PRELIMINARY REPORT

ON THE

INVESTIGATION OF PROTECTIVE IRRIGATION WORKS,

AND ON

IRRIGATION UNDER WELLS,

IN THE

MADRAS PRESIDENCY.

BY

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PREFACE.

In compiling the following report I have attempted to keep in view the wishes of the Government of India as expressed in its Resolution No. 3/61—1 F., dated 13th March 1901 and in the Memorandum of Instructions drawn up by the Inspector-General of Irrigation communicated with Public Works Department letter No. 547 C.W.I., dated 7th May 1901.

In the first part of my report I have attempted to give, as far as possible, the information regarding completed works called for in paragraph 2 of the Memorandum of Instructions. In this part, only Major productive and protective works have been dealt with. The statistics regarding each of the numerous minor works for which Capital and Revenue accounts are kept will be found in part II under the head of the district in which they are situated.

All proposed new projects are described when dealing with the district which they are expected to benefit, with the exception of the Bhavâni project which is shortly described under the Cauvery delta system and the Tungabhadra project the report on which is printed separately.

2. In part II, I have endeavoured to give in as short a space as possible the information which will assist the Commission to come to a definite conclusion as to what should be done in each district in the Presidency where artificial irrigation is needed. A brief account of the physical character of each district is given and a short history of every proposed work of any importance.

Mr. M. R. Khareghat, Assistant to the Chief Engineer for Irrigation in charge of the Tank Restoration Scheme, has supplied a note on the operations of the branch of the department under him.

I have also ventured to make a few recommendations of a general nature concerning the maintenance of our smaller works.

3. The Collector of every district has been consulted by letter and the great majority of them by personal conference. I have also had the opportunity of meeting and consulting a large number of Divisional officers of the Revenue Department. The opinions and suggestions of a large number of private individuals have been invited and only fourteen replies have been received. I regret, however, that they did not afford much assistance as far as projects were concerned, referring as they did to (1) projects which are already under investigation, or (2) projects which are obviously impossible, or (3) schemes of such insignificance as to be unworthy of a place in the present report.

4. A report on wells will be found at the end of this volume.

5. I may take this opportunity of gratefully acknowledging the assistance I have received from all officers of the Revenue and Public Works Departments in collecting the information contained in the following report.

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PRELIMINARY REPORT

ON THE

INVESTIGATION OF PROTECTIVE IRRIGATION WORKS

IN THE

MADRAS PRESIDENCY.

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PART I.

COMPLETED WORKS.

The only works dealt with in this part are the Major productive works and the Rushikulya project—a Major protective work. The Minor systems for which Capital and Revenue Accounts are kept do not differ in any essential particulars from other Minor works, and they have therefore been treated by districts in part II.

2. A short explanation as to the way in which the figures shown in the statements of results are arrived at is necessary.

3. Columns 3 and 4 in the case of canal systems give the mean of the average monthly discharges taken from the river diagrams for the periods taken as first crop and second crop. These are, however, not strictly accurate for two reasons.

(1) The discharges through the head sluices are sometimes, owing to faulty alignment, deposit of silt and other causes, incorrect; and (2) the periods shown as crop seasons are by no means strictly observed.

4. Column 7—*Area actually irrigated* (1st crop) shows all the land cultivated for the first time during the season although grown during what is nominally the second crop period.

5. Columns 10 and 11 are obtained by dividing the area irrigated by the average quantity of water discharged. This, although perhaps useful as a standard of comparison, gives no idea of the real duty, as at certain periods of cultivation more water is required than at others, and the duty is really limited to the amount supplied when there is most demand for it.

6. In the case of reservoir projects, the process of calculating correctly the amount of water issued for irrigation is somewhat difficult, and different principles appear to have been adopted in different systems.

7. It would, therefore, be unwise to place too much faith in the quantities shown in the statements.

8. *Capital cost.*—Columns 12 and 13 are obtained by dividing the Capital outlay to end of 1899-1900, respectively, by the average annual discharge and by the average area annually irrigated. In calculating the Capital cost per acre irrigated, the areas due to old irrigation have not been deducted.

RESULTS of the Godávari Delta System.

Average.													
Water-supply.			Area actually irrigated.			Duty (i.e., Number of acres irrigated per cubic foot per second.		Capital cost		Rate of working expenses per acre charged as irrigated.	Irrigation revenue realised per acre charged as irrigated.
	Quantity of water anticipated when the project was sanctioned.	Average quantity of water discharged at head.						per unit of the quantity of water discharged at head.	per unit of the area actually irrigated.		
		First crop.	Second crop.	First crop.	Second crop.	Total.	First crop.	Second crop.				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	c. ft. per second. 8,516 *	c. ft. per second.	c. ft. per second.	Acs.	Acs.	Acs.	Acs.	Acs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
1891–92 ..	..	6,461	4,461	772,869	667,610	..	..	..	..	..	..	..	..	..
1892–93 ..	..	5,338	5,345	..	..	637,783	89	20	..	..	..	..	0·91	3·26
1893–94 ..	..	6,699	5,261	..	..	631,590	118	12	..	..	..	..	1·02	3·53
1894–95 ..	..	6,361	* 4,552	..	..	638,679	97	15	..	..	..	..	0·86	3·35
1895–96 ..	..	5,764	4,369	..	..	654,126	103	22	..	..	..	..	0·65	3·29
1896–97 ..	..	5,855	* 3,661	..	..	660,362	101	28	..	..	..	..	0·96	3·80
1897–98 ..	..	6,563	4,909	..	..	631,411	108	36	..	..	..	..	0·94	3·82
1898–99 ..	..	6,342	3,900	..	..	638,329	116	34	..	..	..	..	*0·85	3·98
1899–1900 ..	..	4,378	1,367	..	..	657,696	104	31	..	..	..	..	1·00	4·11
1900–1901 ..	..	6,936	4,519	..	..	666,140	97	49	..	..	..	..	1·03	3·77
						674,319	97	30	..	..	..	..	1·06	3·88
Total ..	..	59,537	+2,404	..	..	6,410,224	1,089,494	7,499,478	..	..	..	..	9·48	36·79
Average ..	..	5,959	4,240	..	..	641,022	108,949	749,944	98	26	2,162	18	0·95	3·68

* Maximum discharges of main canals as designed.

Note.—First crop—1st May to 30th November. Second crop—1st December to 31st March.

The discharges shown in columns 3 and 4 of this statement have been calculated from those given in the river diagrams by necdle. They do not always correspond with the figures in Statement I, E, appended to Administration Reports. The latter are supplied by Superintending Engineers some months before the river diagrams are submitted, and are probably only approximate.
For the above reason, the figures in columns 10 and 11 do not agree with those in the Administration Reports.

GODAVARI DELTA SYSTEM.

The results of the system are exhibited in the accompanying table. Too much reliance should not be placed on the figures in columns 3 and 4 which are in some instances evidently wrong.

2. The quantity of water available is in almost all years in excess of the present requirements of the system. In 1899–1900, however, the river discharge was unprecedentedly low and some difficulty was experienced in supplying the total area cultivated. The area of first crop in that year was 666,140 acres, the largest sown up to that year. The diminution in first-crop area in 1895–96 was due to the temporary relinquishment of lands by certain ryots on account of enhanced assessment.

3. *Duty.*—Various local circumstances render the figures entered in columns 10 and 11 somewhat misleading. The more important may be enumerated as follows:—

(1) A very large area of first crop (so-called) is planted after a dry crop and grown during the second-crop season. This is due to the practice of calling the first irrigated crop "first crop" even though grown during the second-crop season.

(2) Sugar-cane, turmeric and other ten months' crops which require one-tenth the quantity of water that paddy does, although irrigated in both seasons, are classed as first crop.

(3) Dry paddy and ragi are often planted during the first-crop season and grown as dry crops in years of normal rainfall. Should, however, the south-west monsoon fail, a few waterings from the canals are taken and the crop becomes a first-crop irrigated one. This goes far to account for the very great duty of water in 1899–1900.

4. The reasons (1) and (2) above can conversely be taken to show that the duty of second crop should be higher than that given. The comparatively low duty is, however, principally due to two reasons —

(1) The over-estimation of discharges through the head sluices.

(2) To the fact that paddy, which is the principal second crop, is actually grown from 15th January to 15th April and not from December 1st to March 31st as given in the statement. Mr. Mullings, Assistant Engineer, now Sub-divisional officer in the Gódávari Eastern delta, who has afforded most of the above facts, considers that the duty, if properly calculated, would amount to between 80 and 90 acres per cusec for first crop and to about 50 for second crop.

5. *Possible extensions.*—No extensions of this system have been suggested by the officers in charge, but a glance at the table of surplus discharges would show that some attempt should be made to utilize a larger portion of the water than is done at present. In the absence of the recommendation of local officers I am unable to make any definite suggestions, but would call attention to my remarks in part II under the head, Gódávari district.

Results of the Kistna Delta System.

	Water-supply.		Acreage.									
	Quantity of water anticipated when the project was sanctioned.	Average quantity of water discharged at head.		Area (cultivable) commanded.	Area for which the work was designed.	Area actually irrigated.		Duty, i.e., number of acres irrigated per cubic foot per second.		Capital cost.		Rate of working expenses per acre charged as irrigated.	Irrigation revenue realised per acre charged as irrigated.
		First crop.	Second crop.			First crop.	Second crop.	First crop.	Second crop.	Per unit of the quantity of water discharged at head.	Per unit of the area normally irrigated.		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	C. FT. PER SECOND.	C. FT. PER SECOND.	C. FT. PER SECOND.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	Rs.	Rs.	Rs.	Rs.
....	(a) 8,126	..	..	859,276	700,000	..	..	..	..	..	..	..	..
1891–92	..	3,685	899	..	..	478,167	397	..	..	..	..	1·13	3·96
1892–93	..	3,566	2,331	..	..	472,119	267	..	..	..	..	1·16	4·05
1893–94	..	4,706	..	..	..	507,321	148	..	..	..	..	1·15	3·96
1894–95	..	4,239	2,303	..	..	514,812	195	..	..	..	..	1·04	3·91
1895–96	..	3,464	1,874	..	..	500,190	261	..	..	..	..	1·19	4·05
1896–97	..	4,528	2,363	..	..	479,711	654	..	..	..	..	1·15	4·57
1897–98	..	4,887	2,869	..	..	513,011	448	..	..	..	..	1·42	4·80
1898–99	..	5,171	2,733	..	..	564,063	194	..	..	..	..	1·22	4·75
1899–1900	..	5,920	1,974	..	..	675,029	545	..	..	..	..	1·17	4·06
1900–1901	..	6,944	3,525	..	..	690,752	218	..	..	..	..	1·13	4·74
Total	..	46,883	20,807 for 9 years.	..	..	6,200,172	3,230	..	..	..	..	12·66	44·04
Average	..	4,653	2,312	..	..	620,017	323	..	..	3,588	26	1·27	4·4

* Information not available.

Second crop—1st December to 31st March.

The river diagrams by months. They do not always correspond with the figures in statement I-E appended to Administration reports. The latter are furnished by Superintending Engineers some months before the river diagrams are submitted, and are probably only approximate.

For the above reason, the figures in column 10 do not agree with those in the Administration reports.

(a) Maximum discharge of main canals as designed.

Note.—First crop—1st May to 30th November.

KISTNA DELTA SYSTEM.

The results of the system are shown in the accompanying statement. It must, however, be premised that the figures of average discharges and duty are of very little value, for the following reasons:—

(*a*) Following the administration report, the period of first-crop cultivation has been taken from 1st May to 30th November, whereas as a matter of fact the head sluices are rarely opened before the latter part of May and the greater part of the cultivation begins sometime in July.

(*b*) The calculations of discharges through the head sluices are far from correct, especially when the river is low. Mr. Howley, who is employed on special duty and has carefully gauged the eastern Main canal, has drawn out a curve of discharges at varying depths, which shows that the calculated discharges through the head sluice are far too high when the river is low and slightly too low when the river is high. This is due to the fact that owing to back eddies at certain times some of the vents are ineffective, and to the fact that a constant velocity of approach is assumed which is incorrect.

2. Mr. Howley has given me actual discharges of the eastern Main canal for two years worked out from the results of his gauging, and I compare them with the figures given in the annual river diagrams:—

Month.	Discharge in cubic feet per second				Remarks.
	1899–1900		1900–1901		
	As gauged.	As calculated.	As gauged.	As calculated.	
May	..	340	342	342	One day only.
June	2,869	2,457	2,056	2,221	
July	5,126	3,923	4,886	4,253	
August	4,717	3,721	5,329	4,360	
September	4,485	3,502	5,476	4,525	
October	1,590	3,191	4,765	4,325	
November	2,136	2,550	3,711	3,552	
December	*	1,287	1,474	2,192	
January	..	1,000	595	1,689	
February	..	850	895	1,565	
March	..	353	640	1,567	

* Discharges on 1st December 1899 about 400 cubic feet, and from 15th December to end of March 1900 probably about 200 cubic feet per second only.

3. Taking the period of cultivation of first crop to be from 1st July to 30th November, we get the following for the Eastern delta in 1899–1900:—

Average discharge for 5 months 1st July to 30th November	...	4,171 cusecs.
Area cultivated	...	3,46,741 acres.
Duty	...	83 acres per cusec.

4. The gaugings carried out by Mr. Chatterton in 1891–92 and now being continued by Mr. Howley, show that the amount of water carried by the canals is largely in excess of that calculated by Bazin's formulæ. The carrying capacity is something like 40 per cent. greater than was originally expected, and there should therefore be no difficulty in cultivating the whole of the ultimate area or even more without any further widening.

The cultivable area commanded is stated to be 859,276 acres. The project was originally designed for 475,000 acres, but this has been increased and the ultimate area has now been fixed at 700,000 acres.

5. *Average quantity of water available for irrigation.*—Owing to the adverse character of the season, the quantity of water discharged at the head during the second-crop season of 1891–92 was much below the average.

6. *Acreage.*—With the gradual extension of canals and distributaries there has been a steady increase in area of first-crop cultivation, and with careful distribution there is no reason why this increase should not continue until the limit of cultivation now fixed is reached. A striking feature in this system is the very small amount of

second-crop cultivation as compared with the Gódávari delta. Various reasons have been adduced for this. The principal may be enumerated as follows:—

(1) There is not enough water at the end of the cultivating season.
(2) The land is not rich enough to yield two crops.
(3) The apathy and conservatism of the ryots.

7. After making careful enquiries I am inclined to attach considerable importance to the first of these reasons and still more to the third. The amount of water available in February and March is greatly overstated in the returns; but even when the correct figures are taken there is enough water for a very much larger area than the ryots now attempt to cultivate. The year 1899–1900 was a particularly bad year, while in 1900–1901 the water was probably higher than usual in March. It seems, therefore, that there is no reason why one should not count on at least 300 cubic feet per second throughout March, when crops are ripened and require very little water. It is also to be noted that in Gódávari district a very large proportion of second-crop area is sown with gingelly and other crops which require comparatively little water. It seems, therefore, that were a similar practice followed in the Kistna district, a considerable area could be cultivated with a second crop even after the requirements of navigation are provided for.

8. *Duty.*—The question of duty in this system is a most interesting and important one, as on it most of the extension in the immediate future depends. It is, I believe, universally admitted that the duty of water in this district, as elsewhere, is much lower than it should be and that it is capable of being considerably increased. The efficiency of the regulating and distributary works has much to do with the economy of water, but still more does it depend on the *personnel* of the controlling staff.

9. It is only by unremitting care and personal attention that duty can be increased, while nothing is so easy as to let it fall again. I would therefore urge that the greatest attention should be given to this matter; for it is in this way alone that any extension of irrigation in the near future may be expected. The work being done by Mr. Howley, the Executive Engineer on special duty, which is to ascertain the true discharge of the various canals and to prepare maps showing the areas actually irrigated under each sluice and spout is most valuable and even necessary before anything like perfect economy of water can be effected; but it will also need, for many years to come, the close personal attention of the Executive and Assistant Engineers to achieve the desired results.

10. The question of making a reservoir on the Kistna to supplement the failing supplies late in the year and to extend irrigation has often been mooted, but up to date no systematic investigation has been made. The project is one which presents many obvious engineering difficulties, but which, if carried out, would probably eventually be very successful.

11. Mr. Reid, who has made some preliminary investigations, has supplied the accompanying note, and although I do not myself consider that he has conclusively disposed of the silting question, I think his proposals deserve the most careful consideration:—

The Kistna Anicut at Bezwada, built in 1855, now supplies an area of 600,000 acres in all seasons. There are, however, indications that its safe limit of expansion has nearly been reached. Twice within the last five years, viz., in 1896 and in 1899, the whole available flow in the river towards the end of the irrrigation season has been turned into the canals. Not only so but in 1896 the whole available supply in the river in November was insufficient for the crops and the Eastern and Western deltas had to be put on turns. The area then was only 482,633 acres. Now it is over 600,000 acres.

The year 1896 was one of great scarcity in the river during the latter months though famous for the maximum flood in August, but it was a year of exceptionally good rainfall. On the other hand in 1899, there was a ten-foot flood over the anicut in mid-September, but a total absence of rain over the whole district. A combination of these two factors—a low river and absence of local rain-fall—may yet come and the loss of crop will exceed anything hitherto experienced.

The year 1896 may be taken as a typical year to emphasise the necessity of providing some means of storage for the surplus waters now running uselessly to sea. In the month of August there was a maximum flood of 20 feet over the anicut and great flood damage ensued, but a few weeks later, the river was so low that the two deltas had to be put on turns. A reservoir would have materially moderated the violence of the flood and held up a large part of the surplus water until it could be turned to some profitable use later on.

With a good flow in the river and a normal local rainfall there is no doubt that the present area can be considerably increased and there is also no doubt that the ryot's profits in years of

plenty are sufficient to enable them to regard with equanimity the loss that may fall on them in an occasional year of scarcity. Had the Kistna irrigation system reached its highest stage of development, the foregoing facts would be sufficient to justify a continued expansion although years of scarcity, involving serious loss of crop, were to be apprehended. They cannot, however, be taken to justify the neglect to provide means of storage by which the present area under cultivation can be nearly doubled and that, too, in years of low river and quite independently of any failure in the local rains.

In the absence of any proposal for a storage reservoir, any estimate of the ultimate area of the Kistna delta has necessarily been based on the irrigating capacity of the low water discharge of the river. On this basis the figure usually taken is 7 lakhs of acres and detailed figures by canals are given for this amount in Mr. Walch's Kistna History, page 155. Mr. Chatterton by taking a slightly higher duty considered that the low Kistna supply was enough for 8 lakhs of acres.

