28,455	
Twelfth ..	61,000	3,92,400	27,600	4,20,000	1,20,240	3,14,760	2,89,146	
Thirteenth ..	71,000	4,57,800	32,200	4,90,000	1,40,280	3,79,720	3,49,837	
Fourteenth ..	81,000	5,23,200	36,800	5,60,000	1,60,320	4,44,680	4,10,528	
Fifteenth ..	91,000	5,88,600	41,400	6,30,000	1,80,360	5,09,640	4,71,220	
Sixteenth ..	101,000	6,54,000	46,000	7,00,000	2,00,400	* 5,74,600	5,31,912	

* 9.29 per cent. on direct charges to Capital Account.

8.92 per cent. on direct and indirect charges to Capital Account.

No. IV.

Estimate of Net Financial Results.

Year.	Direct Capital Outlay during the Year.	Direct Capital Outlay to end of Year.	Simple Interest at 4 per Cent. on Capital Outlay to end of previous Year plus Half Outlay during Year.	Net Revenue including enhanced Land Revenue, Column 7 of Table III.	Simple Interest less Net Revenue.	Net Revenue less Simple Interest.	Remarks.
1	2	3	4	5	6	7	8
	RS.	RS.	RS.	RS.	RS.	RS.	
First ...	4,55,000	4,55,000	9,100	...	9,100	...	
Second ...	9,86,000	14,41,000	37,920	...	37,920	...	
Third ...	9,86,000	24,27,000	77,360	...	77,360	...	
Fourth ...	9,86,000	34,13,000	1,16,800	...	1,16,800	...	
Fifth ...	9,86,000	43,99,000	1,56,240	...	1,56,240	...	
Sixth ...	9,86,000	53,85,000	1,95,680	49,960	1,73,440	...	
Seventh ...	4,00,000	57,85,000	2,35,120	99,920	1,39,480	...	
Eighth ...	4,00,000	61,85,000	2,74,560	1,49,880	77,520	...	
Ninth ...	...	61,85,000	2,74,560	1,99,840	47,560	...	
Tenth ...	...	61,85,000	2,74,560	2,49,800	...	2,400	
Eleventh ...	...	61,85,000	2,74,560	3,14,760	...	67,360	
Twelfth ...	...	61,85,000	2,74,560	3,79,720	...	1,32,320	
Thirteenth ...	...	61,85,000	2,74,560	4,44,680	...	2,17,280	
Fourteenth ...	...	61,85,000	2,74,560	5,09,640	...	2,62,240	
Fifteenth ...	...	61,85,000	2,74,560	5,74,600	...	3,27,200	
Sixteenth ...	...	61,85,000	2,74,560	6,39,560	...	3,27,200	
Seventeenth ...	...	61,85,000	2,74,560	7,04,520	...	...	
Eighteenth ...	...	61,85,000	2,74,560	7,69,480	...	...	
Total ...	...	...	35,29,920	41,22,960	10,51,100	16,43,100	
Net Revenue ...	...	...	...	...	...	5,92,000	

APPENDIX TO TABLE NO. III.

Statement showing the Estimated Charges on Revenue Account in the Public Works and Civil Departments.

Year.	Maintenance Charges in the Public Works Department.	Collection Charges in the Civil Department at 7-2 per Cent. on Revenue.	Total.
	RS.	RS.	RS.
Seventh	15,000	5,040	20,040
Eighth	30,000	10,080	40,080
Ninth	45,000	15,120	60,120
Tenth	60,000	20,160	80,160
Eleventh	75,000	25,200	1,00,200
Twelfth	75,000	30,240	1,05,240
Thirteenth	75,000	35,280	1,10,280
Fourteenth	75,000	40,320	1,15,320
Fifteenth	75,000	45,360	1,20,360
Sixteenth	75,000	50,400	1,25,400

(Signed) J. O. HASTED, Colonel, R.E.,
Ag. Chief Engineer for Irrigation.

List of Plans connected with the Periyár Project to be forwarded to the Government of India.

1. Sketch map showing the sites proposed for the head works, the valleys of the Sooroollyaur and the Vaigai, and the alignment of the distribution channels in the plain of Madura.
2. Sketch map showing the arrangements for the distribution of the Periyár water in the plains of Madura.
3. Plan of lake and ground in its immediate neighbourhood with contours at 50 feet vertical intervals.
4. Plan of ground in the neighbourhood of dam and escape.
5. Longitudinal section along crest of dam and escape.
6. Transverse sections of dams.
7. Arrangements of main work shed.
8. Enlarged half plan of gearing of main work shed.
9. Details of messengers and elevator.
10. Plans showing arrangement of wire tramway at various periods.
11. Framing and concrete distributing apparatus.
12. Escape culvert, gates and lifting gear.
13. Details of gates of escape culvert.
14. Plan and sections of right bank escape.
15. Supply culvert for turbines, gates, &c.
16. Plan and longitudinal section of southern water-shed cutting with part of trace of road from water-shed to site of dam.
17. Plan and section of water-shed tunnel.
18. Details of water-shed tunnel.
19. Plan showing portion of trace of road from water-shed to site of dam.
20. Plan showing portion of trace of road from water-shed to site of dam.
21. Escape syphons.
22. Survey and longitudinal section of the Sooroollyaur from near the foot of the Chinna-mullay hill to the Vaigai.
23. Survey of the Sooroollyaur Sheet No. 2.
24. Do. do. " 3.
25. Do. do. " 4.
26. Do. do. " 5.
27. Do. do. " 6.
28. Plan, sections and elevation of the regulating sluice proposed for construction on the left bank of the Sooroollyaur adjacent to the Katarah weir.