With a reservoir of sufficient capacity the limit of expansion may be taken at the gross area commanded by the anicut making the usual deduction for lands required for village sites and those which for any cause are not likely to be converted into wet.

By carrying out the long projected East Bank canal and supplying other areas which are badly in need of irrigation, the area for the Eastern delta becomes 475,000 acres.

On the western side of the river there is an important omission inasmuch as there is no high level canal, such as the Ellore canal on the eastern side and the two high level canals on the Gódávari. That such a canal was contemplated by the originators of the project is clear from Colonel Orr's map, dated 9th August 1855, on page 75 of the Kistna History where it is called the "Proposed Kistna Southern High Level channel" and had apparently at that time been actually levelled and estimated for although not submitted for sanction. If its alignment as shown on this map is correct and if it were continued as far south as the Gundlakamma river it will command not less than 245,000 acres.

For the present purpose, however, it is enough to put the area commanded by this canal at about half the above figure and the extent of cultivation at 75,000 acres. There are at present figures in existence showing the ultimate area under the existing three main canals as being 350,000. We thus arrive at 425,000 as a total for the Western delta and 900,000 as the total irrigable ayacut of the Kistna system.

At present the cultivation of second crop in the Kistna may be said to be non-existent, the actual figures being a few hundred acres in each year, and the cause is not far to seek. In the adjacent Gódávari delta where the canals are open for 10½ months in the year, the area of second crop averages quarter to one-fifth of the first-crop area. Further south the proportion increases till under the Srivaikuntam anicut on the Támbraparni, which is almost a perennial stream, the second-crop land is almost equal to the entire area of first crop.

In the Kistna, the canals are only open for 9 months in the year which is quite insufficient for the growth of two crops, more especially as local conditions and customs do not permit of an earlier transplantation than the months of July and August.

Were the canals to remain open for eleven months in the year, say from mid-May to mid-April, as could be done with a reservoir, there can be no doubt, to any one acquainted with the delta, that a large demand for water for second crop would arise, and that 200,000 acres might be so cultivated in every season.

On the twofold ground, therefore, of an increase of 50 per cent. in the first-crop area to be guaranteed in all years, as well as the introduction of second-crop irrigation amounting to 200,000 acres, the case for a reservoir on the Kistna would seem to be made out. If this be conceded, it follows that no time should be lost in prosecuting the necessary surveys and preparing complete plans and estimates.

The first-crop area is expanding at the rate of 20,000 acres a year if provided with sufficient water, but we have already seen that, twice in recent years, great care has had to be exercised in the distribution of the available supply.

With the utmost expedition several years must be occupied in the construction of a work of such magnitude, and it is quite certain that even now the natural expansion of the delta must begin to slow down until an additional supply from storage is guaranteed. No delay should therefore be permitted in providing full facilities for the early submission of plans and estimates. As a matter of fact a start has been already made and it would be more correct, therefore, to say that no interruption should be permitted in the work which has now been begun.

In the year 1899 the Kistna only once attained a height of 10 feet over the anicut and then only for a few hours. This year, taken as a whole, is usually considered to represent the lowest flood on record. The total surplus discharge over the anicut, however, amounted to 780,000 millions of cubic feet. As the greatest capacity that can be held up by a 150-foot dam on the Kistna will probably be between 30,000 and 40,000 mills. of cubic feet (about equal to the storage of the Assouan dam), it is clear that there is need for no anxiety on the score of water-supply. In 1899 the reservoir would have been filled nearly twenty times over, while in a year like 1892 it would have been filled nearly fifty times.

The Sunkesula anicut in Kurnool is 270 miles above the Bezwada anicut and is 900 feet higher. This gives an average fall of the river bed of 3½ feet per mile.

A dam 150 feet in height would therefore back water for a distance of 43 miles.

From an estimate based on the discharge of the river in 1899, the worst on record, the requisite storage to safeguard 900,000 acres of first-crop and aid to supply 200,000 acres of second-crop amounts to 22,800 mills. of cubic feet or to allow for losses by evaporation and percolation, say, 25,000 mills. The remaining 10,000 or 15,000 mills. in the reservoir can be utilised as shown below.

Among the numerous successful Madras Irrigation projects there is one comparative failure *e.g.*, the Kurnool-Cuddapah canal. Its purchase from the Madras Irrigation company was effected in 1882, at a cost of 216 lakhs of rupees and its average revenue is less than a lakh and-a-half. It was designed and has been constructed to irrigate 300,000 acres, but it seldom irrigates more than 50,000 acres rising to 80,000 acres in years of deficient rainfall.

It is frequently urged that the construction of the canal has stopped short at the point at which a remunerative return might be expected from any further expenditure, and there is no doubt a certain amount of truth in the assertion.

The canal was intended to irrigate from the Kistna, land in Kurnool, Cuddapah and Nellore, and the connection between the basins of the Kistna and the Penner rivers has been made at a much greater cost than was anticipated and with a very incommensurate return.

For reasons which are well known the ryots in Kurnool refuse water in all but seasons of drought and not much improvement is possible short of a complete realignment of the canal. In Cuddapah, however, the water is much more in demand. In Kurnool there are only 176 acres per mile of main canal but in Cuddapah there are 500 acres per mile.

Unfortunately geographical considerations preclude any great extension taking place in Cuddapah, but by carrying the water down the Penner river into Nellore where water is never refused, a large extension is possible both by means of an anicut to be made at Somasila which is the old site selected by the Irrigation company, and also under the two anicut systems below, where at the present moment the tanks and reservoirs are empty and the crops parched and in a most critical condition.

The Kurnool canal as designed was intended to pass 3,000 cubic feet per second into the Kali river, a tributary of the Kondaur, and thence into the Penner to be caught up as required at the Somasila anicut. The Executive Engineer in charge of the canal says that he is at present in a position to surplus 1,500 cubic feet per second into the Kali river if desired. Allowing for losses *en route*, the large quantity of, say, 1,000 cubic feet per second, could therefore be made available at the site of the proposed Somasila anicut on the Nellore border or at the Sangam and Nellore anicuts, at virtually no charge whatever. This quantity of water would supply 100,000 acres bringing in a revenue of 4 lakhs at the present water-rate, which is nearly three times the present revenue of the Kurnool-Cuddapah canal.

To do this, however, the assistance of the Kistna reservoir is essential. In 1873 it was ruled in the interests of the Kistna delta which was then but little over 200,000 acres that the Kurnool-Cuddapah canal could take off not more than 3,000 cubic feet per second during the irrigation season. During the intervening thirty years the rapid expansion of the Kistna irrigation and the backwardness of that under the Kurnool canal have so radically altered the conditions that any extension under the latter could only be undertaken at the expense of the Kistna system.

Up to mid-October the water in the river may be said to be abundant in all years, but from that date till the end of November, the utmost use of the water is made by the two systems.

If, therefore, the Kurnool canal were to draw off an extra 1,500 cub. ft. per second for these 45 days it would deprive the Kistna of 5,832 mills. of cub. feet. If, however, an equal storage of 5,832 mills. were available in the reservoir for use in the Kistna, then all injustice would disappear.

It would appear therefore that, in addition to nearly doubling the area and the revenue of the Kistna anicut system, the reservoir would also provide the means of trebling the area under the unfortunate Kurnool canal.

There is indeed no need to labour the point as to whether the reservoir is desirable or not. Enough has been said on this aspect of the project and the only thing to consider is its feasibility.

That part of the Kistna which is from 100 to 200 miles above Bezwada runs through a narrow contracted valley with steep rocky sides sloping up from the water's edge.

The summer water-level varies from 10 to 20 feet above the bed with fords at intervals where the depth does not exceed one or two feet. These fords are produced by the out crop of a vein of hard rock which has been scored down less rapidly than the adjacent portions by the swiftly flowing water, and constitute both by reason of their hardness and the shallowness of the water, convenient sites for the construction of a high masonry dam.

Owing to the steeply sloping sides any water impounded by a high masonry dam would be prevented from spreading out laterally to any considerable degree, and a dam 150 ft. in height would hold up a reservoir 45 miles in length but of a width less than one mile at the widest part.

The only serious criticism directed against the project is that it may silt up when the heavily laden flood waters enter the reservoir.

The mind naturally pictures a wide expanse of water, many times the normal width of the river, into which the muddy flood waters plunge. The velocity is immediately checked with the result of depositing all the suspended sediment on the bottom of the reservoir and the issuing waters over the waste weir run off more or less clear.

Under such conditions storage on a river like the Kistna which runs in flood for many weeks would naturally be impossible as the reservoir might conceivably silt up entirely in course of years.

A consideration of the series of cross sections of the river valley which have been lately taken by one of my subordinates will, however, show that during flood time there is no dead water at all, and that the river flows straight on with a gradually slackening velocity as the depth and width increase and that the mean velocity of the cross section of the river through the reservoir till in the immediate neighbourhood of the dam will be such that all silt will continue in suspension. A certain amount of coarse sand may be deposited; but the Kistna is a silt-bearing rather than a sand-bearing river, and the amount will be immaterial.

A number of sections have been taken at intervals of 2 miles along the river at this part. They are all very similar and a consideration of a typical one will make the point clear.

The fall in the river is over three feet per mile.

The depth at maximum flood level is at this typical section about 100 feet and the flood cross section is 115,000 square feet. The maximum flood discharge is known to be 800,000 cubic feet per second and the velocity is therefore $\frac{800,000}{115,000}$ or 7 feet per second at this point.

Suppose a similar section (B) 45 miles lower down where a dam is built 150 feet high with a waste weir on either flank discharging 12 feet deep and suppose the intervening valley between the two points to be of more or less uniform section. A line joining the bed of the river at the upper section (A) with the crest of the weir at the lower one (B), will be a horizontal one and will represent the still-water level with reservoir full. The surface fall in flood time will be the difference of the depth of the river at A (100 ft.) and depth on weir crest at B (12 ft.), *i.e.*, 88 ft. in 45 miles or, say, an average of 2 ft. per mile.

The river therefore will flow steadily on from A to B with a decreasing surface-fall and a correspondingly increasing area of cross section until within, say, one mile of the dam when the effect of its obstruction may begin to be felt.

Up to this point, the mean velocity of the current will gradually diminish. The discharge is constant and known, and the area of cross section and hence the velocity is easily determinable from the typical cross section.

Thus at a point midway between A and B or 22½ miles above the dam the area of cross section will be found to have increased from 115,000 square feet to 178,000 square feet and the velocity to have diminished from 7 to 4·5 feet per second. At a point 4 miles above the dam or about nine-tenths of the distance from the head the velocity is 3·3 feet per second. Similarly at a point one mile above the dam the area is 263,000 square feet and the velocity is 3 feet per second.

Now at 3 feet per second all silt and most of the sand, except the coarser particles, will still be held in suspension and we may say that till within one mile of the dam there will be no silting at all in the reservoir.

The section of river valley is of course not constant, being broken up in places by the cross valleys of inflowing tributaries, but it is thought that this irregularity is not sufficiently important to vitiate a *primâ facie* argument as to whether the reservoir will or will not silt.

It may be said that granting the above argument to be correct, the dam will then have to withstand not only the statical pressure of the water impounded, but a certain dynamical pressure due to the flowing water impinging on its upper face. It is possible that this may be the case and the dam section may require to be widened to meet it, or preferably, the dam itself may be laid out on a curved plan instead of a straight one, but it is not thought that the actual effect will be great. Its effect will be chiefly dissipated by the draught towards the waste weirs and the thirty under-sluices.

The actual conditions of flow in the near neighbourhood of the dam are matter for conjecture rather than for calculation. The actual rate of flow over the flank weirs is 12 feet per second and that through the under-sluices with a head of about 130 feet will be over 55 feet per second. The flow in the river one mile above the dam is, on the above calculation, 3 feet per second which may be supposed to diminish slightly with the slightly increasing area of cross section until it comes within the influence of the draught towards the weirs and under-sluices, but it is not likely to fall much below 3 feet per second, nor is it likely, even if it did, that any large quantity of silt would be deposited.

The foregoing calculations are based on an estimated flood discharge of 800,000 cubic feet per second which corresponds to a height on the Bezwada anicut of nearly 20 feet and which may be said to occur once in fifteen years or so. In more ordinary years the flood discharge will be less and the resulting velocity through the reservoir less, and if this falls below 2 feet per second, then a certain amount of silting may be anticipated.

Such accumulations must however be picked up and carried on again when the periodical maximum flood recurs. This must be so, for if a considerable depth of silt were to accumulate at the point one mile above the dam where we have calculated the flood velocity to be 3 feet per second the only effect of such accumulation would be to contract the area of cross section and therefore increase the velocity until the flowing water was able to pick up the silt and scour out for itself a deeper bed and so return to its former régime.

The maximum quantity of silt carried during heavy floods occurs some few hours after the period of maximum flood has been reached, when the detritus from the surrounding country has had time to reach the river bed. It cannot be contended, therefore, that in time of maximum flood when its scouring action is greatest, the water will be already fully charged with silt and unable to pick up any more.

Similarly, when the flood subsides and the reservoir holds still-water a slight deposition of silt must take place throughout the entire water-spread. Such deposition must however be scoured out in the flood of the following year. The flood water must get through, and to do so must scour out any accumulation of silt that tends to bar its progress.

I think it must be conceded that, granting the physical conditions of the river described above to be correct, the reservoir cannot silt. I would, however, go further than this, and say that the river valley at the length selected is narrower and the resulting velocity through the reservoir is greater than is either necessary or desirable. So much has been made of the silt difficulty that in selecting a site for preliminary investigation I took the narrowest part of the valley that I could find.

It is clear that in the upper nine-tenths of the reservoir a flood velocity of from 7 to 3·3 feet per second is much greater than is required for the prevention of silting. To provide the maximum of storage, as wide a water-spread as possible is required at this part, so long as the velocity does not fall below the limiting value at which silt would fall and which may be put at between 2 and 3 feet per second. The theoretically perfect form of valley for a reservoir of this kind would be one which contracted gradually, keeping the cross section of flood discharge at such an area as would maintain a constant rate of flow through the reservoir of about 2½ feet per second. This would combine the maximum of storage capacity with a minimum of silting.

For instance, the capacity of the reservoir 45 miles in length for which preliminary levels have just been taken is not more than 20,000 mills. Whereas by choosing a wide valley for the upper reaches terminating in a bottle-necked approach to the dam a storage of 35,000 to 40,000 mills, should be obtained.

Endeavours will now be directed towards obtaining a suitable site for the dam which will also conform to the above conditions of storage. So many possible sites for a dam appear to be available that no difficulty should be experienced in approximating to these conditions.

With a wide valley at the entrance it is not to be expected that the river entering the water-spread with a velocity of 7 feet per second will at once widen out to the full extent and proceed onwards with a uniform rate of flow over the entire cross section. It will naturally tend to continue its course down the centre where the depth is greatest, but the effect of this rapid flow down the centre will be to set up eddies and circulating currents in the more slowly moving water on the flanks which will tend to keep the silt in suspension. A small deposition of silt on the flanks would not be material as it would not tend to accumulate beyond a certain point.

The limiting velocity of water at which silt will be held in suspension is probably a varying one depending on local conditions such as ratio of depth to width, etc. As an extreme case, the Ellore canal of the Kistna system may be instanced. This canal has a bed width of 35 ft., a depth of about 6 ft. and a surface fall of less than 2 inches per mile. Its velocity must therefore be less than ½ ft. per second, yet it receives the flood water of the Kistna containing $\frac{1}{10}$ of its weight of solid matter and the deposition of silt for 30 miles of its course is insignificant.

This silting question has been discussed at considerable length, as it formed the basis of the only serious opposition to the reservoir project. If, as I venture to hope, this criticism has now been disarmed there remains no further obstacle to actively setting on foot the necessary investigations for the preparation of complete plans and estimates, which investigation will take up the whole of the time and energies of the officer to whom it may be entrusted.

It has already been shown that in the lowest year hitherto recorded there is sufficient surplus discharge in the Kistna to fill the reservoir twenty times over. Also that for many miles the Kistna runs over a rocky bed with steep rocky flanks providing a number of sites for a high masonry dam from which to choose. There remains only one further point to be noted, viz., the question of compensation to the Nizam of Hyderabad along the southern border of whose territory the Kistna runs.

This compensation may be demanded on two grounds, viz., for the water impounded and for the land inundated when the reservoir is full. The former is usually the more complicated question of the two but I think it can be shown in the present instance that, provided the reservoir is situated as far down stream as possible and therefore below all the irrigation sources belonging to the Nizam, no claim can be substantiated.

Were an anicut in question and not a dam then there would be a diversion of water from the river at all seasons whether water were abundant or not. In such case any irrigation below the anicut might reasonably claim to be defrauded of water they had hitherto enjoyed and a case for compensation might be made out by the Nizam's Government.

With a large storage reservoir on a river like the Kistna the case is different. The under-sluices would be open and no water would be stored at all, unless the Bezwada anicut below was surplusing freely, and any water then stored could not have been by any possibility utilised by any irrigation channel between the dam and the Bezwada anicut, but on the contrary would have flowed uselessly into the sea. It would, on the other hand, be easy to show that any such irrigation channel as may exist would be materially benefited by the increased flow from the reservoir. As a matter of fact, however, I believe there are no irrigation channels belonging to the Nizam below the dam. Any irrigation above the reservoir unless submerged is unaffected by the project.

The other question of compensation for land submerged below the maximum water level in the reservoir is one for fair compensation at reasonable rates and not at fancy prices.

As for the cost of the reservoir the masonry may be put at 50 lakhs at a liberal estimate. The 30 stoney shutters discharging through the body of the dam under a head of from 120 to 140 feet may be put at from 10 to 15 lakhs and the cost of the whole, allowing for compensation and all other items, would probably not exceed 75 lakhs of rupees.

Allowing for the cost of the new channels and distributaries to be made in the delta and Nellore, the total cost may be put at 100 lakhs.

The return on this may be calculated as follows :—

The present area of 600,000 acres has been shown to be considerably in excess of that which was with difficulty supplied in 1896, but in good years this area can be somewhat increased. In the next ten years some definite information will become available as to the average safe crop of the Kistna without storage. Put this for the present at 700,000 acres. Then the further increase of 200,000 acres first crop land, to reach the estimated total of 9 lakhs, may be credited entirely to the storage system and its revenue is 10 lakhs of rupees.

The revenue on the 200,000 acres, of second crop, at present rates, would be 8 lakhs of rupees and the revenue from the 100,000 acres of extension in Nellore to be supplied through the

Kurnool-Cuddapah canal would be 4 lakhs. This makes a total revenue of 22 lakhs of rupees paying 22 per cent. on the estimated capital sum at charge of 100 lakhs of rupees.

12. A note on the irrigation of the Kistna delta cannot be considered complete without some allusion to the Kolair lake and the proposals to drain it which crop up from time to time. The Kolair lake is a natural swamp which receives the natural streams, the Budameru and the Tammileru, and also the drainage of a considerable portion of the Gódávari and Kistna deltas. Its only exit for flood waters is the Upputeru, a river which is comparatively narrow and which is for a great part of its section below M.S.L. Two small waterways, the Parantala Kanama and the Juvi-kanama, also connect the lake with the Upputeru. Valuable wet cultivation extends down to the margin of the Upputeru. The Kolair lake acts as a natural flood moderator and allows the water received to pass off gradually down the Upputeru. There is no doubt that owing to the construction of the delta works the flood level of the Kolair lake has been raised.

13. Even were it possible to drain the Kolair lake the result would be that violent floods would pass down the Upputeru destroying the valuable cultivation on its banks.

14. Mr. Walch, when Chief Engineer for Irrigation, laid down in 1890 the principles on which the Kolair lake should be dealt with and although since then two severe floods have occurred they seem to be as true now as they were then and are quoted *in extenso* :—

"There have recently been complaints that the water in this lake rises higher than it did formerly. These complaints are doubtless due to some extent to the recent spread of cultivation round the edge of the lake and on lands below its maximum level, but inquiry and inspection of the main outlets of the lake show that its means of getting rid of its surplus have somewhat deteriorated and that it is advisable to improve them. With this object the Superintending Engineer has made certain proposals which, after visiting the places with him, I approve with certain modifications and he can send in an estimate for them; they are—

"(*a*) Demolishing the old Kotada weir (300 feet long) constructed under the orders of Sir Arthur Cotton in the early days of the Gódávari delta works, when there was no Ellore canal, for the purpose of *holding up water in the lake* during dry seasons for the irrigation of lands round its edges and to enable the lake to be navigated from the Gódávari system of canals, *viâ* the Chinna-kapuram lock, to near Ellore. The extension of the Gódávari and Kistna irrigation channels and the construction of the navigable canals to Ellore have rendered the weir no longer necessary and it was some years ago partly dismantled; a breach was then cut near it which is known as the "Parantala Kanama" and through it the principal discharge of the lake passes directly into Upputeru.

"(*b*) Excavating a channel 100 feet wide to and from the demolished weir, keeping to waste land as much as possible on the lake side and to the old channel from the weir on the Upputeru side.

"(*c*) Opening out the "Junnikanama" by clearance of weeds, etc., excavating as deep as possible without much baling, a channel 100 feet wide from the deep water in the lake near at hand to the stream which conveys the flood water to the Upputeru, and widening the head of that stream for about ½ mile by 50 feet, all spoil to be thrown 50 feet from edge of cutting and no attempt to be made to embank the stream. Besides the two "Kanamas" or outlets from the lake abovementioned there are three others of less importance. The discharge through all of them is much hindered and the channels are being deteriorated by stakes and barriers placed across them by fishermen; this must be put a stop to and the Superintending Engineer will address the Collector on the subject.

"In dealing with this subject it seems advisable to state that no attempt should be made to *drain* the lake and so arrest the silting up which is gradually raising large areas to a level at which they will become properly fitted for cultivation. It should also be remembered that the lake is the "regulator" which absorbs with a moderate rise the vast quantities of water poured into it during the rains for some 2,000 square miles of uplands, passing the accumulated waters gradually and gently into the Upputeru which conveys them to the sea. When the time comes that the lake can no longer thus act as a regulator, the Upputeru will have to be enlarged and embanked and the flood-waters will sweep down it with violence, rising to much above the adjacent lands, which will then be in danger of destructive inundations."

15. A proposal to divert the Badameru into the Kistna has been made, but it was not considered that the work would form any appreciable relief to the Kolair lake while it would undoubtedly be very expensive. Some slight relief might be given by forming more efficient cross drainage to the Polraz canal which now diverts to the Kolair lake water which would not otherwise enter it.

18. The drainage in the Kistna delta is to be taken up by Mr. Howley, the officer on special duty there, when the question of Kolair lake will *inter alia* be systematically gone into. It would at the same time be well to investigate sites for possible reservoirs on the Tammileru to act as flood moderators.

Results of the Penner River Canals System.

Year.	Water-supply. Quantity of water anticipated when the project was sanctioned.	Water-supply. Average quantity of water discharged at head. First crop.	Water-supply. Average quantity of water discharged at head. Second crop.	Acreage. Area (cultivable) commanded.	Acreage. Area for which the work was designed.	Area actually cultivated. First crop.	Area actually cultivated. Second crop.	Duty, i.e., number of acres irrigated per cubic foot per second. First crop.	Duty, i.e., number of acres irrigated per cubic foot per second. Second crop.	Capital cost. Per unit of the quantity of water discharged at head.	Capital cost. Per unit of the average area annually irrigated.	Rate of working expenses per acre charged as irrigated.	Irrigation revenue realised per acre charged as irrigated.
	CUBIC FEET PER SECOND.	CUBIC FEET PER SECOND.	CUBIC FEET PER SECOND.	ACRES.	ACRES.	ACRES.	ACRES.	ACRES.	ACRES.	Rs.	Rs.	Rs.	Rs.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1891-92	1,706 *	512	24	140,000	165,385	167,060	..	107,736	200	28	..	..	..	..	..
1892-93	..	1,495	130	..	..	131,943	676	144,362	92	95	..	..	1·48	3·57	4·02
1893-94	..	(a)1,065	(a) 450	..	..	134,811	7,114	141,925	134	15	..	..	·96	..	..
1894-95	..	1,262	93	..	..	135,625	7,462	142,157	107	83	..	..	·92	4·08	4·08
1895-96	..	1,322	154	..	..	135,825	6,020	141,852	103	30	..	..	·88	4·12	4·12
1896-97	..	618	98	..	..	130,803	10,356	141,164	212	108	..	..	·58	4·17	4·17
1897-98	..	1,088	150	..	..	131,517	8,465	140,052	121	85	..	..	·94	4·09	4·09
1898-99	..	1,196	265	..	..	126,331	7,983	144,314	114	30	..	..	·82	4·13	4·13
1899-1900	..	724	17	..	..	126,148	4,613	130,761	174	272	..	..	·76	4·16	4·16
1900-1901	..	1,021	452	..	..	138,997	12,340	151,337	136	27	..	..	·67	3·77	3·77
Total	..	10,181	1,836	..	..	1,308,589	77,364	1,385,950	..	..	..	..	9·20	40·12	40·12
Average	..	1,018	183	..	..	130,859	7,736	138,595	129	43	7,066	42	·92	4·01	4·01

* Maximum discharge of main canals as designed.
First crop—1st July to 31st January. Second crop—1st February to 31st March.
(a) Administration report figures

PENNER RIVER CANALS SYSTEM.

The Penner river canals system consists of the Nellore system and the Nellore tank together with the Sangam anicut system. The latter anicut is the higher on the river; but it being of more modern date the former has a prior claim to the water which comes down the Penner. The Nellore anicut supplies 64,000 acres, of which about 40,000 is direct irrigation and the balance is supplied from tanks connected with the anicut. The Nellore tank is at present supplied from its own catchment and a supply channel with an open head in the Penner river; but it is to be supplied by a right bank channel from the Sangam anicut. This work is under construction. The Sangam anicut has two main channels (i) the Duvvur which supplies Duvvur tank and a small area of direct irrigation, and (2) the Kanigiri main canal from which the Duvvur canal is taken for direct irrigation, the rest going direct into Kanigiri tank. From Kanigiri tank there are two main channels with direct irrigation under them. They also fill sundry tanks.

2. The surplus channel of the Kanigiri tank forms the Maldevi drain across which there is an anicut which catches up the field drainage and leakage from the tank and supplies Udavalur tank. This tank has also a supply channel from the east main channel. It is however not used until the supply from the Maldevi channel fails. The Alur tank is supplied by the Pyderu river and, when necessary, by a branch from the Eastern main channel. When the new escape to Kanigiri tank is made, it can be supplied from thence also.

3. The above is a brief description of the arrangement of the system. The following is the order in which the water is supplied :—

(1)	Duvvur tank	25 cusecs.
	Duvvur canal	75 „
(2)	Nellore tank	*100 cusecs.
	Nellore anicut	1,000 „

* On the completion of the new supply channel this will be supplied from Sangam anicut.

4. The freshes in the Penner are uncertain and often of short duration so that, although a large quantity of water goes to waste over the Nellore anicut, it is frequently impossible to fill the tanks.

5. The figures giving the duty of water in the accompanying table are particularly misleading inasmuch as a large amount of irrigation is from tanks which receive a supply from their own catchment.

6. Whatever the duty may be, column 3 of the statement shows that the river discharge fluctuates very considerably and the river diagrams also show that a considerable amount of water flows over the Nellore anicut in most years without being utilised (*vide* statement III in appendix H).

7. A good deal is now being done to improve the system first by improving the Kanigiri reservoir and secondly by improving the supply to Nellore tank. The Kanigiri tank is a large reservoir which is practically the key to the Nellore anicut system. Its depth at F.T.L. is 21·45 above the sill of the southern main channel head sluice; but hitherto it has not been deemed safe to fill the reservoir till the end of the north-east monsoon and by that time floods in the Penner have abated. The rule at present is that from 10th October to 15th November water is not to be raised above 17 feet and from 15th November to 25th December it is to be kept below 18 feet. Water has only once risen to 19 feet in the tank and that was by filling sooner than the present rules permit. The following capacities show the amount of storage lost at present:—

	MILLS. C.FT.
Capacity at 16·45	3,870
„ 17·45	4,379
„ 18·45	4,842
„ 21·45 (F.T.L.)	6,419

We see that in most years a storage of 2,000 mills. cubic feet is wasted. An estimate is being carried out to raise and strengthen the bank and to revet it to the top, and also to open a new escape on the extreme left flank. When these works are finished it is intended to fill the tank whenever water is available irrespective of dates.

8. The new supply channel to Nellore tank from the Sangam anicut has already been alluded to. It is also contemplated to raise the Nellore tank level by 3 feet. This will afford largely increased storage, but the estimates for this have not been prepared.

9. Even if the above improvements are carried out there would still be a large amount of water going to waste, and I think it important that every possible site for storing flood water above the Sangam anicut should be investigated. A proposal has been made to form a reservoir at Someswaram, where the Penner enters the district from Cuddapah. There is however no likelihood of good foundations being found there and a large area of valuable land would be submerged by a reservoir at that place. It has also been proposed to form a reservoir on the Biraperu, a tributary of the Penner, which joins it a few miles above the Sangam anicut. The scheme has however been condemned on account of the large area of valuable land which would be submerged and the consequent great expense. The owners of lands in the proposed waterspread also protested strongly. I do not consider that the proposal need be reopened.

10. I think that our best chance of finding sites for reservoirs will be in the Cuddapah district, where there are likely to be sites which cannot conveniently irrigate an *ayacut* of their own immediately below them. An Assistant Engineer has been applied for for investigation in Cuddapah and it will be part of his duty to look for sites with a view to improving the supply to the Penner system.

11. A great deal may also be done by passing down water through the Kurnool-Cuddapah canal during the early part of the year; but this additional supply cannot be looked on as a lasting one as it is quite probable that irrigation may so expand under the Kurnool canal that the lands under it will require all the water which can conveniently be passed down it.

RESULTS of the Kurnool-Cuddapah Canal.

Water-supply.			Acreage.			Duty, i.e., number of acres irrigated per cubic feet per second.		Capital cost.		Rate of working expenses per acre charged as irrigated.	Irrigation revenue realised per acre charged as irrigated.
	Quantity of water anticipated when the project was sanctioned.	Average quantity of water discharged at head.	Area (cultivable) commanded.	Area for which the work was designed.	Area actually irrigated.			Per unit of the quantity of water discharged at head.	Per unit of the average area annually irrigated.		
					First crop.	First crop.	Second crop.				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	C. FT. PER SECOND.	C. FT. PER SECOND.	C. FT. PER SECOND.	ACS.	ACS.	ACS.	ACS.	ACS.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
1891-92 ..	1,488 *	..	..	300,000	80,000 (a)	..	..	..	..	..	..	..	..	..
1892-93 ..	..	1,001 (b)	744 (b)	..	..	97,300	5,952	75,252	67	8	..	..	1·83	1·83
1893-94 ..	..	884 (b)	1,236 (b)	..	..	24,563	6,033	30,596	28	5	..	..	6·50	4·50
1894-95 ..	..	954 (b)	1,255 (b)	..	..	25,165	5,921	31,089	26	5	..	..	4·54	3·77
1895-96 ..	..	503	402	..	..	25,832	6,710	32,542	46	17	..	..	3·27	3·12
1896-97 ..	..	512	444	..	..	25,606	6,236	32,046	50	14	..	..	3·32	3·98
1897-98 ..	..	449	1,000	..	..	27,896	8,466	35,956	173	8	..	..	1·10	1·64
1898-99 ..	..	584	684	..	..	38,226	7,778	46,004	65	13	..	..	2·64	3·19
1899-1900 ..	..	737	1,006	..	..	36,977	10,136	47,113	50	10	..	..	2·42	3·19
1900-1901 ..	..	842	544	..	..	70,326	6,346	76,671	84	12	..	..	1·59	2·32
	..	1,032	930	..	..	48,926	12,550	61,476	45	13	..	..	1·77	2·75
Total ..	..	7,618	8,205	..	..	441,018	75,768	516,724	..	..	..	..	27·98	30·19
Average ..	..	762	821	..	..	44,101	7,571	51,672	58	9	27,784	425	2·80	3·02

* Maximum discharge of main canals as designed.

(a) Area irrigable by the complete project.
(b) River diagrams for these years not being available, the figures have been taken from Statement I-E. of the Administration Report.

NOTE.—First crop—1st April to 30th November.
Second crop—1st December to 31st March.

13

KURNOOL-CUDDAPAH CANAL.

The canal was constructed under a 5 per cent. guarantee by a Company known as "the Madras Irrigation and Canal Company" which was incorporated under an Act of Parliament in 1858. The work was started in 1859 and virtually completed in 1871. Difficulties arose in connection with the working of the canal. The result was that in 1882 the Company's rights and interests in the canal were acquired by the Secretary of State, the sum paid amounting to no less than £1,742,246.

2. In 1887–88, the working expenses exceeded the gross revenue by Rs. 79,424, and the Government of India thereupon remarked that it might be economical to close the canal as an irrigating system, merely keeping it in repair so as to be ready to be put in working order again if a season of drought should create a sudden demand for water. But the Government of Madras strongly deprecated closing the canal. They, however, promised to reduce the cost of the navigation establishment and to effect other petty economies.

3. The canal was inspected in December 1896 by the Inspector-General of Irrigation. The principal questions raised in his inspection notes were :—

(1) The possibility of improving the canal supply at times when the Tungabhadra is low.
(2) The policy of improving and extending the distributaries.
(3) The abandonment of navigation.

4. As regards (1), it was reported that the canal could not be much enlarged without great expense and that it was large enough to carry all the water that would be required for a much larger extent of regular irrigation than then existed.

5. With regard to (2), the Superintending Engineer, III Circle, pointed out that improvements in distribution should be made only on demand by the ryots and suggested that the Velgode, Chepaud and Maidkur projects be carried out. Of these, the last two projects have since been sanctioned. The first is in abeyance, pending improvements to the surplus works through which much waste now occurs.

6. The proposal to abandon navigation on the canal was not approved by the Executive Engineer, the Superintending Engineer and the Chief Engineer for Irrigation. They all urged that, without means of navigation, inspection could not be efficiently carried on and that, on this ground, navigation should not be abolished.

7. The subjoined statement shows the growth of revenue and decrease in working expenses of the canal from 1882–83, the year in which it was taken over by Government :—

Year.	Working expenses (direct charges).	Revenue.	Deficit.	Surplus.
	Rs.	Rs.	Rs.	Rs.
1882–83	1,36,410	78,023	57,387	..
1883–84	1,81,710	42,896	1,38,814	..
1884–85	2,02,520	1,32,286	70,234	..
1885–86	1,80,944	85,000	1,05,944	..
1886–87	1,84,921	65,964	1,18,957	..
1887–88	1,41,440	65 518	75,922	..
1888–89	1,43,046	77,727	65,319	..
1889–90	1,19,566	78,959	40,607	..
1890–91	1,50,439	1,23,566	26,873	..
1891–92	1,23,199	1,42,722	..	19,523
1892–93	1,58,105	1,48,281	9,824	..
1893–94	1,32,472	1,29,440	3,032	..
1894–95	1,01,081	1,13,056	..	11,975
1895–96	98,824	1,39,731	..	40,907
1896–97	86,387	1,43,098	..	56,711
1897–98	1,12,140	1,56,220	..	44,080
1898–99	1,06,273	1,62,315	..	56,042
1899–1900	* 1,23,492	1,86,939	..	63,447
1900–1901	1,09,993	1,77,647	..	77,654

* Includes indirect charges.

Though the financial results attained have been unsatisfactory, it will be seen that there has been a marked improvement in later years.

8. The causes of the failure of the canal are explained in paragraph 80 of the monograph printed with G.O., No. 455 I., dated 10th June 1882. Since then various reasons have been adduced for the failure of the ryots to make use of the canal water, but the principal one is that it does not pay them to do so. A ryot can with a given establishment cultivate with dry crops ten times the area he could irrigate, and as the money returns from rice cultivation are less than twice that from dry crops on good soil, it is not to be wondered at that he prefers the more paying and easier method.

9. The financial results of the system are shown in the accompanying statement. The large fluctuations in the area irrigated are due to water being taken for dry crops in years of scanty rainfall. The great differences in duty are owing to the same cause. In normal years the duty has been very low. This is owing to (1) there not having been in the past much demand for the water, (2) to large quantities having been deliberately sent down the canal in order to tempt the ryots to take it, and (3) to the great percolation through the banks and leakage at the surplus works.

10. It has unfortunately been the fashion for many years past to regard this canal as a hopeless concern only fit to save dry crops in years of deficient rainfall. Quite recently, however, several extensions have been proposed and sanctioned by which water can be taken to lands which will be readily irrigated. Among these may be mentioned the Chepad project designed to irrigate 5,000 acres.