37. The estimates have been made on liberal terms, for the rates of Rs. 350 per ton material and Rs. 200 per ton for workmanship are certainly in excess of what will be found actually necessary.

38. It will be seen that the actual cost is Rs. 51,000 against Rs. 39,000 provided in the estimates for the culverts; the difference of Rs. 12,000, is so small in comparison with the total of the estimate, that it does not seem necessary to alter the Financial Statements.

39. Three alternative arrangements have been considered, but it is unnecessary to discuss them here, as they are all clearly inferior to that now proposed.

40. There is, however, an alternative mode of constructing the pipes, which I think is worthy of consideration, that is, to make them of wooden planks, say 2 inches thick, bound round with iron or steel wire or wire rope. The timber at Rs. 3 per cubic foot would cost Rs. 14 and Rs. 10 per running foot for the two sizes of pipes and the lining Rs. 15 and 9 respectively, to which might be added Rs. 5 and Rs. 3 for painting, tarring, and caulking, making the total cost Rs. 32 and 22 per foot against Rs. 44 and 31, which is the estimated cost of the iron pipes. I see no reason why wooden pipes should not be made perfectly water-tight under such small pressures as we are dealing with, and they would be more easy to make up and keep in repair than the iron ones.

CHEPAUK,
31st March 1883.

(Signed) J. PENNYCUICK, Major, R.E.

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Appendix to G O., No. 355 I., dated 27th April 1883.

From Major J. PENNYCUICK, R.E., Superintending Engineer, on Special Duty, to the Chief Engineer for Irrigation, dated Bangalore, 14th September 1882, No. 92.

I have the honor to forward, herewith, the plans and detailed estimates for the Periyár Project, as shown in the enclosed list.

2. The report, classified abstract estimate, tables, financial and other statements are being printed, but the delay in printing has been so great that I do not consider it advisable to remain here until they are completed, and am therefore about to return to Bellary, having given instructions for the printed papers to be sent to me there for transmission to Government.

3. In forwarding them explanation will be given upon all points which may require it; the plans and estimates are only forwarded now, in order to avoid the inconvenience of carrying them with me to Bellary.

4. Certain duplicate plans, plans no longer required, and papers received from your office in connection with the work are being returned with a separate letter. The plans and estimates accompanying this letter are all that are required for consideration of the project.

5. I leave for Bellary on the 15th instant.

List of Plans and Estimates.

	Plans. Nos.	Estimates. Nos.
General ...	1 & 2	...
Head Works in Periyár Valley ...	1 to 18	1 to 10
Regulating Works in Sooroolly Valley ...	1 to 11	1 to 5
Distribution Works in Vaigai Valley ...	1 to 79	1 to 69

From Major J. PENNYCUICK, R.E., Superintending Engineer, to the Chief Engineer for Irrigation, dated Bellary, 6th November 1882, No. 1434.

I have the honor to report that I have at length received a specimen copy of my report on the Periyár Project, and have requested the Manager of the Caxton Press at Bangalore (where the papers have been printed) to send the remaining copies, ninety-nine in number, direct to your office.

2. The delay in printing has been very annoying, and was of course increased by my having to leave Bangalore before the work was completed, so that the proofs had to be sent here for examination and returned for correction.

3. A few errata are found still to exist, and, to avoid further delay, I enclose a list of these, which I request may be printed as a separate slip at the Government Press and attached to the report.

4. I have endeavoured to make the report complete in itself, requiring no reference to any other document except Major Oakes' memorandum on the works in the plains of Madura, and Mr. Clogstoun's report on the revenue returns; the former of these is reprinted in full as an appendix to the report; the latter is also named as an appendix, but is not actually printed with the other papers, as copies can, presumably, be obtained from the Government Office, and it seemed undesirable to occupy time in reprinting it. A copy is, however, enclosed herewith.

5. For the designs and estimates for the head works I am entirely responsible; Mr. Smith's plans have been used for topographical features, but none of them are sent up, fresh plans having been prepared for all works in the Periyár Valley, and the levels having been re-arranged to a datum more suitable to the present project than that of Smith's surveys, which was originally selected with reference to site No. 1.

6. It will be observed that large allowances have been made, both in the rates and in the estimates for the head works, on account of "Sundries" and "Contingencies;" I hope that a good deal of these will not be required, but looking to the novel nature of the work, and the peculiar conditions under which it has to be executed, I do not consider it would be wise to reduce the estimates by their omission or reduction.

7. It is probable that the principle on which the section of the main dam is designed, as explained in Appendix I, will be the subject of some discussion, but there need be no delay in the sanction of the estimates on this account, as the total quantity of material involved is only 24,000 cubic feet, which, at the rates entered in the estimate, would cost Rs. 4,800, but in reality the extra cost, if this extra quantity be required, will not be nearly so much. There is surplus stone to a considerably greater amount than that in question, and the cost of plant and labor will be no more for 6,030 cubic feet per day than for 6,000; the extra expense will really be only that of the lime and sand or, say, Rs. 2,000 in all. The questions for discussion will of course be settled long before the main dam comes to be built, which cannot, under any circumstances, be for another two years.