11. The Maidkur project is to irrigate 6,000 acres in Cuddapah district and the Ukkayapalli project to irrigate a small area near Cuddapah. The most important projected extension is, however, the Velgode project. This takes off from the 75th mile of the canal and in its present stage is intended to irrigate 2,900 acres direct and to fill 9 tanks. This appears to me to be the commencement of a most promising project. Along the foot of the Nallamalais is a strip of land, stretching almost down to the canal, eminently suited for wet cultivation. At present there are numerous small tanks, but they are very shallow and the supply to them is precarious. Under these tanks, coarse inferior paddy is grown and it is certain that were a better supply given the water would be utilised. The population is no doubt somewhat scanty, but the channel can be carried on a long distance into the Sirvel taluk, thus serving a large number of villages. The project can be pushed on step by step, but it appears to me to be likely that in the end it may be found advisable to abandon the old line of canal entirely except so far as it may be found necessary to keep up the line of navigation.

12. As the extensions above indicated are carried out, a serious difficulty which has already shown itself will have to be faced. That is the question of supply in years of failure of rain. At such seasons there is great demand for the canal water on the part of the growers of dry crops in the upper reaches, with the result that the supply, which is below the normal, fails to reach the regular cultivator at the lower end who has in all equity a prior claim to the water. This difficulty has already been alluded to by the Chief Engineer for Irrigation in his note printed with G.O., No. 851 I., dated 8th October 1900, but nothing has been done to meet the difficulty. The most obvious remedy for it is to make the casual user pay for the privilege. The grower of dry crops on land commanded by the canal is at present "on velvet". In normal years he gets good returns from his dry crops, and when rain does fail he can take what water he wants at the nominal charge of Re. 1 per acre. Considering the prosperity of these ryots and the value to them of the water that they take when it can least be spared, there would be no injustice or hardship in raising the rate 300 or 400 per cent. This would, I think, be better than charging them an annual rate which would give them a claim.

13. In addition to this the canal should be made as watertight as circumstances will permit and the surplus works brought into as efficient a state as possible so that a depth of 7 feet might be passed down the canal at all seasons when water is available. An estimate for remodelling all the weirs is under preparation and should be carried out as soon as possible. At present this is only done during the month of November, and considering the present state of the weirs and surplus sluices it would no doubt be unwise to raise the water above 6 feet on the rear gauge during September

and October when heavy rain may be expected. There appears to me to be no reason why a depth of 7 feet should not be kept up during July and this water although not used for the system itself would be of great use in filling tanks in Nellore district if passed down the Penner from the Adinayamapalli anicut. It is probable that a considerable extension of wet cultivation can be made, but it cannot be successful unless the following points are attended to:—

(1) The leakage is stopped as far as possible.
(2) The duty is increased by careful regulation.
(3) The supply of water to dry crops is curtailed.

14. The above recommendations are made without any reference to the proposed reservoir on the Tungabhadra. The consideration of the part the Kurnool canal may play in any such scheme is reserved for the section of the report in which that project is dealt with.

RESULTS of the Barur Tank Project.

Water-supply.		Acreage.						Capital cost.		Rate of working expenses per acre charged as irrigated.	Irrigation revenue realized per acre charged as irrigated.
		Area (cultivable) commanded.	Area for which the work was designed.	Area actually irrigated.			Duty (i.e.) supply per acre irrigated.	Per unit of the quantity of water rendered available.	Per unit of the average area annually irrigated.		
Quantity of water anticipated when the project was sanctioned.	Quantity of water rendered available for irrigation.			First crop.	Second crop.	Total.					
1	2	3	4	5	6	7	8	9	10	11	12	13
	MILLS. OF C. FT.	ACS.	ACS.	ACS.	ACS.	ACS.	MILLS. C. FT.	RS. PER MILL. C. FT.	RS. PER ACRE.	RS.	RS.
	* 6,800	† 5,796	† 5,796	1,687	549	2,236	1·86			2·96	2·71
1891–92	4,169·31			2,062	1,039	3,101	·44			1·40	2·58
1892–93	1,361·23			2,324	1,434	3,758	·34			1·13	2·55
1893–94	1,396·22			2,375	1,168	3,543	·15			1·09	2·64
1894–95	625·78			2,444	957	3,401	·54			0·90	2·61
1895–96	1,834·85			2,389	1,214	3,763	·34			0·97	2·60
1896–97	1,378·38			2,608	1,011	3,619	·24			0·87	2·63
1897–98	861·32			2,736	1,072	3,808	·19			0·56	2·43
1898–99	708·56			2,872	1,409	4,281	·18			0·58	2·40
1899–1900	749·64			2,841	997	3,838	·43			1·01	2·48
1900–1901	1869·60										
Total ..	14,448·76	..	..	24,488	10,850	35,338	..	..	..	11·47	25·53
Average ..	1,414·26	..	..	2,449	1,085	3,534	·41	295	124	1·15	2·55

* Represents quantity of water expected to drain off the catchment area at the sill of Tengal anicut.

† Represents the irrigable area of the project.

15

BARUR TANK PROJECT.

The project was undertaken in August 1877 as a famine-relief work. It was intended to improve and enlarge the Barur tank and to provide it with a supply from the Ponniar. It was estimated that an extent of 5,430 acres of dry lands would be brought under the project, besides 1,457 acres of wet lands already irrigated by tanks and other sources which merged in the scheme. The works were fully completed in 1892.

2. The results of the system are shown in the accompanying statement.

3. The growth of irrigation under the project has been very slow. Mr. Walch in his inspection notes of April 1891 commented upon this slowness, the reasons for which were stated to be—

(1) that the owners of "dry" lands commanded by the project often could not get the labour, or could not afford, to convert them into "wet", but would not relinquish the pattas in favour of outsiders who would be willing to bring both capital and labour; and

(2) that there was an order of the Board of Revenue to the effect that waste lands commanded should be rented only on "Eksala" pattas and that on such tenure people would not spend money for preparing land for wet cultivation.

4. The matter was referred to the Revenue Department for consideration.

5. It was observed that the irrigable area had been differently estimated by officers, and a correct list of the area commanded was called for. This, after proper survey, was ascertained to be 5,796 acres, of which the old irrigation amounted to 1,328 acres.

6. The order relating to "Eksala" pattas was subsequently cancelled.

7. As regards the first reason given, viz., want of capital and labour, the Collector reported in 1897 that the Chief Engineer was not correct and that the real reason was the uncertain and insufficient state of the supply of the project. This view was shared by Mr. O'Connell, then Executive Engineer, who suggested that the supply to the tank be improved and its capacity increased. To this end the Superintending Engineer, Mr. Hannan, proposed to raise the anicut. He stated that it was unnecessary to increase the capacity of the tank.

8. The Chief Engineer for Irrigation thereupon observed that the practice of raising anicuts to a greater height than that provided in the original designs had been found open to very great objections. He considered that, if it was proposed to improve the supply to the tank by increasing the full supply depth in the channels, it should be seen whether falling shutters could not be fitted on the anicut crest.

9. In reply, the Executive Engineer, Mr. Murray, submitted a full report on the subject. He showed that the present capacity of the tank was sufficient for what was required of it. He stated that, in the year 1900 which was a very unfavourable one in consequence of the failure of the north-east monsoon, the tank had water in it after all cultivation was over. The Executive Engineer pointed out that the irrigated area would slowly but steadily increase, but that it would never reach the figure calculated when the project was sanctioned. This, he said, was due to there being a large area of land, especially under the east side channel, to which water could be sent from the tank, but which would never be irrigated owing to want of population, unsuitability of soil, and want of money to convert the sloping land into terraces suitable for wet cultivation. Mr. Murray's views are thus at variance with those of a former Collector and a former Executive Engineer.

10. The Chief Engineer for Irrigation thereupon remarked that what was wanted was to encourage the extension of irrigated area and that, when the area became so large as to be badly supplied, it would be time enough to consider the question of improving the tank or the channel.

11. The project not having fulfilled the conditions of a productive public work, all current capital outlay thereon is met from Provincial funds.

12. The accompanying statement B, provided by the Executive Engineer of Salem district, shows that the tank is almost invariably full from September until December, but that no supply is received after that until May or June. The capacity of the tank is stated to be 540 mills. c. ft. There is therefore only enough water available for about 3,000 acres of second crop, and if there is any chance of this area being largely exceeded, the tank must be enlarged.

13. The reason of the failure to increase the area of first-crop cultivation is fairly well ascertained. The lands under the west main channel are already occupied to the full extent anticipated, but under the east main channel there are still considerable areas commanded which are not cultivated. This country is composed of poor soil and owing to its sloping character needs much labour and capital to fit it for cultivation. The population is scanty and attempts to import labour have not been successful. The above is the chief reason for failure to extend first-crop irrigation, and the subsidiary reasons are—

(1) That a large area of the land is held on compounded assessment and it is not cultivated because the holder fears there is not enough water for second crop. (I have not very accurate information about this and the Collector has been consulted.)

(2) It is also stated that the holders of land which is assessed on the compounded assessment do all they can to discourage extension of irrigation fearing that there will not be enough water for their second crop.

14. The recommendations I would make with regard to this system are—

(1) The abandonment as far as possible of compounded assessment, especially with regard to newly-taken-up lands.

(2) Instruction of the ryot on the best method of preparing the lands for cultivation by manuring, etc.

(3) The grant of favourable terms in the matter of remission of water-rate for a series of years to enable the land now lying waste to be brought under cultivation.

(4) An enquiry to be made as to what the probable extension of second-crop cultivation would be. If it is found to materially exceed 3,000 acres, the tank should be enlarged. It is believed that there will be no great difficulty in this respect.

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Statement B.

Supply received in the Barur tank, available for irrigation.

Year.	Month.	Million cubic feet at Nedungal head sluice.	Number of acres for which there is sufficient water.
1894	January	267 (full)	3,000 acres.
	May	71 (full)	
	June	117 (full)	
	July	67	
	August	62	
	September	216 (full)	7,500 acres.
	October	152 (full)	
	November	84 (full)	
	December	(full)	(no surplus).
1895	January	21	2,500 acres.
	February	59 ½ full	
	May	89	
	June	79	
	August	13	
	September	272 (full)	7,500 acres.
	October	(full)	
	November	70 (full)	
	December	100 (full)	
1896	January	27	1,800 acres. Actual area irrigated 2nd crop = 1831.
	June	165	
	July	120	
	September	272	
	October	18 (full)	7,500 acres.
	November	46 (full)	
	December	100 (full)	
1897	January to May		1,700 acres. Area of 2nd crop = 1,757 acres.
	June	122	
	July	61	
	August	35	
	September	290 (full)	7,500 acres.
	October	191 (full)	
	November	18 (full)	
	December	46 (full)	
1898	April	47	2,500 acres.
	May	99	
	June	38	
	September	290 (full)	7,500 acres.
	October	18 (full)	
	November	18 (full)	
	December	18 (full)	
1899	April	38	3,000 acres.
	May	276 (full)	
	June	311 (full)	
	September	290 (full)	7,500 acres.
	October	18 (full)	
	November	full	
	December		

Results of the Cauvery Delta System.

	Water-supply.		Acreage.			Capital cost.		Rate of working expenses per acre charged as irrigated.	Irrigation revenue realised per acre charged as irrigated.
			Area (culturable) commanded.	Area for which the work was designed.	Area actually irrigated.				
	Quantity of water anticipated when the project was sanctioned.	Average quantity of water discharged at head.				Per unit of the quantity of water discharged at head.	Per unit of the average area annually irrigated.		
		First crop.	Second crop.		First crop.				
1	2	3	4	5	6	7	8	14	15
	C. FT. PER SECOND.	C. FT. PER SECOND.	C. FT. PER SECOND	Acs.	Acs.	Acs.	Rs.	Rs.	Rs.
	Natural river.	..	..	865,342	868,342	..	..	..	..
1891-92	..	11,078	568	..	..	862,178	..	0·37	3·06
1892-93	..	12,396	769	..	..	872,024	..	0·34	3·07
1893-94	..	14,738	1,489	..	..	868,962	..	0·35	3·25
1894-95	..	11,260	351	..	..	855,258	..	0·46	4·58
1895-96	..	15,858	1,174	..	..	858,349	..	0·46	4·60
1896-97	..	17,193	2,868	..	..	851,568	..	0·47	4·39
1897-98	..	18,074	890	..	..	855,412	..	0·44	4·38
1898-99	..	13,128	2,174	..	..	856,124	..	0·46	4·37
1899-1900	..	*7,808	*45	..	..	758,094	..	0·45	4·00
1900-1901	..	20,735	506	..	..	851,775	..	0·48	4·39
Total ..	..	140,268	10,784	..	..	8,566,744	..	4·78	46·09
Average ..	..	14,027	1,078	..	..	856,974	..	·48	4·61

	Area actually irrigated.			Duty, i.e., number of acres irrigated per cubic foot per second.			Capital cost.		Irrigation revenue realised per acre charged as irrigated.
	First crop.	Second crop.	Total.	First crop.	Second crop.		Per unit of the quantity of water discharged at head.	Per unit of the average area annually irrigated.	
	8	9		10	11		12	13	15
	Acs.	Acs.		Acs.	Acs.		Rs.	Rs.	Rs.
1891-92	..	..	..	..	..	..	..	..	..
1892-93	94,630	956,808	78	167	..	..	..	..	3·06
1893-94	94,550	966,264	70	123	..	..	..	..	3·07
1894-95	108,802	962,764	58	72	..	..	..	..	3·25
1895-96	101,087	956,345	76	280	..	..	..	..	4·58
1896-97	97,626	955,075	62	91	..	..	..	..	4·60
1897-98	91,536	943,104	50	82	..	..	..	..	4·39
1898-99	99,107	954,519	47	111	..	..	..	..	4·38
1899-1900	105,760	961,884	65	49	..	..	..	..	4·37
1900-1901	89,639	877,733	101	1,986	..	..	..	..	4·00
	93,479	945,264	11	157	..	..	..	..	4·39
	970,926	9,480,670	..	..	..	..	..	..	46·09
	97,093	948,067	61	90	..	†163	† 2	·48	4·01

* Administration report figures are—first crop, 10,290; second crop, 509.
† The capital cost is low as the system is only an old work remodelled.
Second crop, 1st December to 31st March
Note.—First crop, 1st June to 30th November. They agree approximately with the figures given in the Administration reports, in all the years except
The discharges shown in columns 3 and 4 above have been calculated from the river diagrams.
899-1900.

CAUVERY DELTA SYSTEM.

The results of the system are given in the accompanying statement, but they are more than usually inaccurate for the following reasons:—

(*a*) The division of first and second crop follows that adopted in the administration report. The actual practice, however, is to grow a short 3 months' crop from beginning of July and a 5 or 6 months' crop after it. But even this practice is not rigidly adhered to, and as a matter of fact there are some crops on the ground nearly all the year round.

(*b*) The figures given in columns 3 and 4 of the statement show the amount of water which enters the delta at the Cauvery-Vennar regulators, but give no idea of the amount actually utilized. When the river is in fresh, from 20 to 40 per cent. more water passes down the river than is actually used; and at other times the supply is considerably augmented by local rainfall and drainage.

In these circumstances it is useless discussing the variations shown in the statement. The main facts to be borne in mind are that while there is a superabundant supply during July and August, there is often a slight deficiency of water in September and that there is also a great demand for water in the latter portion of the year in the case of the north-east monsoon failing or bringing less than its normal quantity of rain.

The following note by Colonel Smart, R.E., describes what has been proposed to be done to utilize the present surplus:—

Extension of irrigation under the Cauvery and its branches is only possible now by storage of surplus waters running to waste into the sea, as measured at the Lower Coleroon anicut and outfalls into the sea in the district. Statement A gives the discharges in millions cubic feet of all water over 6 C.D. measured at the Upper anicut; it may be said generally that in a bad year, two-thirds of this may be regarded as surplus available for storage. It is believed that the actuals are considerably greater than the calculated quantities. It will be seen that in 5 out of 6 years there is a very large surplus and that the possibilities of storage are great.

In my opinion we should have a storage work on the Bhavani to contain, say, 10,000 millions cubic feet, one on the Amaravathi to contain, say, 5,000 millions cubic feet, and one on the Cauvery to contain 30,000 millions cubic feet. The Bhavani and Amaravati works should be used for irrigation in Coimbatore, the Cauvery work for irrigation in the delta of Tanjore and in those parts of the districts of Tanjore and Trichinopoly now regarded as outside the delta proper. All these works should be built to discharge floods through sluices, as in the Nile case, in order to reduce the deposit of silt to a minimum. I have some reason to believe that the Bhavani work should be in the upper basin so that the water may be brought out on to the Coimbatore plain somewhere between the towns of Coimbatore and Méttupálaiyam; this requires further investigation. See, however, Mr. Fraser's report printed with G.O., No. 599, dated 22nd February 1870. The Amaravati work may be on any suitable site on the river near the Hills. The Cauvery work should either be at Pogalore or Neringepet.

Investigation has now been completed so far of a Bhavani work to contain 27,000 millions cubic feet and of the distributary works for new irrigation under the so-called Vadavar-Pattukkóttai extension. In the case of storage for Tanjore being on the Bhavani, the area of new irrigation is to be restricted to 90,000 acres; with a Cauvery work it may be fixed at a maximum of 300,000 acres.

Vadavar-Pattukkóttai Extension.—This part of the storage project has been practically completed. It is simply an enlargement of the present Vadavar and its extension and final outfall into a large and new terminal tank close to the town of Pattukkóttai—capacity 3,000 millions cubic feet—which may perhaps be reduced on further investigation to 1,500 millions cubic feet. The area to be irrigated by the distributaries as worked out has been fixed at 120,000 acres direct (including 20,000 old) irrigation and 60,000 acres under the tank. There are also about 50,000 acres available for new irrigation in the delta proper.

Ponnéri Project.—Is now under investigation; was originally proposed by Sir Arthur Cotton. It is doubtful, so far as the investigations have gone, whether this project can ever be classed as "productive"; it may be "famine protective." The channel will have its head close to the Upper anicut and will be taken along the north bank of the Coleroon to supply three tanks of some size, probably with a total capacity of 8,000 to 10,000 millions cubic feet and capable of irrigating 50,000 acres. An alternative has been proposed and that is to supply the first or Nandiyar tank by the channel from the anicut and then to take off another channel from the Coleroon from a regulator to be constructed across that river for the supply of two tanks as shown on the survey. It is impossible to say at present which is likely to prove the best project. Unfortunately the ground slopes down and drains into the Coleroon so that the area of land commandable between channel and river is not very great.