8. I have made no alteration whatever in Mr. Smith's designs or quantities for the works below the ghât, but the estimates have been re-written in accordance with existing rules as regards form and classification, and a few errors in calculation corrected.

9. The classified abstract is in accordance, as regards general arrangement, with the specimen given in G.O., No. 377 L, of 8th May 1882 (the Rushikulya Project), but the actual form used is one received from the Examiner's Office.

10. In paragraph 30, Appendix I of the Code, it is stated that under main head (3) all works falling under sub-heads other than L. Earthwork are to be classed under sub-head C. Works, but the reason given for this is that under other sub-heads the expenditure would be so small as not to justify their separate entry. This reason does not apply here, as the expenditure under these sub-heads amounts to more than 50 per cent. of the total, exclusive of land, and it would render the classification altogether meaningless to lump together this proportion of the total under a sub-head to which no part of it belongs.

11. The whole of the works under main head (3) have therefore been classed under their proper sub-heads, and this renders it inconvenient to prepare the general abstract precisely in the form prescribed by your memorandum, No. 14 M.D., of 31st July 1882; the form has therefore been slightly modified.

12. Separate estimates have been prepared for all individual works, and (except for the head works in the Periyár Valley) these estimates have been kept separate from the tables of quantities, as it may possibly be considered necessary to submit the former, but not the latter, to Government.

13. No definite decision having yet been arrived at as to the amount to be paid to the Travancore Government, Rs. 8,00,000 has been entered on this account; if this sum is deviated from by any considerable amount, it may be necessary to alter the Financial Statements 1 and 2, but this can easily be done in your office.

14. Duplicate plans of the works in the Periyár Valley have been prepared. No duplicates have been taken of the plans for the works in the Vaigai and Soreally Valleys, but I cannot help thinking that such duplicates must exist somewhere, or rather that those forwarded to me and sent up with my letter mentioned below (paragraph 20) are really duplicates, and that the originals are in your office.

15. The duplicate plans of the head works, Mr. Smith's original plans, and all other papers connected with the project received from your office, except such as are required to accompany the report, have been returned separately.

16. You will see that the Financial Statement No. 3 is not in the form prescribed by G.O., No. 514 L, of 4th July 1882, which had not been received when the papers were sent to the press, but in that used in G.O., No. 377 L, of 8th May 1882, forwarded to me for guidance with your No. 14 M.D. of 31st July.

17. A copy of the latter form has been sent to the Collector for countersignature, but has not yet been returned; it is, however, believed that you have discussed the matter personally with him. The alteration from this form to the later one used in G.O., No. 514 L, can be made in your office, the only difference being that columns 3, 4, and 5 of the earlier form are included in column 3 of the later, and columns 8, 9 and 10 of the earlier in column 8 of the later.

18. It is very desirable that experiments should be undertaken at once as to the quality, strength, &c., of the lime to be used; it was proposed to undertake these some time ago, but there was a difficulty in getting any one to take charge of them. I would suggest the immediate employment of an experienced subordinate under the general supervision of the Executive Engineer, Madras, the expenditure being charged hereafter adjusted against the provision in the estimate for "preliminary expenditure" in fixing the amount of which regard was had to the necessity of these experiments; Rs. 500 will probably cover the cost, and if desired, I will draft the necessary instructions for the conduct of the experiments.

19. I shall take it as a favor if Government will allow me a few copies of the report for personal disposal.

20. The plans, detailed estimates, and other papers not requiring to be printed were forwarded from Bangalore with my letter, No. 92, of 14th September 1882.

ERRATA.

Contents—

Page I, last line but three, for "vent," read "crest."

Page II, line 7, for "Turlines," read "Turbine."

" 8, for "culvert," read "culvert."

" 13, for "Fraction," read "Traction."

Report—

Paragraph 5, line 2, insert "4,32,170."

" " 3, " "7,92,047."

" " 7, " "3,85,394."

" " 8, " "1,48,110."

" " 9, " "1,20,626." and "1,27,901."

" 20, 3rd, line 2, for "pouring," read "passing."

" " 3, for "ancient," read "ancients."

" 25, line 4, for "masonry," read "masonry."

" 34, line 5, for "equilibrium," read "equilibrium."

" 112, last line, after "paragraph," add "221."

" 173, lines 4 and 6, for "n" read "h."

Tables—

No. V, last column, for "maximum," read "minimum."

" VI, column headed "Third Season," for "2,759" read "2,759."

The second entries in this column and the corresponding ones under "Fourth Season" refer to the flood of 17th to 19th November 1869, and not to that of 7th to 8th November as entered.

No. VII, last column but two—

January: for "26," read "5-26."

February: for "77," read "2-77."

Appendix I, page 5, line 2, for " $\sqrt{2}$ " read " $\sqrt{2}$."

No. 3-A.

LEFT BANK SIPHON.

QUANTITIES.

Number.	Length.	Breadth.	Height or Thickness.	Content or Weight.	
	FEET.	FEET.	FEET.	C. FEET.	
...	80	12	25/2	12,000	Upper cutting.
...	160	20	35/2	52,500	Lower do.
				64,500	Total removing rock.
			INCH.		
...	188	28		26,320	Main pipe.
...	10	Diameter		785	Cover at upper end.
...	4	29		580	Regulating valve.
...	13	Diameter		1,323	Bottom of tank at lower end.
...	4 1/2	41		923	Side of do. do.
				29,931	
				7,483	Add for rivets, covering plates and contingencies.
				37,414	Total pounds.
				16-71	Tons of sheet iron.

Number	Length	Breadth	Height or Thickness	Content or Weight	
2	FEET. 2	FEET. Diameter	FEET. ...	C. FEET. ...	Iron ball floats with chain.
...	188	6	Diameter	...	Cast-iron flanged pipe.
2	...	...	...	...	Stop-valves at ends of pipe.
2	...	2	Diameter	...	Stop-cock in main and cast-iron pipe.
1	...	...	...	...	Five horse-power turbine fixed in cast-iron pipe.
1	...	...	...	...	Air pump to exhaust 60 cubic feet per minute.
12	7	1	14	234	Blocks for supporting main pipe.
24	14	1	1	36	Pair of wedges.
				270	Total cubic feet of timber.
					<i>Lifting Trestles.</i>
4	18	1	1	24	Upper cross bars.
4	32	1	1	16	Upper frame.
4	48	1	1	24	Lower frame.
				64	Total cubic feet of timber.
8	25	...	...	R. FEET. 200	Legs.
16	10	...	...	160	Braces.
				360	Running feet of bamboo.
4	9	Diameter	...	...	Wheels.
4	35	1" Diameter	...	...	Chain.
8	...	12" do.	...	...	Pulleys.
2	...	...	...	...	Water tanks to hold 100 gallons each.
2	...	...	...	...	Counterbalance weights, each 2½ tons, or 40 cubic feet of stone.

ESTIMATE.

Number of Units	Description of Work	Rate	Unit	Amount	Total
645-00	Removing rock	RS. 8	100 C. ft.	5,160	RS.
16-71	Sheet iron	350	Ton.	5,849	
188	Cast-iron flanged pipe	3	Foot.	564	
2	Iron ball floats	20	Each.	40	
2	Stop-valves	40	...	80	
2	Stop-cocks	16	...	32	
1	Five horse-power turbine	...	...	800	
1	Air pump	600	...	300	
270	Timber	3	Cubic ft.	810	
	Erection and fitting	...	...	3,400	17,133
64	Timber	3	C. ft.	192	
360	Bamboo	1/40	Foot.	9	
4	Wheels	25	Each.	100	
140	Chains	1	R. ft.	140	
8	Pulleys	25	Each.	200	
2	Water tanks	30	...	60	
2	Counterbalance weights	10	...	20	
	For each trestle	...	...	686	
	For four trestles	...	...	2,744	
	Labor for shifting	...	...	2,000	
	Additional cost of temporary dam	...	...	3,123	
	Contingencies	...	...	...	
	Total	...	...	...	27,000

No. 6-A.
RIGHT BANK SIPHON.
QUANTITIES.

Number	Length	Breadth	Height or Thickness	Content or Weight	
...	FEET. 140	FEET. 12	FEET. 25/2	C. FEET. 21,000	Upper cutting.
...	85	12	28	28,560	Lower do.
...	40	12	21	10,080	Turbine supply channel.
...	30	22	5/2	1,650	Weir.
...	8	8	31	1,944	Penstock cutting.
...	24	15	30	10,800	Turbine vault.
...	210	15	30/2	47,250	Do. tail race.
				121,284	Total removing rock.
			INCHES.	lbs.	
...	188	20	1	18,800	Main pipe.
...	7	Diameter	1	385	Cover at upper end.
...	10	...	1	785	Bottom of tank at lower end.
...	3½	31½	1	551	Side of do.
...	4	21	1	420	Regulating valve.
				20,941	
				5,235	Add for rivets, covering plates and contingencies.
				26,175	Total pounds.
				11.69	Tons of sheet iron.
2	2	Diameter	...	...	Iron ball floats with chain.
...	188	6	Diameter	...	Cast-iron flanged pipe.
2	...	...	...	...	Stop-valves at ends of cast-iron pipe.
2	...	2	Diameter	...	Stop-cocks in main and cast-iron pipe.
1	...	...	...	...	Five horse-power turbine fixed in cast-iron pipe.
1	...	...	...	...	Air pump to exhaust 60 cubic feet per minute.
12	5	FEET. 11	FEET. 11	C. FEET. 130½	Blocks for supporting main pipe.
24	7	1	1	36	Pair of wedges.
	14	1	1	166½	Total cubic feet timber.
					<i>Lifting Trestles.</i>
4	18	1	1	24	Upper iron bars.
...	32	1	1	16	Upper frame.
...	48	1	1	24	Lower do.
				64	Total cubic feet timber.
				R. FEET. 200	Legs.
8	25	...	...	160	Braces.
16	10	...	...	360	Running feet of timber.
4	9	Diameter	...	...	Wheels.
4	35	1" Diameter	...	140	Running feet of chain.
8	...	9	Do.	...	Pulleys.
2	...	...	...	...	Water tanks to hold 60 gallons each.
2	...	...	...	...	Counterbalance weights, each 2 tons or 32 cubic feet of stone.