Line of Cutlay Channel.—Very little is known of this project; we have a few levels up to and just beyond Trichinopoly. It is known that a large area is commanded on the table land between Sanjipatti and Vallam and again in the valleys of the Vellaur and Umbylliar discharging into the sea in the Pattukkóttai taluk; whether, however, a feasible line of channel can be formed through the Pudukkóttai territory and whether storage is possible are both at present uncertain. Investigation alone can prove whether any extension of irrigation is possible on this side. The irrigation must be from tanks, and can in no case be direct.

STATEMENT A.

Table of discharges in millions cubic feet, Cauvery dam, over 6 feet from June to 15th October and over 5 feet from 16th October to end of December, Upper anicut and Lower anicut (using Major Montgomerie's table of discharges for Lower anicut).

Years.	June.				July.				August.				September.			
	C.D. over 6 feet.	Upper anicut.	Total.	Lower anicut discharges.	C.D. over 6 feet.	Upper anicut.	Total.	Lower anicut discharges	C.D. over 6 feet.	Upper anicut.	Total.	Lower anicut discharges	C.D. over 6 feet.	Upper anicut.	Total.	Lower anicut discharges.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1876	..	..	..	..	48,217·24	45,256·32	93,473·56	48,244	15,002·49	14,273·28	29,275·77	34,604	10,406·88	9,724·32	20,131·20	14,583
1877	20,406·81	21,725·28	42,132·09	24,527	6,745·24	6,186·24	12,931·48	15,860	14,117·76	12,182·40	26,300·16	14,254	16,241·47	11,331·36	27,572·83	18,075
1878	..	201·04	201·04	292	4,911·84	3,866·40	8,778·24	6,033	22,067·42	21,712·32	43,779·74	37,194	15,967·58	13,857·69	29,825·27	20,702
1879	11,524·89	11,378·83	22,903·77	16,025	40,481·85	33,505·92	73,987·77	58,064	33,626·88	24,334·56	57,961·44	45,093	19,175·61	17,128·80	36,304·41	29,607
1880	..	..	..	..	40,820·54	37,687·68	78,508·22	26,792·64	26,792·64	24,788·16	51,580·80	23,270	1,111·96	1,105·92	2,217·88	2,661
1881	..	..	..	..	15,780·96	14,130·72	29,911·68	16,897	16,897·24	16,549·92	33,447·16	20,670	1,111·10	725·76	1,836·86	4,294
1882	49,357·72	54,332·64	103,690·36	87,762	153,945·79	177,932·16	331,877·95	281,230	56,782·08	59,011·20	115,793·28	100,365	14,992·12	11,525·76	26,517·88	20,480
1883	..	..	..	..	62,316·00	62,951·04	125,267·04	100,236	32,028·46	28,157·76	60,186·24	60,738	26,186·11	24,585·12	50,771·23	70,624
1884	..	..	..	..	3,114·72	2,596·32	5,711·04	4,227	33,597·50	25,522·56	59,120·06	36,052	17,917·63	19,474·56	37,392·19	41,914
1885	2,316·38	2,013·12	4,329·50	2,487	22,648·89	20,312·64	42,961·53	24,142	33,670·94	35,691·84	69,362·78	55,290	..	..	..	1,675
1886	10,524·38	10,164·96	20,689·34	14,694	32,190·04	31,440·96	63,631·00	63,778	17,172·86	13,776·48	30,949·34	59,503	9,752·83	8,078·40	17,831·23	19,996
1887	3,187·29	3,836·16	7,023·45	14,261	24,505·63	24,451·20	48,956·83	70,165	..	..	..	3,342	555·55	712·80	1,268·35	2,883
1888	2,967·00	2,622·00	5,589	502	37,270	34,806	72,076	46,856	16,015	13,798	29,813	21,764	1,483	1,053	2,536	2,059
1889	..	103	103	..	21,586	21,301	42,887	36,589	19,079	16,372	35,451	21,633	40,509	35,942	76,451	64,964
1890	..	..	..	155	21,480	21,363	42,843	32,236	13,889	11,348	25,237	17,007	..	60	60	491
1891	..	..	..	..	42,274	43,130	85,404	49,092	24,120	27,337	51,457	43,088	185	371	556	50
1892	371	38	409	..	64,460	70,320	134,780	103,655	25,076	21,306	46,382	55,727	8,870	7,456	16,326	12,044
1893	9,444	8,208	17,652	6,928	2,040	2,311	4,351	2,608	11,685	10,614	22,299	11,486	4,614	4,259	8,873	4,779
1894	2,503	2,108	4,611	1,810	22,230	23,772	46,002	39,081	9,462	8,169	17,631	18,173	..	..	..	1,881
1895	18,578	18,276	36,854	26,815	14,626	14,510	29,136	19,541	36,175	35,929	72,104	72,751	1,669	1,272	2,941	2,979
1896	37,065	43,675	80,740	66,650	86,898	93,908	180,806	165,679	97,949	107,568	205,517	207,727	3,801	3,304	7,105	6,067
1897	26,802	27,345	54,147	27,625	35,929	38,406	74,335	51,480	96,939	105,537	202,476	166,373	31,086	30,348	61,434	68,595
1898	7,386	6,082	13,468	5,370	17,534	18,959	36,493	19,329	12,287	11,724	24,011	22,794	11,954	11,154	23,108	13,245
1899	11,964	11,862	23,826	13,343	19,600	17,337	36,937	19,075	278	280	558	..	8,329	7,011	15,340	6,951

The discharges over Lower anicut, when uncomplicated by rain in the Coleroon basin, represent "nomal" surplus discharged waste to sea. There is no offtake for irrigation below Lower anicut.

STATEMENT A—*cont.*

Table of discharges in millions cubic feet, Cauvery dam, over 6 feet from June to 15th October and over 5 feet from 16th October to end of December, Upper anicut and Lower anicut (using Major Montgomerie's table of discharges for Lower anicut)—cont.

Years.	October. C.D. over 6 feet up to 15th and then over 5 feet.	October. Upper anicut.	October. Total.	October. Lower anicut discharges.	November. C.D. over 5 feet.	November. Upper anicut.	November. Total.	November. Lower anicut discharges.	December. C.D. over 5 feet.	December. Upper anicut.	December. Total.	December. Lower anicut discharges.	Total south-west monsoon (June to 15th October).	Total north-east monsoon (16th October to December).
	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1876 ..	..	90·7	90·7	160	..	..	..	..	..	..	..	..	142,970·60	..
1877 ..	56,382·04	15,379·20	71,761·24	99,634	58,773·60	47,187·36	105,960·96	99,214	18,186·36	5,412·96	23,599·32	22,719	141,334·56	168,923·52
1878 ..	25,919·99	27,423·36	53,343·35	32,804	1,586·30	7,456·32	9,042·62	7,488	..	..	..	..	18,228·29	46,741·97
1879 ..	7,305·12	2,168·64	9,473·76	3,330	9,405·50	1,010·88	10,416·38	2,832	..	..	..	..	191,157·39	19,890·14
1880 ..	23,238·14	12,817·44	36,055·58	11,230	45,373·82	27,518·40	72,892·22	18,191	21,165·40	11,780·64	32,946·04	..	133,133·90	141,066·84
1881 ..	184·89	293·76	478·65	2,816	5,271·26	760·32	6,031·58	313	..	..	..	2,235	65,656·70	6,049·22
1882 ..	38,657·94	24,935·04	63,592·98	49,504	19,793·37	4,207·68	24,001·05	19,240	4,235·36	352·48	4,587·84	1,841	587,179·49	82,857·87
1883 ..	29,749·24	18,649·44	48,398·68	67,242	45,010·94	26,529·12	71,540·06	81,265	6,654·52	1,270·08	7,924·60	5,112	242,131·51	121,956·34
1884 ..	19,111·67	8,557·92	27,669·59	24,617	18,879·26	6,156·00	25,035·26	19,122	10,682·49	5,698·08	16,380·57	20,106	103,695·29	67,613·42
1885 ..	25,876·80	11,486·68	37,363·48	39,983	7,077·88	1,499·04	8,576·92	12,460	3,030·04	142·56	3,172·60	35,183	127,744·81	38,022·00
1886 ..	793·15	..	793·15	1,880	12,309·26	4,104·00	16,413·26	14,121	..	..	..	..	133,900·91	17,296·41
1887 ..	33,416·06	25,315·20	58,731·26	38,571	28,885·24	9,646·56	38,531·80	31,547	7,758·00	1,576·86	9,334·86	..	9,679·63	64,196·95
1888 ..	92	241	333	2,791	11,683·97	2,825	6,070	6,141	..	..	..	1,967	110,347·00	14,509·25
1889 ..	62,904	53,749	116,653	116,679	864	..	864	116	..	..	..	817	206,185·00	66,224·00
1890 ..	10,300	8,467	18,767	12,416	32,237	21,656	53,893	51,500		..	..	..	68,192·00	72,608·00
1891 ..	20,111	8,527	28,638	19,928	1,180	518	1,698	9,508	..	..	..	67	135,869·00	31,864·00
1892 ..	6,574	682	7,256	2,283	..	..	..	..	..	..	..		197,897·00	7,255·00
1893 ..	38,845	25,604	64,449	50,071	31,046	16,235	16,281	67,081	856	..	856	786	77,967·00	86,794·00
1894 ..	10,583	2,769	13,352	6,634	5,763	946	6,709	2,969	..	..	..	36	68,544·00	44,901·00
1895 ..	16,744	7,914	24,658	13,947	19,525	10,860	30,385	54,588	1,462	552	2,014	6,985	148,085·00	32,007·00
1896 ..	6,859	5,399	12,258	12,203	5,529	812	6,341	5,350	7,572	1,752	9,324	2,488	180,842·00	21,229·00
1897 ..	87,180	82,093	69,273	78,596	207	..	207	131	..	..			413,420·00	48,452·00
1898 ..	36,770	25,315	62,085	43,480	49,910	35,199	85,109	86,254	7,254	1,261	8,515	18,750	118,037·00	134,752·00
1899 ..	..	..	..	1,519	..	..	..	26	..	..	..	36	76,661·00	*Nil.*

BHAVÁNI PROJECT.

Full information regarding this project has been laid before the Inspector-General of Irrigation, and orders have been issued by the Government of India directing the lines on which further investigation should be made. It is, therefore, only necessary for me to attempt to state here for the benefit of the members of the Commission who have not had time to study the subject the broad features of the scheme, referring them for details to the report and other papers on the subject now before the Government of India. In 1884 the late Captain Romilly, R.E., submitted an estimate amounting to Rs. 44,50,000 (for works) for forming a reservoir on the Bhaváni, 4 miles above Satyamangalam. This reservoir was to have a capacity of 26,000 millions cubic feet.* With its aid 20,000 millions cubic feet were to be passed to the Cauvery in September and October to supplement the supply to existing irrigation in Tanjore and an area of 70,000 acres of new land were to be irrigated. Of this 20,000 acres were to be under existing Bhaváni channels and 50,000 under a new channel from the reservoir. This scheme, Mr. Hughes states, is defective in two ways—

(1) It took no account of the extent to which Tanjore is dependent on the Bhaváni.

(2) The calculations were based too much on averages, which have always to be used with the greatest caution when the supply is fluctuating and especially where a proposed work is of a protective character.

These estimates were never finally dealt with, but the project was taken up again in 1892 and the following years, when considerable discussion took place as to the best site for a dam and to the way in which the water should be utilized. The former question was satisfactorily settled by a committee of Engineer officers; with regard to the latter question opinion is not so unanimous. The project in its present form omits all consideration of the cultivation of Coimbatore and provides for all the extension being carried out in Tanjore. The following are the reasons which led to this decision:—

(1) The country in Coimbatore which would be commanded is undulating and it is difficult and expensive to command any appreciable area of land.

(2) Owing to the fact that there is plenty of water available in the Cauvery for many months it would only be necessary to supply water from the reservoir for new irrigation in Tanjore for two months in the year; a very much larger area could therefore be taken up in Tanjore than in Coimbatore.

(3) The cost of distribution would be much less in Tanjore.

The above reasons may be summed up in the general statement that although it would be very desirable to irrigate the dry district of Coimbatore, the only way to make the reservoir pay would be to devote the whole supply to the extension of cultivation in Tanjore where, although protection is not so much required, the water can be much more profitably used from a financial point of view.

As soon as it is proposed to abandon the idea of irrigating Coimbatore from the water of the Bhaváni, the question at once arises, is the Bhaváni the best place to make a reservoir. An alternative proposal has been made to construct a reservoir on the Cauvery at Nerinjipet, which would have obvious advantages over the Bhaváni site. The catchment area of the Bhaváni at the proposed site is 1,650 square miles, whereas that of the Cauvery at Nerinjipet is 16,700. The Bhaváni reservoir would impound such a comparatively small portion of the floods that very careful and somewhat complicated arrangements have to be made for working the reservoir to enable it to supply a sufficient area to warrant its being classed as productive. Mr. Hughes has elaborated a scheme by which this can be done, but his proposals have been challenged. A reservoir on the Cauvery would not be open to this objection; and although there have been no detailed investigations, it is probable that a dam to impound the necessary quantity of water could be constructed for approximately the same cost as on the Bhaváni. Mr. Hughes, however, rejected this proposal on account of the great deposit of silt that would occur which would not only choke up the reservoir, but would seriously diminish the fertilizing properties of the Cauvery water on which much of the success of the Tanjore irrigation is said to depend.

It is believed that this slight explanation will assist readers in understanding the memorandum on the subject by the Inspector-General of Irrigation, in which all the important points at issue are dealt with and in which clear instructions are given for further investigation. It appears to me, therefore, that it will be unnecessary for the Commission to go into the details of this difficult and complicated question.

* The reservoir proposed by Mr. Hughes is to contain 27,000 millions cubic feet.

RESULTS of the Srivaikuntam Anicut System.

Year.	Water-supply.		Average.										Irrigation revenue realised per acre charged as irrigated.
	Quantity of water anticipated when the project was sanctioned.	Quantity of water rendered available for irrigation.			Area actually irrigated.		Duty of supply per acre irrigated.		Capital cost.		Rate of working expenses per acre charged as irrigated		
		First crop.	Second crop.	Area (culturable) commanded.	Area for which the work was designed.	First crop.	Second crop.	First crop.	Second crop.	Per unit of water rendered available.	Per unit of the average area irrigated.		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	CUBIC FEET PER SECOND. 1860(a)	MILLS. CUBIC FEET.	MILLS. CUBIC FEET.	ACS.	ACS.	ACS.	ACS.	MILLS. CUBIC FEET.	MILLS. CUBIC FEET.	Rs.	Rs.	Rs.	Rs.
1891–92	..	5,287	3,481	27,798	..	20,879	..	·25	·24	..	..	0·56	4·54
1892–93	..	5,016	1,500	..	..	16,426	11,422	·24	·13	..	..	1·17	4·71
1893–94	..	7,953	1,649	..	..	20,600	12,826	·39	·12	..	..	0·93	4·46
1894–95	..	7,168	1,281	..	..	20,669	11,606	·36	·12	..	..	0·94	4·59
1895–96	..	3,432	2,997	..	..	20,454	11,285	·17	·27	..	..	1·17	4·67
1896–97	..	3,440	4,047	..	..	19,819	15,609	·17	·32	..	..	2·21	4·63
1897–98	..	5,043	6,875	..	..	20,043	18,054	·25	·38	..	..	1·12	4·59
1898–99	..	6,761	2,514	..	..	20,302	13,133	·32	·19	..	..	1·01	4·46
1899–1900	..	2,978	3,742	..	..	20,698	14,765	·14	·23	..	..	1·02	4·66
1900–1901	..	5,254	6,679	..	..	21,954	20,692	·25	·32	..	..	·74	4·46
Total	..	52,302	35,524	..	..	201,344	142,987	844,311	..	..	..	11·26	45·78
Average	..	5,230	3,552	..	..	20,134	14,299	34,183	·26	169	43	1·13	4·58

Note.—First crop—1st November to 30th April. Second crop—1st June to 31st October.

(a) Maximum discharge of main canals as designed.

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SRIVAIKUNTAM ANICUT SYSTEM.

The statement appended shows the financial results of the system. The following are the only noticeable variations.

Acreage.—As compared with the average, there was a fall of 5,773 acres in 1892–93 and an increase of 4,456 acres in 1897–98. The former was due to the unfavourable character of the season, while in the latter case it was specially favourable for cultivation.

Working Expenses.—The abnormal increase in the working expenses in 1896–97 was a result of the heavy expenditure incurred in restoring works which were damaged by floods.

Duty.—The supply per acre irrigated fluctuates widely and is in some cases much in excess of the theoretical supply required at 2 cubic yards per hour.

The discharges shown in columns 3 and 4 are the total calculated monthly discharges through the head sluices at Srivaikuntam anicut. The tanks in which this water is stored also receive a supply from the local rainfall. The duty would therefore appear to be very low in this system; but it is probable that, owing to silt, the discharges through the head sluices are largely overestimated. It is also probable that in years of large discharges during the pishanam period there is also heavy local rainfall and that the tanks are not large enough to contain the supply.

2. The most striking feature of this system is the high proportion which second crop cultivation bears to the first. It would be still greater, if the supply of water during the south-west monsoon were not so scanty and uncertain as it is. It should be explained that in this system a short or kar crop is first grown followed by the pishanam or five months' crop. In the accompanying table the area shown as first crop is cultivated from 1st November to 30th April and second crop from 1st June to 31st October.

3. An examination of the river diagrams shows that the time when water is generally deficient is the month of September, and to supplement this it has been proposed to construct a reservoir on the Tambraparni just above the falls at Pápanásam. The catchment area at this point is only 160 square miles; but it has a heavy rainfall in both monsoons. Levels have been taken, but the investigation is not sufficiently advanced to give any idea of the height of the dam or capacity of the reservoir. It is stated that its construction will involve the submersion of a great deal of valuable forest, but I could not obtain any idea as to the amount, and until the waterspread of the proposed lake is ascertained, it would be impossible to form any estimate. It is believed that no reconnaissance of the Pachiar and Manimuthar tributaries have been made. These should be investigated to see if alternative or supplemental sites cannot be found. The project is not likely to be a remunerative one as the returns will not be very great. The officers of the Revenue Department have estimated Rs. 80,000, but probably Rs. 65,000 will be as much as can be expected. The water will have to be stored in November of one year for use in the following September, for there is in few years any surplus in the river at Srivaikuntam during July and August, so that the loss in evaporation will be very great.