ESTIMATE.

Number of Units.	Description of Work.	Rate.	Unit.	Amount.	Total.
1212-84	Removing rock	RS.		RS.	RS.
11-69	Sheet iron	8	100 C. ft.	9,703	
2	Iron ball floats	350	Ton.	4,092	
188	Cast-iron flanged pipe	20	Each.	40	
2	Stop-valves	3	Foot.	564	
2	Stop-cocks	40	Each.	80	
1	Five horse-power turbine	15	...	30	
1	Air pump complete	...	...	800	
166	Cubic feet of timber	600	...	300	
...	Erection and fitting	3	C. ft.	500	
				2,500	18,609
<i>Trestles.</i>					
64	Timber	3	C. ft.	192	
360	Bamboos	...	Foot.	9	
4	Wheels	25	Each.	100	
140	Chain	...	Foot.	70	
8	Pulleys	20	Each.	160	
2	Water tanks	25	...	50	
2	Counterbalance weights	8	...	16	
	Total for one trestle	...	...	597	
	Total for four trestles	...	...	...	2,388
	Labor for shifting	...	...	...	1,000
	Contingencies	...	...	...	2,003
	Total	...	...	...	24,000

NOTE.

Since submitting my report on the Periyar Project, I have learnt that Colonel Brownlow, R.E., Inspector-General of Irrigation, objects to the method therein proposed of passing the water of the river round the flank of the dam during construction, and considers that the culverts provided for that purpose would be a source of risk.

2. This method was proposed after careful consideration of every possible alternative (including that about to be discussed in this note), and I am convinced that no risk whatever is to be apprehended from its adoption, and that no other plan combines in the same degree the required elements of security, efficiency, and economy.

3. It gives, what no other practicable scheme does, the power of absolute control over the water-levels during the construction of the work (except during quite abnormal floods), and that of emptying the lake after completion, or of discharging a portion of its contents into the river below, a power which under certain circumstances may be of great value.

4. In case, however, Colonel Brownlow's objections should be insuperable, the best alternative remains to be considered.

5. The simplest and cheapest is simply to allow the water to go freely over the dam, but I do not recommend its adoption; the perpetual trouble of setting up frames in water, the annoyance to the workmen of moving about in it, and, above all, the impossibility of testing leakage where water is constantly running down the rear slope, are all evils for avoiding which a considerable expense may well be incurred.

6. It is true that many dams have been constructed in this manner, but they were all over streams which were either dry for part of the year, or which were mere rivulets in comparison with the Periyar, and I do not know of any case in which the water of a considerable stream has been allowed to pass during construction over a dam of any height.

7. If the ordinary stream cannot be passed by a culvert under the dam, it must be passed by a siphon above it, and the question is what the dimensions of this siphon should be. No arrangement can be considered satisfactory in which the passing of water over the substance of the dam is an ordinary as distinguished from an exceptional occurrence.

8. The scheme submitted by me provides for passing the whole stream under the dam except during about eight or ten days of the whole period (900 working days) occupied in its construction, but it is not necessary to keep to so small a number as this, if doing so involves any considerable expense.

9. I consider that, in order to ensure safety, thorough inspection, and careful workmanship, it is necessary that the siphon should be able to pass the whole discharge of the stream during at least five days out of six; and, in order to do this, there being but little margin between the water-level and the top of the work, the records show that the discharging power must be about 1,800 cubic feet per second, the maximum effective head being 25 feet.

10. A single pipe with an area of 72 square feet or a diameter of 9.58 feet would provide for this, but as it is necessary to make separate provision for the supply of water to the driving machinery, two pipes must be provided.

11. In order to get during the early part of the work (when it is most wanted) the full effect of the atmospheric pressure, the temporary dam must be made 35 feet high instead of 30 feet as originally proposed.

12. The arrangements recommended are shown on drawing No. 10-A, and their cost in the Estimates Nos. 3-A and 6-A submitted herewith. There is a pipe on the left bank, 8.91 feet in diameter, and one on the right for the supply of the driving machinery, 6.32 feet in diameter.

13. The effective head in a siphon is the difference between the water surfaces above and below, or 33 feet minus the maximum height of the diameter of the pipe above the upper surface, whichever may be the least.

14. In this case the latter is 26 feet, but during the early part of the work the former is on the left bank 25 feet, as the water will be headed up in the discharge cutting to about 10 feet, and on the right bank 8 feet, as the weir which regulates the level in the penstock cutting is at 25 feet, and there will be about 2 feet go. 3 over this when the water above is up to the crest of the temporary dam.

15. The areas of the pipes are 62.36 and 31.82 square feet respectively, and if the velocity in feet per second be taken at $4\frac{1}{2}$ times the square root of the head, the discharges will be 1,403 and 540 cubic feet per second, rather more than the required amount.

16. The discharging power of the right bank pipe will increase as the main dam rises, until the latter reaches 50 feet, when the full head of 25 feet will be available for both pipes, and the total discharge will be 2,115 cubic feet per second.