4. Although the estimated returns are comparatively small, there are other reasons for the execution of this work. The total area of occupied wet under the Srivaikuntam anicut system is about 23,000 acres and most of the lands are compounded for double crop, *i.e.*, they pay full assessment whether one crop or two are raised. The loss of crops is therefore much greater than is shown in the returns. As a matter of fact about 6,000 acres, or 26 per cent. of the whole area, are left waste during the south-west monsoon. The large remissions which are given every year do not refer to such lands but only to those on which either no crop at all or a very short single crop is raised. It is therefore evident that something must be done to remedy this state of affairs. Otherwise at the next settlement a large number of the Srivaikuntam ryots will refuse to accept a compounded rate for their lands and will convert them to single crop.

5. The works will probably not be suitable for the employment of famine labour and will not affect a tract liable to famine. They should therefore be carried out as ordinary works, even though they may pay but a small interest on the capital expended.

RESULTS of the Periyár Project.

Water-supply.	Acreage.				Capital cost.		Rate of working expenses per acre charged as irrigated.	Irrigation revenue realized per acre charged as irrigated.
	Quantity of water anticipated when the project was sanctioned.	Quantity of water rendered available for irrigation.	Area (culturable) commanded.	Area for which the work was designed.	Area actually irrigated.			
					First crop.	Second crop. Total.		
1	2	3	4	5	6	7 8	12	13
	MILLS. OF C. FT.	MILLS. OF C. FT.	ACS.	ACS.	ACS.	ACS.	RS.	RS.
1896-97	29,670	..	107,650	99,761 (a)	..	..	..	..
1897-98	..	13,817	..	..	43,628	.. 43,628	0·94	4·19
1898-99	..	15,361	..	..	65,373	.. 65,373	1·00	4·01
1899-1900	..	17,649	..	..	77,710	.. 77,710	1·35	4·30
1900-1901	..	18,430	..	..	88,723	.. 88,723	1·08	4·13
	..	19,458	..	..	109,168	.. 109,168	1·07	4·28

Duty, i.e., supply per acre irrigated.	Capital cost.	
	Per unit of water rendered available.	Per unit of the average area irrigated.
9	10	11
MILLS. OF C. FT.	RS.	RS.
..	..	..
·23	..	..
·18	..	..
·17	..	..
·16	..	..
·15	..	..

Note.—The project was brought into operation in 1896-97.
As the system has not yet fully developed, columns 10 and 11 have not been filled in, nor have averages been struck.

(a) Represents the area irrigable by the complete project.

PERIYAR PROJECT.

The following note by Mr. KEELING, Executive Engineer, describes the requirements of this system.

The total culturable area commanded by the Main canal and its twelve branch channels is 121,461 acres including land of all classes. The supply available is sufficient only for about 100,000 acres. This latter fact may be disputed. It is, however, in my opinion confirmed by the facts that the present estimated maximum discharge of the tunnel is only slightly over 1,100 cusecs and that, unless rain has fallen in sufficient quantities in the irrigated area to fill up the tanks, there is a difficulty in meeting the demand at the times of minimum duty. It may be asserted that at times when the maximum discharge from the lake is not required, the maximum quantity should still be drawn off in order to fill the tanks. I am very strongly of opinion that such a policy is not only wrong but wasteful inasmuch as the tanks are meant to retain and store rain water. The actual total catchment area of the tanks and irrigated area is upwards of 400 square miles. Taking the average rainfall at 36 inches and estimating a run off of 6 inches, the total quantity works out to 5,575·68 millions of cubic feet. Assuming a run off of 3 inches only, the quantity works out to 2,787·84 millions of cubic feet. If the policy of filling the tanks with Periyár water were to be adopted, the greater portion of the rainfall supply is wasted. It is absolutely necessary that not a drop of water should be wasted and, in my opinion, the only truly economical and correct policy is to allow the tanks in the irrigated area to perform their legitimate function of catching rain-water and to use the Periyár water for direct supply. If the policy of always allowing the tunnel to run full bore and storing the surplus from this in the Madura and Melur tanks were adopted not only would the rainfall supply be minimised and to a large extent wasted but there would be the undoubted risk of an unduly low lake at the end of the season.

When we start with a high lake there would be no objection to filling tanks early in the year, only the whole quantity the tunnel can discharge is required for direct irrigation; discharge is 1,100. This can be got with shutter about 3 feet high.

H.E.C.

2. The cultivation seasons within the Periyár area are locally known as kodai and kálam. In years previous to the introduction of Periyár water the kodai, or short crop, cultivation was precariously raised in the hot weather months by rain supplies from thunder showers and the slight south-west monsoon fall; the kálam, or long crop was raised by rain supply from the more copious north-east monsoon. The catchment area of the Periyár reservoir is not so well watered in the north-east monsoon as in the south-west monsoon, and the lake receives most of its supply from the latter monsoon. Rain is an essential factor affecting the yield of a rice crop, and it is, in my opinion, necessary for the best development of the project that the maximum area should be under cultivation when the rain supply in the irrigated area is likely to be greatest. In this locality this occurs in the north-east monsoon. The difficulty with the cultivators is that they wish to keep to their old seasons. What is required is that they should cultivate the short crop from June to August and the long crop from September to January and February, and where one crop only is grown begin in August and end at the latest in January. This is but a small alteration in the old time seasons and is gradually but very slowly being adopted by the more intelligent minority who will, I hope, by their success, induce the more ignorant majority to follow their example.

This means that the kálam crop should be started earlier than at present and the kodai crop a little later.

H.E.C.

3. The earlier an *assured* and *increasing* supply can be given, the greater will be the extent of the second crop cultivation. It will not be possible from the nature and season of the rainfall in the Periyar catchment to as a rule give an assured supply before 1st June. To put our supply in the canals by this date, it is necessary to open the head sluice at Thekady in the last week of May. In 1900 this was not possible. The sluice was opened on June 7th and subsequent events proved that it might have

been opened on June 5th, but had it been opened before in the last week of May, not only would the lake have run down to its minimum level, but the crops planted would have suffered from want of water.

4. Since the project was opened the average annual quantity of water lost over the escape has been 10,300 millions of cubic feet. Now much of this was lost when no attempt was made to regulate the sluice at Thekady owing to the character of the sluice gate; this shows that even were the policy of always discharging full bore adopted there would be wastage, and I would point out that the biggest wastage occurred in a year when no regulation was possible. It is therefore, I think, perfectly clear that there is wastage water that ought to be caught and used.

In 1899 there was no discharge over weir at all. H.E.C.

5. Assuming the catchment area to be 300 square miles and a flood sufficient to discharge 400 cusecs per square mile for 24 hours, the accompanying diagrams show that the existing surplus arrangements are inadequate. Such a flood would rise to about 165 and the dam would be seriously in tension. The assumption of a possible discharge of 400 cusecs per square mile of catchment may be excessive, and it is only put forward as a possible maximum under circumstances which are possible and perhaps not often probable. In my opinion, however, it is not safe to rely upon the records of the flood of November 1869, because that flood was gauged at a point nearly 10 miles above the site at which the dam is now built. The second diagram shows that it is possible to store water up to 157 without bringing the dam into tension if certain additions are made. It is also clear from Nos. 1 and 3 diagrams that it is possible to hold water up to 156 without bringing the dam into tension. The fifth diagram shows that, if the escape level were reduced to 135, it would be possible to discharge the flood assumed above as a possible maximum.

6. The formula for calculating the flood curves is arrived at as follows above the escape level, below which it is calculated as in the Periyár Blue book:—

h = Depth in feet over escape.
t = Time in hours from commencement of overflow.
a = 3·672.
c = Capacity of lake in millions of cubic feet for every foot of depth.
q = Discharge of river *less* discharge of tunnel per hour in millions of cubic feet.

$$\delta h = \frac{q - ah^{\frac{3}{2}}}{c}\,\delta t$$

$$\frac{\delta t}{\delta h} = \frac{c}{q - ah^{\frac{3}{2}}}$$

Taking limits

$$\frac{dt}{dh} = \frac{c}{q}\left\{1 + \frac{a}{q}h^{\frac{3}{2}} + \frac{a^2}{q^2}h^3 + \frac{a^3}{q^3}h^{\frac{9}{2}} + \cdots\right\}$$

$$\int \frac{dt}{dh}dt = t = \frac{c}{q}xh\left\{1 + 2\left(\tfrac{1}{5}\frac{a}{q}h^{\frac{3}{2}} + \tfrac{1}{7}\frac{a^2}{q^2}h^3 + \tfrac{1}{11}\frac{a^3}{q^3}h^{\frac{9}{2}} + \cdots\right)\right\}$$

There is no use going further as a $\frac{1}{11}\frac{a}{q}$ = ·00000006 for the first level.

7. It is clear from the diagrams that it is possible and safe to hold up water to 152. This would give an additional storage of 2,361 millions of cubic feet. But it will be necessary to increase the discharging capacity of the tunnel and to cut down the escape. This is not a sufficient increase in storage, but it is possible to create an additional storage reservoir at the foot of the hills. The capacity and size of this depend upon what height is deemed safe for an earthen dam, as a masonry dam is out of the question here. In any case a portion of the work where the sluices are situate must be of masonry. The cost of the earth work for a dam to store up 1,620 millions of cubic feet would be about 6½ lakhs at Rs. 10 per unit of earth work.

8. Were this reservoir made and the escape cut down and fitted with shutters to hold water up to 152, an additional storage capacity of 3,981 millions of cubic feet would be obtained and there is water to fill this additional capacity more than twice over. A design for the shutters has to be made and cross sections of the escape have to be taken before the cost of the upper portion of the scheme can be arrived at. As regards the bund for the reservoir at the foot of the hills, trial pits must be sunk and borings taken in the bed of the stream.

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9. I consider that the need for additional storage capacity is evident. We can, if sufficient additional storage capacity is provided, utilize every drop of the Periyár water and extend cultivation by at least 20,000 acres. This amount is what the total extra amount at present proposed to be impounded will irrigate. It is obviously below the possible increase which, if the full average surplus quantity is used for irrigation, will, after deducting 2,300 millions for losses by evaporation and absorption, amount to 40,000 acres. It is, however, not advisable to count on the whole of this as a portion of the surplus impounded is required for regularizing the supply at the commencement of the season. If from the 8,000 millions left we deduct 2,000 millions for this purpose, there is left sufficient to extend irrigation by 30,000 acres. The additional supply is needed the more as it will avert the necessity for a distinction between Inam and Zemin and Government lands which must otherwise be made. I submit that it is abundantly proved that the supply is available and that it is possible to impound it.

— An important point not alluded to by Mr. Keeling in the above note is the scarcity of manure which is likely to retard any rapid extension of the project; this matter should receive attention from the officers of the Revenue and Forest Departments.

The results of the system are shown in the accompanying statement.

RESULTS of the Rushikulya Project.

1	Water-supply. Quantity of water anticipated when the project was sanctioned.	Water-supply. Quantity of water rendered available for irrigation.	Acreage. Area (culturable) commanded.	Acreage. Area for which the work was designed.	Acreage. Area actually irrigated. First crop.	Acreage. Area actually irrigated. Second crop.	Acreage. Area actually irrigated. Total.	Duty, i.e., supply per acre irrigated.	Capital cost. Per unit of the quantity of water discharged.	Capital cost. Per unit of the average area annually irrigated.	Rate of working expenses per acre charged as irrigated.	Irrigation revenue realised per acre charged as irrigated.	Remarks.
1	2	3	4	5	6	7	8	9	10	11	12	13	14
	MILLS. OF C. FT. 25,000	MILLS. OF C. FT.† ..	AC. 1,42,000	ACS. 1,20,000	ACS. ..	ACS. ..	ACS. ..	MILLS. OF C. FT. ..	RS. ..	RS. ..	RS. ..	RS. ..	
1892-93 ..	..	*	..	..	3,508	675	4,183	..	..	..	2·38	1·39	
1893-94 ..	..	*	..	..	8,212	..	8,212	..	..	..	1·83	2·08	
1894-95 ..	..	*	..	..	27,407	9	27,416	..	..	..	0·57	1·72	
1895-96 ..	..	*	..	..	35,758	112	35,870	..	..	..	0·88	1·77	
1896-97 ..	..	2,832	..	..	66,154	407	66,561	·043	..	..	0·69	1·71	
1897-98 ..	..	2,993	..	..	67,953	1,333	69,286	·043	..	..	0·54	1·68	
1898-99 ..	..	10,115	..	..	79,396	3,017	82,413	·123	..	..	0·53	1·69	
1899-1900 ..	..	3,756	..	..	78,445	3,181	81,626	·046	..	..	0·68	1·70	
1900-1901 ..	..	*	..	..	80,204	2,164	82,368	..	..	..	1·05	1·78	

* Information not available. † This is from readings at Janamilli anicut.

NOTE.—(1) The revenue account of the project was opened in 1892-93.

(2) The project not having fully developed, columns 10 and 11 have not been filled in nor have averages been struck for other columns.

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RUSHIKULYA PROJECT.

The first investigation of this project was commenced in 1868 as the result of the disastrous famine of 1865–66. Captain Beckley was deputed to this duty and he submitted a general report, accompanied by plans and estimates, in 1872. The project was reviewed by the Government of Madras in 1875, who were of opinion that the execution of the work would not have such appreciable effect as to warrant its being sanctioned in preference to many needed improvements which could be effected at a moderate cost and with more certain results. The work was, however, eventually sanctioned by the Government of India as a protective work. The works were practically completed in 1896, with the exception of the Suradá reservoir, which was opened in 1898.

2. The project is a combined system of storage and direct irrigation. The Russellkonda reservoir is formed by damming the Boringa river, and its supply is supplemented by means of a channel taken from an anicut across the Gulleri river. The water from the reservoir is allowed to pass by a natural stream to its junction with the Mahánadi river. Across this is an anicut which supplies the Mahánadi canal. This canal irrigates directly by means of water from the Mahánadi, supplemented when necessary by the supply in the Russellkonda reservoir. The Mahánadi canal tails into the Rushikulya river, where is situated the Janamilly anicut and head sluice from whence takes off the Rushikulya canal.

The supply of the Rushikulya canal is supplemented by water from the Suradá reservoir formed by damming the Johoro and Pathama rivers.

3. According to the forecast framed in 1893, it was anticipated that the project would be completed in 1899–1900, and that the ultimate area of irrigation would be 117,250 acres and that, at the end of the tenth year after completion of the work, there would be a net revenue of Rs. 1,88,085, which was equivalent to 3·38 per cent. on the capital outlay. The forecast was erroneous for two reasons—

(1) It assumed the whole area reported to be commanded as that for which water would be taken.

(2) No deduction was made on account of revenue due to old irrigation.

The present Collector of Ganjám has accordingly prepared for submission to the Government of India revised statements showing the growth of irrigation and increase of revenue under the system. He states that, in a district like Ganjám, where rains in normal years are copious, it is not safe to expect that more than 75 per cent. of the area commanded will be irrigated. The ultimate area is thus placed at 93,075 acres. The Collector calculates that the interest on the capital outlay will never fall below 2·12 per cent. The project is therefore not a remunerative one.

4. It may, however, be claimed that the execution of the scheme as a famine protective work is justified. In the famine of 1897 the Goomsur and the Berhampur taluks were saved from want by the project. In 1898 there was a partial failure of the monsoon, and the Suradá reservoir supplemented the deficiency. In the year 1899–1900, there was a great demand for water throughout the season, as the rains of the south-west monsoon were light and the north-east monsoon failed. Had it not been for the supply available in the Rushikulya canals from the reservoirs, there would have been a total failure of crop, and a severe famine would have been the result. There is also no doubt that the project has improved the condition of the ryot and the district generally.

5. The results of the system giving the information asked for by the Inspector-General of Irrigation are shown in the accompanying statement. The only point requiring explanation is the duty of water. It will be seen that the supply per acre irrigated is generally very low. It was in 1896–97 only 42,547 cubic feet. This was enough to mature the crop, as local rainfall supplemented the supply. This is a special feature of the system and was contemplated when it was originally designed.

6. The only way in which the project can be made to yield better results is by the extension of second crop cultivation. The Collector's views on this important subject, as expressed in his note on the revised financial statements of the project, are as follows:—

"There has up to now been very little revenue under this head. For future years it is estimated from Rs. 1,000 to Rs. 5,000. Second crop cultivation, if once started, is sure to spread rapidly. The difficulty is to start it generally in different local areas. I am taking steps for the popularisation of second crop cultivation among ths Uriya ryots. It is impossible to forecast the revenue under the head with any degree of certainty."

7. The local Public Works officers appear to accept the above views with certain reservations. They consider that indiscriminate extension of second crop cultivation, especially in the lower reaches of the Rushikulya canal, would cause a waste of water out of all proportion to the benefits and would rob the system of its protective character. The second crop area should at present be confined to the neighbourhood of the Russellkonda reservoir.

8. To improve the supply to the lower reaches of the Rushikulya canal, it has been proposed to construct a reservoir on the Godaballo river. This is one of the sites originally suggested by Captain Beckley, but abandoned in favour of the more suitable ones afterwards adopted. The catchment area at the site selected is 450 square miles, but there is already some irrigation from the river which must be provided for. It is stated that the compensation will be heavy. He estimated the cost at 4½ lakhs. The proposed scheme is now under investigation and should be gone on with by a special party.

9. The increasing demand for water, especially in the Berhampur sub-division, and the high prices fetched for waste lands commanded by the project at the sales which took place at Berhampur are clear indications that the ryots are beginning to appreciate the benefits of canal irrigation and point to the advisability of the construction of more storage works.

PART II.

INTRODUCTION.

In this portion of my report, each district is dealt with *seriatim*. A short description of the physical features which affect or are affected by irrigation works is given with certain statistics regarding its existing works and liability to famine. I may here note that a large proportion of the figures given are taken from Benson's Statistical Atlas of the Madras Presidency, which is now nearly ten years old. Some of the figures given are not strictly accurate. They are, however, near enough the truth for all practical purposes. When any striking change has taken place, a note to that effect has been made.

2. It should be explained that the "area protected in all seasons" is the area actually irrigated during the famine of 1876–77, and that the "area protected in ordinary seasons" represents the average actual cultivation prior to 1891–92. These areas, unlike those shown in the tables of results, do not include the extent under withered crops or waste charged. It is, however, probable that, with the gradual extension and improvement of our irrigation works, the protected areas have also increased.

3. With regard to the diagrams of areas cultivated and revenue derived, it will be noted that in some cases there are serious discrepancies between those shown in the diagrams, and those in the tables of results. This is due to the fact that the diagrams are prepared on figures furnished by the Executive Engineers of the divisions concerned, whereas those in the tables are supplied by the Board of Revenue. The latter are the more accurate.