17. The pipes will be made of $\frac{1}{2}$ -inch iron sheet, with double rivetted butt joints. The diameters are those corresponding to circumferences of 7 and 4 sheets of 4 feet each, which is the greatest breadth usually made. The materials will be sent out ready prepared, and put together *in situ*; ample allowance is made in the estimate for the cost of erection.

18. The maximum pressure, either internal or external, to which the pipes can be subjected is that of about 25 feet of water or, say 11 pounds on the square inch, so that the greatest strain on the material is $8 \times 11 \times 8.91 \times 6 = 4,704$ pounds on the square inch for the left bank pipe, and $8 \times 11 \times 6.36 \times 6 = 3,375$ pounds on the square inch for the right bank, which is very moderate for good double rivetted joints.

19. When the discharge of the river is low, the water-level above the temporary dam would fall below the 25 feet necessary for the supply of the turbines, as for instance in February, when it averages only 352 cubic feet per second and the level would fall to about 11 feet; to prevent this a cover is provided at 4 feet from the upper mouth of the pipe of diameter slightly larger than the latter and fixed to it by iron bars. A valve consisting of a length of plain pipe 4 feet long and just large enough to slide easily over the main pipe is attached to floats by chains of such a length that when the water sinks to near the desired minimum level the valve descends and closes the space between the covering plate and the main pipe, thereby shutting off the water from the latter. This valve is obviously in equilibrium throughout, and may be made to slide quite loosely over the main pipe, as there is no necessity for anything like an absolute closure of the latter.

20. In order to prevent the entrance of air at the discharging mouth of the siphon, the latter is surrounded by a tank whose diameter is about one and-a-half that of the main pipe, and its upper rim 6 inches above the mouth of the latter; this is a simpler and cheaper arrangement than turning up the pipes at their mouths. These tanks are not necessary during the early part of the work, when both siphons will discharge into water standing above the level of their mouths.

21. It will be seen from the plan that the left bank siphon rests on the ground at 35 feet above the river-bed and communicates with the latter by cuttings; until the main dam reaches this level the work can proceed without interruption, and no moving of the siphon is required. After the 35-feet level the latter has to be moved from time to time as the space under it has to be filled in, and this will be done in the following manner.

22. The pipe being emptied will be raised by the trestles, shown on the drawings, to a height sufficient to allow of the completion of the work under it, the water-supply of the river (over and above what the other siphon can take) being absorbed by the margin between the water-level and the crest of the work.

23. This margin varies in depth, under normal circumstances, from 10 to 15 feet, and in content from 150 millions to 4,000 millions of cubic feet. The total time occupied in raising, completing the work below, lowering and filling the pipe again is calculated at ten hours as a maximum, a period for which the minimum margin of 150 millions of cubic feet would absorb a discharge of 4,200 cubic feet per second. Of course, if the river was in high fresh at the time, the available margin would be reduced, and the risk of submersion increased, but this is a risk which must be faced so far as it cannot be avoided by judicious timing of the various operations.

24. To allow of the easy raising and lowering of the pipes, they are attached to counterbalances, composed of blocks of concrete of weight slightly less than their own. To each counterbalance is fixed a small water tank, which when filled causes the counterbalance to descend, and when emptied causes it to rise.

25. The tanks will be filled at leisure when the siphon is at work, and when the latter is emptied it will rise at once; the work below being completed, the water will be allowed to run out of the tanks and the pipe will descend into position again.

26. The siphon will be raised and lowered in one vertical plane until its lower limb is clear of the ground level, after which it will be moved longitudinally up the bank from time to time so as to keep this lower limb just clear of the ground, and reduce as much as possible the height of the trestles, which will be necessary to support the rear portion of the pipe as the thickness of the dam diminishes.

27. The right bank siphon does not require to be removed until the work reaches the 45 feet-level, and here the conditions are somewhat different from those on the left bank. The supply of power to the whole of the machinery depends upon this pipe, and consequently it cannot be raised during working hours. That is to say, that the space underneath its original position cannot be filled in until it is lowered again, and it cannot therefore be raised and lowered in one vertical plane, but must have a certain amount of longitudinal traverse. This is provided for by the return cuttings shown on the plan which allows the pipe to be traversed to any position between the limits *a* and *b*. Of course, when once the lower limb is clear of the ground, this pipe, like the other, will be moved longitudinally up the bank.

28. It is necessary that the siphon should be emptied before being moved, because their weight when full would be too great to be conveniently dealt with, even if horizontal traversing only were to be adopted (as would be possible, though the arrangements would be far less convenient than those proposed); and the following arrangements are provided to allow of this being easily and rapidly done.

29. A small cock is fixed in the highest part of the main pipe, by the opening of which cock, air is admitted to the pipe and the water at once driven out.

30. Alongside of the main pipe runs an ordinary cast-iron pipe 6 inches in diameter; this pipe is never emptied (the weight of water contained in it being trifling), being furnished with a stop-cock at each end, which is closed before the pipe leaves the water on lifting.

31. The object of this tube is twofold: first, to provide a convenient source of power (by means of a small turbine fixed in its length) for working the air pump, by which the main pipe has to be exhausted; and, second, to supply water to the tank at the lower end of the latter during the process of exhaustion.