GANJÁM DISTRICT.

General Features.—The district is divided into two portions by the Eastern Ghâts. The country above the ghâts, which is known as the Agency, pays but little revenue to Government. That below the ghâts is open and undulating and is remarkable for its potential fertility. The general configuration of the district is such that there are large expanses of gently sloping country lying between ranges of hills, thus affording abundant sites for irrigation works. Near the coast and sometimes further inland, are found lakes formed by shallow depressions, of which the Chilka lake is the largest.

2. *Rainfall.*—The rainfall of the district is usually considerable and is more evenly distributed through the year than in most other parts of the Presidency. The average rainfall amounts to 45·46 inches, of which more than one-half is contributed by the south-west monsoon. The maximum fall is 57·51 inches at Udayagiri and the minimum 36·63 at Narasannapet.

3. *Rivers.*—As the hills are nowhere more than 50 miles from the sea, no rivers are of great length. They are from the same cause liable to sudden floods. The most important are the Rushikulya and the Vamsadhara. The former with its tributaries, the chief of which are the Mahanadi and the Godahallo, drains the northern parts of the district. The Vamsadhara rising in Jeypore flows through the southern portion of the district. The Langulya at the southernmost end is also a river of some importance.

4. *Existing Irrigation.*—The area lying between the ghâts and the sea comprises three Government taluks, besides a large number of zemindaries and proprietary estates for which no detailed statistics are available. The information at hand relates solely to the three Government taluks.

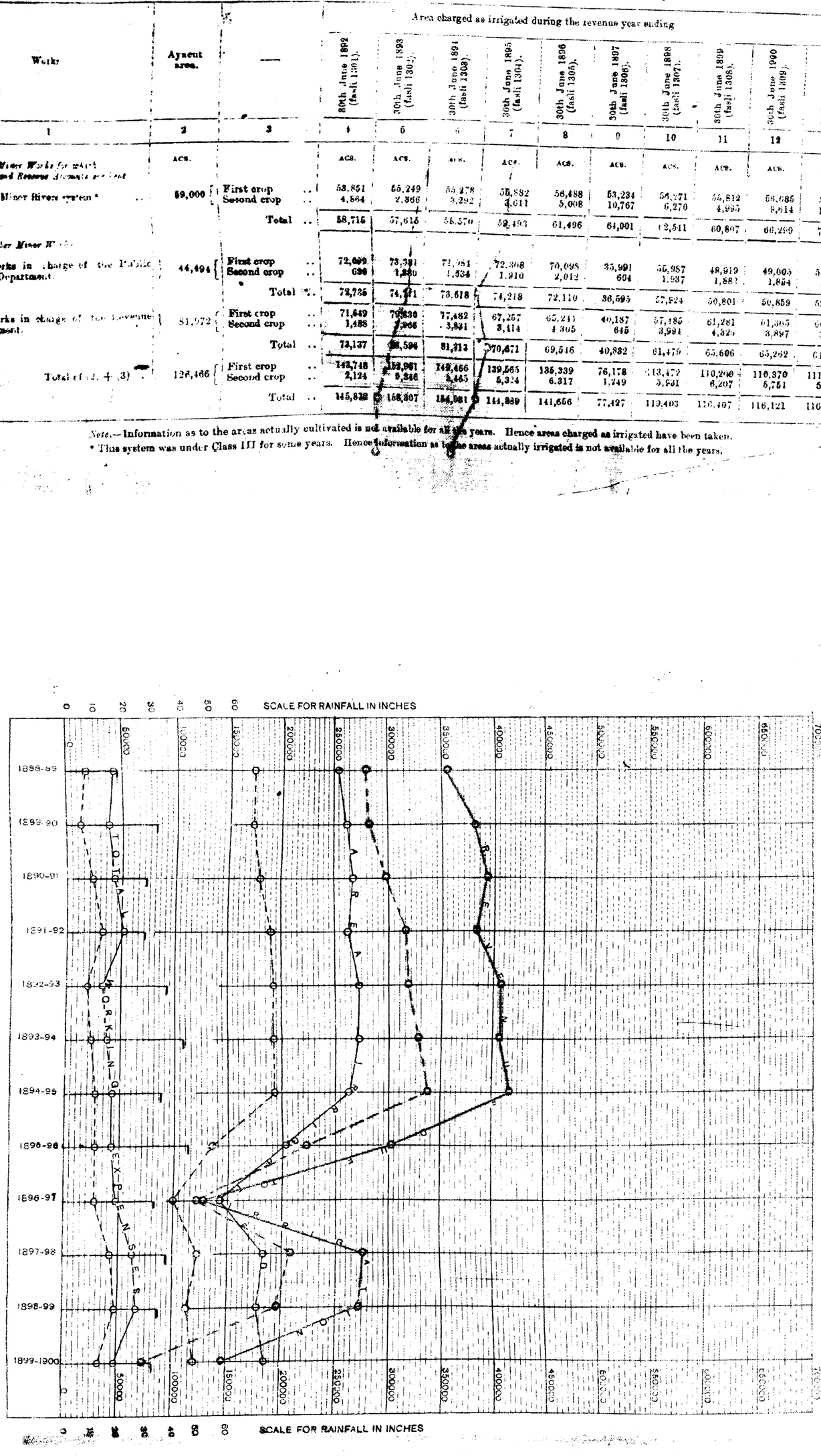
Besides the Rushikulya project which is dealt with in Part I, the only large irrigation works are the channels taken off from the Langulya and the Vamsadhara in the Chicacole taluk. They are known as the Ganjám minor rivers system. There are 3,347 tanks and channels, of which 2,571 irrigate less than 50 acres. The supply in these tanks is very precarious and usually needs to be replenished several times to bring the crops under them to maturity. The accompanying statement shows the areas irrigated during the past ten years.

STATEMENT showing the Ayacut areas and the areas cultivated during the past ten years.

Works	Ayacut area.		Area charged as irrigated during the revenue year ending 30th June 1892 (fasli 1301).	30th June 1893 (fasli 1302).	30th June 1894 (fasli 1303).	30th June 1895 (fasli 1304).	30th June 1896 (fasli 1305).	30th June 1897 (fasli 1306).	30th June 1898 (fasli 1307).	30th June 1899 (fasli 1308).	30th June 1900 (fasli 1309).	30th June 1901 (fasli 1310).	Average area irrigated.
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Minor Works for which Capital and Revenue Accounts are kept	ACS.		ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.
1. Ganjam Minor Rivers system * ..	59,000	First crop ..	53,851	55,249	55,278	55,892	56,488	53,234	56,271	55,812	58,685	59,921	55,867
		Second crop ..	4,864	2,366	3,292	3,611	5,008	10,767	6,270	4,995	5,614	13,383	6,416
		Total ..	58,715	57,615	58,570	59,493	61,496	64,001	62,541	60,807	66,299	73,284	62,282
Other Minor Works													
2. Petty works in charge of the Public Works Department.	44,494	First crop ..	72,699	73,391	71,761	72,308	70,098	35,991	55,987	48,919	49,005	50,457	60,018
		Second crop ..	636	1,280	1,534	1,910	2,012	604	1,937	1,882	1,854	1,554	1,540
		Total ..	73,735	74,671	73,618	74,218	72,110	36,595	57,924	50,801	50,859	52,011	61,558
3. Petty works in charge of the Revenue Department.	81,972	First crop ..	71,649	72,830	77,482	67,257	65,241	40,187	57,185	51,281	61,305	60,739	64,232
		Second crop ..	1,488	1,966	3,831	3,414	4,305	645	3,994	4,325	3,897	3,885	3,375
		Total ..	73,137	74,796	81,313	70,671	69,546	40,832	61,179	55,606	65,202	64,624	67,607
Total (1, 2 + 3) ..	126,466	First crop ..	143,748	145,961	148,466	139,565	135,339	76,178	113,172	110,200	110,370	111,196	124,250
		Second crop ..	2,124	5,346	5,465	5,324	6,317	1,249	5,931	6,207	5,751	5,429	4,916
		Total ..	145,872	151,307	154,931	144,889	141,656	77,427	119,103	116,407	116,121	116,625	129,165

Note.—Information as to the areas actually cultivated is not available for all the years. Hence areas charged as irrigated have been taken.

* This system was under Class III for some years. Hence information as to the areas actually irrigated is not available for all the years.



Note.— The vertical lines at foot of diagram represent the rainfall of the different years in inches, the blue portions of the lines showing that due to the North-East monsoon and the red portions that due to South-West monsoon.

The lengths between the bottom of the diagram and the dotted lines represent areas irrigated, &c., for works in charge of the P. W. D. and between the dotted lines and the full lines of the same colour for works in charge of the Revenue Department. The total areas, &c., relating to works in charge of both Departments are therefore shown by the full lines.

It will be observed that the scales for the areas irrigated and for rupees (revenue & working expenses) are the same and a comparison of the lengths representing revenue with those representing area irrigated readily gives the receipts per acre irrigated. Thus if the lengths are as 2 to 1, this represents receipts of Rs. 2 per acre.

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5. *Area protected—*

	ACRES.
Area protected in all seasons	*132,700
Percentage of area cultivated	29·9
Area protected in ordinary seasons	*194,900
Percentage of area cultivated	43·8

* Exclusive of the area protected by the Rushikulya project.

6. *Liability to Famine.*—The district was visited by famine in 1792 and again between 1836 and 1839. The famine of 1865–66 was very severe, during which the mortality was great. In 1872 some relief was given to the helpless poor. Considerable distress was caused in 1878, chiefly by the high prices of grain in consequence of the demand to supply the famine-stricken parts in the south. In 1888–89 another severe famine occurred. The district also suffered in 1896–97. The following is a statement of the numbers relieved since 1866 :—

Period.	Duration.	On works.	Gratuitously.	Total.
1866-67 ..	13 months.	351	11,265	11,616
1876-78 ..	3 ,,	415	..	415
1888-89 ..	13 ,,	10,897	17,177	28,074
1896-97 ..	10 ,,	† 13,262	21,558	34,820

† For 8 months besides an average of 3,765 weavers for 7 months.

N.B.—The maximum number on relief was 143,816 in July 1897.

7. *Possible extension of Irrigation.*—Mr. Lacey, who was well acquainted with the district, made certain proposals to the Collector for the investigation of projects suitable for famine-relief and his letter is printed as appendix A. In addition to the proposed Godahallo reservoir, which will form an extension of the Rushikulya project and is described in its proper place, the following works have been proposed :—

(1) *Mallada Tampara Project.*—A project of this name was first reported on by Captain Beckley in 1875. It was then proposed to improve an existing anicut across the Koratori nullah which drains about 160 square miles of country and to take a channel thence to the Mallada tampara or natural swamp, from which irrigation was to be conducted and a channel taken to supply Ganjám with water. In 1889 the scheme was ordered to be abandoned, principally because the supply from the Koratori nullah was so precarious that the scheme would be useless unless considerable storage was provided. It was then stated that the cost of increasing the capacity of the tampara and making it into a reservoir was prohibitive. An entirely different scheme has now been proposed, viz., to convert the tampara into a reservoir to be filled from its own catchment of 5 square miles with two catch channels which would give about 2 square miles more catchment. This project is now being worked out. Enquiries have been made whether it would not be possible to obtain a supply from the Koratori nullah as originally proposed by Captain Beckley ; but it is stated that the crest of the weir as proposed by him is 3 feet below the F.T.L. of the enlarged tampara. This idea must therefore be abandoned, unless it were possible to take off a channel higher up the nullah. This may be enquired into. The project in its present form is only suitable for a famine-relief work.

(2) *Ganjám-Gopalpur Canal.*—This canal which was originally intended for navigation purposes was put in hand in 1889 as a famine-relief work and an expenditure of about Rs. 1,10,000 was incurred on it. When famine ceased, the work was abandoned as the advantages to be gained from completing it did not appear to be commensurate with the probable cost. The project is, however, retained in the programme of famine-relief works. The balance of work to be done on the canal according to the estimate is Rs. 2,50,000, of which about Rs. 2,00,000 is suitable for famine relief. It would, however, probably be necessary to spend a considerable sum on re-doing the work which is already done, as the excavation has been much filled up by blown sand. At present the excavated portion is bunded across at several places and holds water, which is baled out by ryots and used for cultivation. It has been suggested that the whole reach should be cleared and filled from the Rushikulya canals, from which water can at certain seasons be spared, and the water used for irrigation by baling or pumping. It would have to be ascertained that the sole and

sides of the canal are throughout sufficiently impermeable to retain water. If this is the case, the idea is *primâ facie* a good one, as it is in a tract where irrigation would be much appreciated. The difficulty of the reservoir silting from blown sand could be got over by planting casuarina topes along the windward side.

It is improbable that the canal would be much used for navigation even if it were opened.

(3) *Vamsadhara Project.*—The Vamsadhara project was first proposed by Captain Rundall about 1854. His proposals were to build an anicut across the Vamsadhara at Hiramandalam with a channel on the left side to irrigate as much fresh land as it could command, as well as to improve the supply to the existing river channels. He also proposed a navigable canal from the left bank of the Vamsadhara which was to run through the Parlakimedi estate to Nangada. In 1858 Captain Beckley, while employed on the Rushikulya project, took some preliminary levels and recommended a project similar to the above omitting the navigation canal. About this time Major Fischer, R.E., Superintending Engineer of the Circle, suggested a scheme for forming a large reservoir 2 miles above Hiramandalam and excavating from that point combined irrigation and navigation canals to the seaports of Bimlipatam and Barwa, but this project was finally abandoned. As a result of the representations of the inhabitants of Berhampur, Mr. Paul, Executive Engineer, was deputed to report on the project, and in 1893 he submitted a report in which he showed that the small returns likely to accrue were insufficient to render it worth while carrying out the project; the reason being that the zemindars whose lands would be benefited were unwilling to pay anything but a very small water-rate. He, however, thought that it was quite possible that if more favourable revenue returns could be shown the excavation of a channel on the left side as far as Narasannapet might be a useful famine work. The local officers of the Public Works Department appear to think that this work would not do much good, but it appears to me that it would be worth while for fresh enquiries to be instituted in the Revenue Department as to whether the zemindars concerned are not willing to pay a higher water-rate than they were in 1893. If not, the project may be abandoned.

(4) *Gedaka Nullah.*—This is a proposal to form a reservoir in the Chikati zemindari. Two streams would be impounded by a bund 2 miles long. The waterspread would be 5 square miles with an average depth of 12 feet. These are the figures given by the subordinate in charge of the preliminary investigation. If they are correct, the reservoir would have a capacity of 1,672 mills. cubic feet. The catchment area is approximately 240 square miles. The rainfall is about 45 inches and there is no doubt about filling the reservoir. The water stored in the reservoir could probably best be used to assist the extension of cultivation under the Ichchápur channel. The project would be useful as a famine-relief work and requires investigation. This project is a much larger one than the one proposed by Mr. Lacey when Executive Engineer who only apparently proposed to impound the smaller stream.

(5) *Reservoir at Bubarada.*—This is on a tributary of the Rushikulya near Bugada. The stream has a good catchment. No investigations have been made, but it is situated in a tract where relief is often required.

(6) *Reservoir near Ballipadru.*—This is a proposal to form a reservoir on a stream in the same area with a supply channel from the Baguva river.

(7) *Mahendratannir Project.*—A proposed reservoir in the Mandasa zemindari 2 miles north of Mandasa. No investigation yet made.

(8) *Baruva river Project.*—An anicut at Kasipuram with a channel has been suggested by Mr. Lacey in connection with a possible reservoir about 6 miles south-west of the Jarada.

(9) *Gounazu Tampara.*—This is a proposal to drain the tampara, or swamp, by cutting a channel to the sea in order to make lands to be cultivated. Some levels have been taken, but no estimates framed. The tampara is situated 2 miles south-west of Gopalpur.

8. I consider it advisable to form a party for the investigation of these projects. They are not very large ones, but it is probable that other reservoir sites could be found. The necessity for increased storage, especially for the Rushikulya project, is undoubted.

VIZAGAPATAM DISTRICT.

General Features.—The district is divided by the Eastern Ghâts into two unequal portions, the larger and inland portion being mountainous and covered with forest, and the smaller flat. The plain along the Bay of Bengal to the east of the Ghâts is rich and fertile.

2. *Rainfall.*—The rainfall of the district is chiefly dependent on the south-west monsoon, but it varies greatly both in amount and in distribution in different parts. The average fall for the 30 years ending with 1899 amounts to 41·32. The maximum is 76·35 at Jeypore and the minimum 28·44 at Polavaram.

3. *Rivers.*—The chief sources of irrigation are the Varahánadi, Saradánadi and Nagavalli rivers and two large natural lakes called the Komeravolu and Kondakirla avas. The Indravati on the west is also a river of some importance. Besides these, there are several mountain streams.

4. *Existing Irrigation.*—The district comprises chiefly zemindaries and proprietary estates, the Government taluks being no more than three in number. All these taluks are fairly well protected by irrigation. The Palkonda taluk is irrigated by the Nagavalli and its tributary, the Swarnamuki, but no information is available as to the area irrigated in the taluk. The Golgonda taluk is irrigated by the Varahánadi and the Komaravolu ava. The Sarvasiddhi taluk is also irrigated by the Varahánadi as well as by the Saradá and the Kondakirla ava. There are on the whole 703 tanks and other sources, the bulk of which irrigate less than 50 acres. The areas irrigated during the past ten years are shown in the following statement:—

STATEMENT showing the Ayacut areas and the areas cultivated during the past ten years.