32. This latter is required because, without it, it would be necessary to provide an air-tight valve for closing the lower mouth of the siphon during the process, and the cost of this valve and the apparatus for opening and closing it would probably exceed that of the small pipe and its appurtenances, and be far less practically convenient. Indeed, I have failed in designing any arrangement of this kind, which I consider thoroughly satisfactory.

33. The siphon having been lowered empty into position, the air pump will be set up in a position where it can be conveniently worked by a strap from the small turbine and connected by a flexible pipe to the cock in the main pipe, the air from which will be thoroughly exhausted.

34. It has been said that the small pipe is never intended to be emptied, but if by any accident the water should be allowed to run out it can be re-filled by the air pump in a few minutes, a cock similar to that on the main pipe being provided for the purpose.

35. The small turbines cost but little, and it will be a great convenience to have a source of power which can be immediately and rapidly applied to the working of the air pump. Indeed, it will probably be often found convenient to have on the work itself a source from which power may be taken for pumping, working a hoist, or other contingent work.

36. The turbine will supply from three to six horse-power, according to the water-levels; the smaller of these powers will suffice to exhaust at the rate of 60 cubic feet per minute, so that the exhaustion of the larger pipe will take about 2½ hours, and of the smaller about half that time.

29. Plan, sections and elevation of the regulating sluice proposed for construction on the right bank of the Socroollynur immediately above the Ootamuth weir.
30. Plan, sections and elevation of the regulating sluice proposed for construction on the left bank of the Socroollynur above the Seliamputty weir.
31. Plan, sections and elevation of the regulating sluice proposed for construction on the right bank of the Socroollynur immediately above the Gullianoor weir.
32. Plan, sections and elevation of the fall proposed for construction adjacent to the Paliam-parava weir.
33. Plan of the Parany anicut showing the positions of the proposed head and under-sluices.
34. Survey, longitudinal and transverse sections of the northern main channel.
35. Northern main channel, longitudinal and transverse sections of the line recommended for adoption.
36. Do. do. do. do.
37. Do. do. do. do.
38. Do. do. do. do.
39. Do. do. do. do.
40. Do. do. do. do.
41. Do. do. do. do.
42. Do. do. do. do.
43. Do. do. do. do.
44. Do. do. do. do.
45. Do. do. do. do.
46. Do. do. do. do.
47. Do. do. do. do.
48. General plan of head sluices for distribution channels taking off from 188 to 288 cubic feet per second.
49. Do. do. do. from 42 to 94 cubic feet per second.
50. General plan of the regulators proposed for construction at the head of the subsidiary branch channels.
51. General plan of sluices proposed for construction at the heads of minor distribution channels.
52. General plan of irrigation sluices for areas from 200 to 300 acres.
53. Do. do. do. 100 to 200 acres.
54. Do. do. do. 50 to 100 acres.
55. Do. do. do. for plots not exceeding 50 acres.
56. General plan for falls of 6 feet in the main distribution channel.
57. General plan for overfalls in branch channels with crest up to 10 feet in length.
58. Plan and sections of the aqueduct proposed for construction in the third mile.
59. Plan, sections and elevation of the surplus sluice proposed for construction in the embankment of the Ramarajapuram tank in sixth mile.
60. Plan, sections and elevation of the surplus sluice proposed for construction in the embankment of the Natchicullam tank in seventh mile.
61. Plan of proposed shutter and raising and holding gear for sluices Nos. 54 and 55.
62. General plan of inlet weirs to admit the drainage from catchment basins not exceeding six square miles.
63. General plan of outlets for catchment basins not exceeding six square miles.
64. General plan of the occupation bridges proposed for construction in the third reach of the northern main channel.
65. Plan, sections and elevation of the bridge proposed for construction in the 21st mile.
66. Plan, sections and elevation of the bridge proposed for construction in the 29th mile.

ORDER—dated 27th April 1883, No. 355 I., Public Works.

The revised estimates for the Periyár Project as follows:—

Direct Charges.		RS.	RS.
Works	...	52,00,000	
Establishment	...	9,25,000	
Tools and Plant	...	60,000	
			61,85,000
Indirect Charges.		RS.	RS.
Capitalization of Land Revenue	...	85,413	
Loss by Exchange	...	40,000	
Leave and Pension Allowances	...	1,31,050	
			2,56,463
Total	...		64,41,463

27TH APRIL 1883

will be submitted to the Government of India for the sanction of the Secretary of State.

2. It has been shown that the
Including Enhanced Land Revenue
Excluding Enhanced Land Revenue
charges;

the project has therefore every claim to the immense importance of providing a continuous supply of water to the Madurai District stamps it as of the utmost importance.

3. The question of compensation to be in a fair way of settlement, and believed to be ample.

4. The Government of India G. L. Molesworth, C.I.E., on the subject of calculating pressures in masonry.

5. The Government desire to project has been worked up, after Major Pennycuik, and feel confident to a more competent officer.

(Here enter No.)

355 I., PUBLIC WORKS.

of India for the sanction of the Secretary of State.

turns anticipated are—

Revenue, 9.29 per cent. on direct charges;
Revenue, 8.92 per cent. on direct and indirect

to be considered a Productive Public Work, giving a continuous supply of water to the Madurai District as a Famine Protective Work.

to the Travancore Government is believed to be a provision in the estimates under this head is

It will be requested to invite the remarks of Mr. G. L. Molesworth, C.I.E., on the subject of calculating pressures in masonry.

knowledge the complete way in which the project has been worked up, after Major Pennycuik, and feel confident to a more competent officer.

L., dated 27th April 1883.)

Extract.)

(Signed) J. O. HASTED, Colonel, R.E.,
Ag. Joint Secy. to Govt., P.W.D.,
Irrigation Branch.

To the Superintending Engineer, Sixth District,
" the Chief Engineer for Irrigation.
" the Examiner, Public Works Accounts,
" Major J. Pennycuik, R.E.
" the Revenue Department.
" the Board of Revenue.
" the Political Department.

Encl. A. F. Goodall and C. Howarth.
Spare Copies

2834

18

3-9-06

17-1-11

R 29010

IRRIGATION.

Govt. of (1883) Madras.

PUBLIC WORKS.

Dated April, 27th.

Recd.

Encl.

G.O., 27th April 1883, No. 355 I.

APRIL.

Periyar Project

Passing orders on the revised estimates for,
and other points connected with, the —

On

24/10

No. 192 I.

GOVERNMENT OF INDIA.

PUBLIC WORKS DEPARTMENT.

CIVIL WORKS.

Irrigation.

2834
15



To

The Secy. to the Govt. of Madras.
P. W. Deptt.

Simla, 30th September 1887.

Sir,

I am directed to acknowledge the receipt of your letter No. 2315 P, dated 29th August 1887, requesting sanction to the grant to the staff employed on the Periyar project of the extra allowances detailed in paragraph 245 of Lieut. Colonel Penny-quick's report forwarded with your endorsement No. 356 I of 27th April 1883.

2. In reply I am directed to state that no allowances beyond the ordinary ones allowed by rule, can be given. If it is desired for special reasons

such

R/C# 7979

Such as unhealthiness or expensiveness
of locality to recommend the grant of
special allowances, the case must be
separately submitted for orders with
full and complete explanations. No
additional allowances must be given
without the sanction of the Govt. of
India.

I have the honor to be,
Sir,
Your most obedt. servt.

N. B. Kuchley -

Under Secy. to the Govt. of India

R/10-10-87

K/7-4-87

Documents accomp.

Nil

GO 3563 d/27-4-83

Ln. 15
25000 d/27-5-87

GO 2304, 1500 d/27-5-87

3 sub papers

* The figures in column 3 are calculated on the assumption that an officer & traveller claims more than 10 days in each month -

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PROCEEDINGS OF THE MADRAS GOVERNMENT.

UNDER date the *28th* *17* *Oct 22 1887*

READ the following

From the Govt of India, P. W. Department. H. E. No. 192 I of 30 September 1887.

*Ordered that the following
letter be addressed to the Govt of India*

H. E. No. 192 I of 30 September 1887

*To
The Secy to the Govt of India
P. W. Department.*

*Sir,
I am directed to acknowledge
the receipt of your letter No. 192 I dated
30th September 1887 in which it is stated
that no allowances beyond the ordinary
ones allowed by rule can be given to
the staff employed on the Periyar project,
and that if it is desired for special
reasons such as unhealthiness or ex-
cessiveness of locality to recommend the
grant of special allowances, the case
must be separately submitted for orders*

*Chief Engr for Irrigation
W. H. Corrie
Govt P. W. Accounts
Public Deptt
Decr 31. 10. 87.*

with

with full and complete explanations.

2. In reply, I am to say that the Govt. are satisfied that the conditions of life at the head works of the Periyar are little less unfavorable, whether as regards cost of living and locomotion or risk to health, than those prevailing in other Districts of the Madras Presidency where special allowances are granted.

3. In proposing the scale of allowances recommended in my letter No. 2315 W dated 29 August 1887, the Superintending Engineer pointed out that special allowances had always been given at the Periyar, but that they had hitherto taken the form of double travelling allowance plus a personal allowance; but as the former appeared objectionable as being opposed to the principle that travelling allowances should not be looked to as a source of emolument, he recommended certain fixed allowances.

4. The following statement shows how these allowances compare with those drawn by officers and subordinates employed in the Wynad and other hill tracts.

(H. B.)
(A)

5. It will be seen that the amounts are considerably less than would be granted under the usual ²³³⁴ rules for expensive and unhealthy localities, the difference in favor of the proposed scale being no less than Rs. 76,000 for the whole period.

6. I am, under these circumstances, to request that the sanction of the Govt. of India may be communicated to the very moderate proposals put forward by the Superintending Engineer in charge of the works.

W. B.
19.10.87

J. B.
19/10/87

Drawn 31-10-87.

W
22.10

circ. 20-10-8 > R. 22-10-8

circ. 20-10-8 > R. 22-10-8

7979.

Govt. of India

PUBLIC WORKS.

24/10
2035

22 Oct. 2034
2035

Special allowances
to the staff employed
on the Periyar project

The Govt. of India
be addressed with
regard to the grant
of —

Special allowances to
the staff employed on
the Periyar project

The Govt. of India
be recommended to the
Govt. of India