Works.	Ayacut area.		Area charged as irrigated during the revenue year ending 30th June 1892 (fasli 1301).	30th June 1893 (fasli 1302).	30th June 1894 (fasli 1303).	30th June 1895 (fasli 1304).	30th June 1896 (fasli 1305).	30th June 1897 (fasli 1306).	30th June 1898 (fasli 1307).	30th June 1899 (fasli 1308).	30th June 1900 (fasli 1309).	30th June 1901 (fasli 1310).	Average area irrigated.
1	2	3	4	5	6	7	8	9	10	11	12	13	14
	ACS.		ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.
1. Class III works		First crop ..	11,841	18,070	19,720	18,975	19,774	12,168	19,115	19,246	18,115	* 32,775	19,740
		Second drop ..	7,683	14,788	15,012	14,522	15,212	9,986	15,142	14,765	14,260	30,882	15,225
		Total ..	19,524	32,858	34,732	33,497	34,986	22,464	34,557	34,010	32,375	70,657	34,965
Class IV Works.													
2. Petty works in charge of the Public Works Department.		First crop ..	8,963	27,591	29,115	32,140	33,887	23,284	33,710	31,426	7,301	10,642	23,741
		Second crop ..	5,450	27,037	24,302	28,913	28,597	23,911	28,913	31,282	7,119	5,764	21,129
		Total ..	14,413	54,628	53,417	61,053	62,484	47,195	62,625	62,708	14,420	16,806	44,870
3. Petty works in charge of the Revenue Department.		First crop ..	13,603	50,807	54,366	47,111	47,893	29,088	50,055	42,451	61,806	57,287	45,587
		Second crop ..	12,413	48,851	50,606	43,972	44,581	31,805	45,851	35,183	51,697	53,502	42,167
		Total ..	25,420	99,658	104,971	91,083	92,474	60,893	95,906	77,634	113,503	110,789	87,754
4. Total of 1, 2 and 3	108,784	First crop ..	34,407	96,468	103,201	98,226	101,554	64,540	102,880	93,122	87,222	100,704	88,868
		Second crop ..	25,546	90,676	89,920	87,407	88,390	65,802	89,908	81,230	73,076	90,148	78,511
		Total ..	59,383	187,144	193,121	185,633	189,894	130,342	192,088	174,352	160,298	197,252	167,379

NOTE.—Information as to the areas actually cultivated not being available for all the years, areas charged as irrigated have been entered.

* In 1900-1901 certain works under class IV were transferred to class III.

Diagram showing
Area irrigated Revenue and Total working Expenses
under class III & IV works in
VIZAGAPATAM DISTRICT
From 1888-89 to 1899-1900

SCALE FOR AREAS IN ACRES AND REVENUE AND WORKING EXPENSES IN RUPEES

SCALE FOR RAINFALL IN INCHES

1888-89
1889-90
1890-91
1891-92
1892-93
1893-94
1894-95
1895-96
1896-97
1897-98
1898-99
1899-1900

Note.— The vertical lines at foot of diagram represent the rainfall of the different years in inches, the bold portions of the lines showing that due to the North East monsoon and the rest that due to South-West monsoon
The heights between the bottom of the diagram and the dotted lines represent areas irrigated, &c., for works in charge of the P. W. D. and between the dotted lines and the full lines of the same colour for works in charge of the Revenue Department. The total areas, &c., relating to works in charge of both Departments are therefore shown by the full lines.

It will be observed that the scales for the areas irrigated and for inputs (revenue & working expenses) are the same and a comparison of the relative heights representing revenue with those representing area irrigated readily gives the receipts per acre irrigated. Thus if the lengths are as 1 to 1, this indicates receipts of Rs. 1 per acre.

5. *Area protected.*—Area protected in all seasons, 20,000 acres. Percentage of area cultivated, 17·8. Area protected in ordinary seasons, 34,900 acres. Percentage of area cultivated, 31·0.

6. *Liability to famine.*—In common with the rest of the northern districts, this district suffered from a serious dearth between 1790 and 1792. Again in 1824 it was found necessary to give employment to a large number of persons. In the famine of 1876–78, the district suffered considerably owing to high prices. It escaped in 1889, the year of the last Ganjám famine, chiefly owing to the proximity of the Gódávari district where there is always a large demand for labour in the hot weather. On the whole the district can hardly be regarded as a famine area, though it is liable to periods of great scarcity. The subjoined statement shows the numbers relieved since 1876 :—

Period.	Duration.	On works.	Gratuitously.	Total.
1877–78 ..	6 months.	1,552	295	1,847
1896–97 ..	7 ,,	11,573	8,659	20,232 *

* Besides an average of 5,018 weavers relieved for a period of four months.

N.B.—The maximum number on relief was 62,528 in July 1897.

7. ***Possible extension of irrigation.***—The principal river in the district is the **Nagavalli, which, rising in the Jeypur hills,** irrigates the Palkonda taluk. **The Executive Engineer has, under preparation,** an estimate for constructing an anicut **across this river at Tottapalli and forming** a channel to irrigate 16,000 acres, of which 4,000 acres are zamindari and the rest belong to Government. The cost of the scheme is roughly estimated at Rs. 2,50,000 and the revenue at Rs. 86,500 or 34 per cent. on the capital cost. The project is now being worked out. The supply to this scheme might probably be largely supplemented and the area to be irrigated increased by the construction of reservoirs to impound the flood water of which there is a great amount. The area has not been investigated, but the country is in every way suitable and it is most likely that sites could be found where reservoirs could be economically constructed. The party proposed for the Ganjám division could well undertake this work.

8. Beyond this it does not seem as though much could be done in this district. **There was a proposal to extend cultivation under Kondakirla ava (a natural lake artificially enlarged) by still further increasing its capacity. The Superintending Engineer, I Circle, Mr. Larminie,** condemned the proposal on account of—

(1) **The uncertainty of the supply from the Saradá river.**
(2) **The unfavourable nature of the tank to store a large supply**
(3) **The need for a channel about 9 miles in length, the first 3 miles of which would be in cutting ranging to a maximum of 40 feet in depth.**
(4) **The high cost of the scheme which would be about 40 lakhs.**

The project does not seem worth further investigation.

9. **There is a great deal** of cultivation from the Varahá and Saradá rivers by means of a **series of small anicuts and channels.** The ryots in this tract seem to be fully aware of the value of water and to make full use of it. No alteration in the existing system seems advisable. A large stream which passes Tuni in the Gódávari district but drains the southern portion of Vizagapatam affords possibilities for the construction of reservoirs and should also be investigated.

GÓDÁVARI DISTRICT.

General Features.—The district may be divided into two portions, viz., the delta and the uplands. The soil of the former consists chiefly of alluvium and is exceedingly fertile. The latter is occupied mostly by gneiss and sandstones.

2. *Rainfall.*—The average rainfall for the 30 years ending with 1899 amounts to 38·73 inches, of which nearly two-thirds is brought by the south-west monsoon. The eastern delta, owing to its greater exposure to the cyclones which visit the coast, receives far more rain during the north-east monsoon than the rest of the district, while the inland portions have a heavier fall during the south-west monsoon. The total annual fall in the various parts of the district does not widely differ.

3. *Rivers.*—The chief rivers are the Gódávari and its tributary, the Sabari. The only lake of importance is the Koleru, lying on the borders of the Kistna district.

4. *Existing Irrigation.*—Besides the Gódávari delta system, whose results are reviewed in Part I, there are 1,679 tanks and other sources, of which 1,121 irrigate less than 50 acres. A portion of the district is irrigated from the Kistna canals. The following statement shows the areas irrigated by Minor works during the past ten years:—

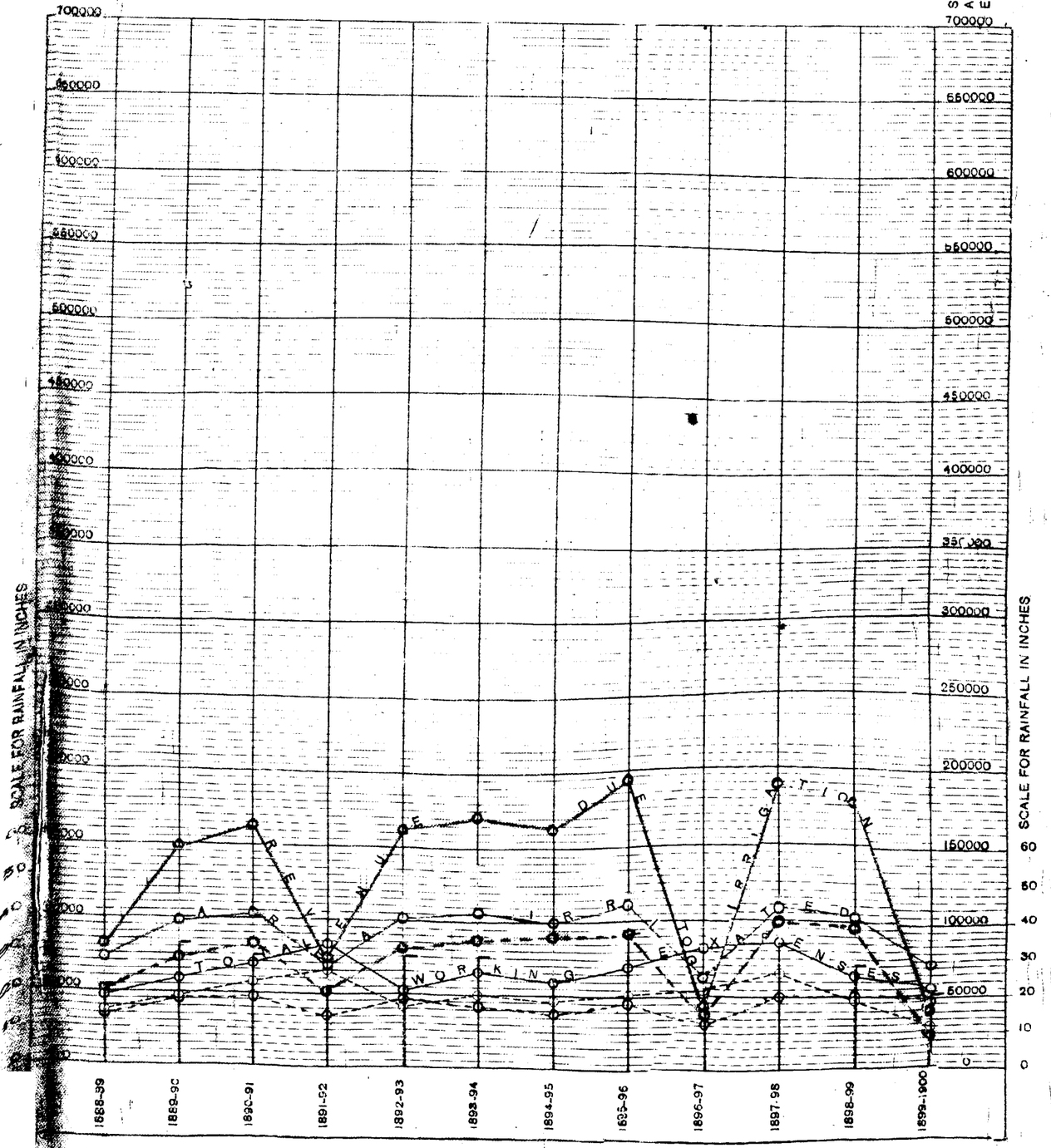
Diagram showing

Area irrigated Revenue and Total working Expenses

under class II & IV works in

GODAVARI DISTRICT

From 1898-89 to 1899-1900



Note.—The vertical lines at foot of diagram represent the rainfall of the different years in inches, the blue portions of the lines showing that due to the North-East monsoon and the red portions that due to South-West monsoon.
The lengths between the bottom of the diagram and the dotted lines represent areas irrigated &c. for works in charge of the P. W. D. and between the dotted lines and the full lines of the same colour for works in charge of the Revenue Department. The total areas, &c., relating to works in charge of both Departments are therefore shown by the full lines
It will be observed that the scales for the areas irrigated and for rupees (revenue & working expenses) are the same and a comparison of the lengths representing revenue with those representing area irrigated readily gives the receipts per acre irrigated. Thus if the lengths are as 2 to 1, this represents receipts of Rs. 2 per acre.

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1902

STATEMENT showing the Ayacut areas and the areas cultivated during the past ten years (class I works excluded).

Works.	Ayacut area	Area charged as irrigated during the revenue year ending										Average area irrigated.
		30th June 1894. (fasli 1303).	30th June 1895. (fasli 1304).	30th June 1896. (fasli 1305).	30th June 1897. (fasli 1306).	30th June 1898. (fasli 1307).	30th June 1899. (fasli 1308).	30th June 1900. (fasli 1309).	30th June 1901. (fasli 1310).			
1	2	3		4		5		6		7		8
Minor Works for which neither Capital nor Revenue Accounts are kept.	Acs.											Acs.
1. Petty works in charge of the Public Works Department.	45,263	First crop ..	..	31,961		42,462		44,059		44,059		41,829
		Second crop ..	..	2,941		1,775		4,014		2,189		2,308
		Total ..		34,902		44,240		48,073		46,253		44,137
2. Petty works in charge of the Revenue Department.	48,660	First crop ..	..	36,749		57,373		55,360		49,095		47,215
		Second crop ..	..	236		290		2,964		964		1,122
		Total ..		35,985		57,663		58,814		50,059		48,337
Total of 1 and 2 ..	93,923	First crop ..	..	67,710		99,836		99,919		93,264		89,044
		Second crop ..	..	3,177		2,065		6,978		3,153		3,430
		Total ..	..	70,887		101,901		106,897		96,417		92,474

NOTE.—Information as to the areas actually cultivated not being available for all the years, areas charged as irrigated have been entered.

5. *Area Protected*—

	ACRES.
Area protected in all seasons	*559,650
Percentage of area cultivated	60·7
Area protected in ordinary seasons	*595,950
Percentage of area cultivated	64·6

* The figures are from Benson's Statistical Atlas. † Since its publication the area irrigated under the Gódávari delta system has increased by about 100,000 acres.

6. *Liability to famine.*—The district suffered from a serious dearth between 1790 and 1792, during which many died from starvation. A severe famine again occurred in 1833. In 1838 there was distress owing to continued bad seasons. In 1839, a disastrous cyclone ravaged the district and was accompanied by a destructive inundation from the sea, while the season of 1840–41 was calamitous. This continued recurrence of bad seasons drew special attention and led to the construction of the Gódávari anicut, the irrigation under which affords protection in the driest years to the greater part of the cultivation of the district. For all practical purposes the district may be regarded as beyond the reach of famine; for, though in the upland tracts much of the crop is precarious, the delta produces surplus food, and in it there is always a demand for labour. There has, however, of recent years been considerable distress in the Bhadráchalam taluk, which is too far removed from the delta for the population to emigrate there.

7. *Possible extension of irrigation.*— A few proposals have been made to extend irrigation in the upland taluks. Colonel Haig, R.E., when Superintending Engineer, prepared a note on the possibilities of irrigation in the Rékapalli taluk from the Saveri or its tributaries—*vide* appendix B. His proposal was to form an anicut across the Sukkaleru and to irrigate about 18,000 acres in the Rékapalli taluk. A good many levels appear to have been taken, but these are not now forthcoming. The country to be supplied is sparsely populated and unhealthy, so that extension of irrigation here would inevitably be slow. Colonel Mullins, alluding to this project in his inspection notes printed with G.O., No. 93, dated 11th February 1879 (paragraph 58), says that surveys and levels for this project have been completed, and states that the area that could be irrigated would probably be 14,000 acres. These surveys do not appear to be forthcoming. The project is worth investigating again, but at the same time the possibility of forming reservoirs on the Saveri or its larger tributaries should be considered. Unfortunately this part of the country is very feverish and but little is known of the features of the rivers which drain it; but there are probably suitable sites for reservoirs. The country is covered with forest and the land is at present practically valueless. If any extensive area of irrigation were contemplated it would be necessary to pass the water through the gorge and pick it up down below. It is probable that an anicut somewhere near Polavaram would command a large area of land suitable for cultivation in the Yernagúdem taluk on the right bank and a smaller area in the Rajahmundry taluk on the left bank. It would even be possible to cultivate a large area of single crop land by a channel without any anicut taking off from somewhere in this neighbourhood. Such a channel would only take the comparatively high floods, but they are sufficiently continuous to irrigate a single crop.

8. *Anumaluka project.*—An estimate for the project amounting to about 8½ lakhs was prepared in 1874 by Lieutenant Dorward, R.E. It was proposed to form a reservoir by damming the Yerrakalva in the Yernagúdem taluk, where its drainage area is 672 square miles. The reservoir was to have an effective capacity of 4,115 mills. cubic feet and to irrigate 45,000 acres first crop and 20,000 acres second crop. It was also to act as a flood moderator to check the violent floods in the Yerrakalva which did great damage on the delta. Consideration of this estimate appears to have been deferred pending receipt of information regarding the amount of compensation payable, but in 1894 the Chief Engineer for Irrigation, in reviewing the project, showed that the estimate of water available was excessive, based as it was on gaugings taken in a year when the rainfall was far above the average. He considered that in normal years there would only be enough water for 10,000 acres and ordered a revision of the project with a smaller reservoir having a capacity of about 1,800 mills. cubic feet.

Since then continuous gaugings have been taken, and although the results are somewhat irregular, it seems pretty certain that the amount of water available was largely overestimated in the first instance. The present Executive Engineer estimates that there will be 3,000 mills. cubic feet available for storage or enough for 15,000 acres, but there are already 8,000 acres under irrigation from anicuts and channels below the site of the weir, which would have to be provided for, so that there is only enough water for 7,000 acres of new irrigation. He considers that the return from this would be totally insufficient to render the project paying. The drainage of the delta has now been improved so that the object of constructing the reservoir as a flood moderator no longer exists.

Mr. Larminie, when Superintending Engineer, I Circle, in 1896, condemned the project on the following grounds:—

(*a*) The catchment, though large, is an unfavourable one, yielding a very low run-off in all but years of exceptionally heavy rainfall.

(*b*) The site for the embankment is not a good one, and there are no facilities for disposing of the surplus.

(*c*) The configuration of the valley is not a good one for a reservoir.

He also states that the area which would be submerged is highly cultivated with dry crops, and that the project is unpopular with the inhabitants. He estimates the compensation (presumably for the larger reservoir) at 3 lakhs. It is, however, to be noted that the officers of the Revenue Department have reported that it would be Rs. 77,000.

It is obvious that the project could not be remunerative. It is not likely to be required as a famine-relief work, as the spot is within a few miles of the delta. There is probably quite enough wet cultivation already to suit the requirements of the people, and I do not think that any useful purpose would be served by investigating the project any further.

9. *The Yelleru* in the north of the district is a river which carries a good deal of water. It is used extensively for irrigation in the Pithápuram zamindari, but there is probably room for the construction of a reservoir somewhere near Yelaishvaram. This should be investigated.

10. The Executive Engineer has under preparation an estimate for Mahadevapuram tank in Badráchalam taluk. This reservoir has a catchment of 9 square miles and is expected to irrigate 2,000 acres, giving a revenue of Rs. 9,000. The anticipated area appears disproportionately large. The estimate is under preparation.

11. Two estimates have recently been sanctioned for restoring breached tanks, but it is not necessary to refer to them here.

12. No immediate action in this district is necessary, but the possibility of the utilization, on a large or small scale, of the surplus waters of the Saveri and Gódávari should not be lost sight of, and the question of forming a reservoir on the Yelleru may be taken up hereafter.

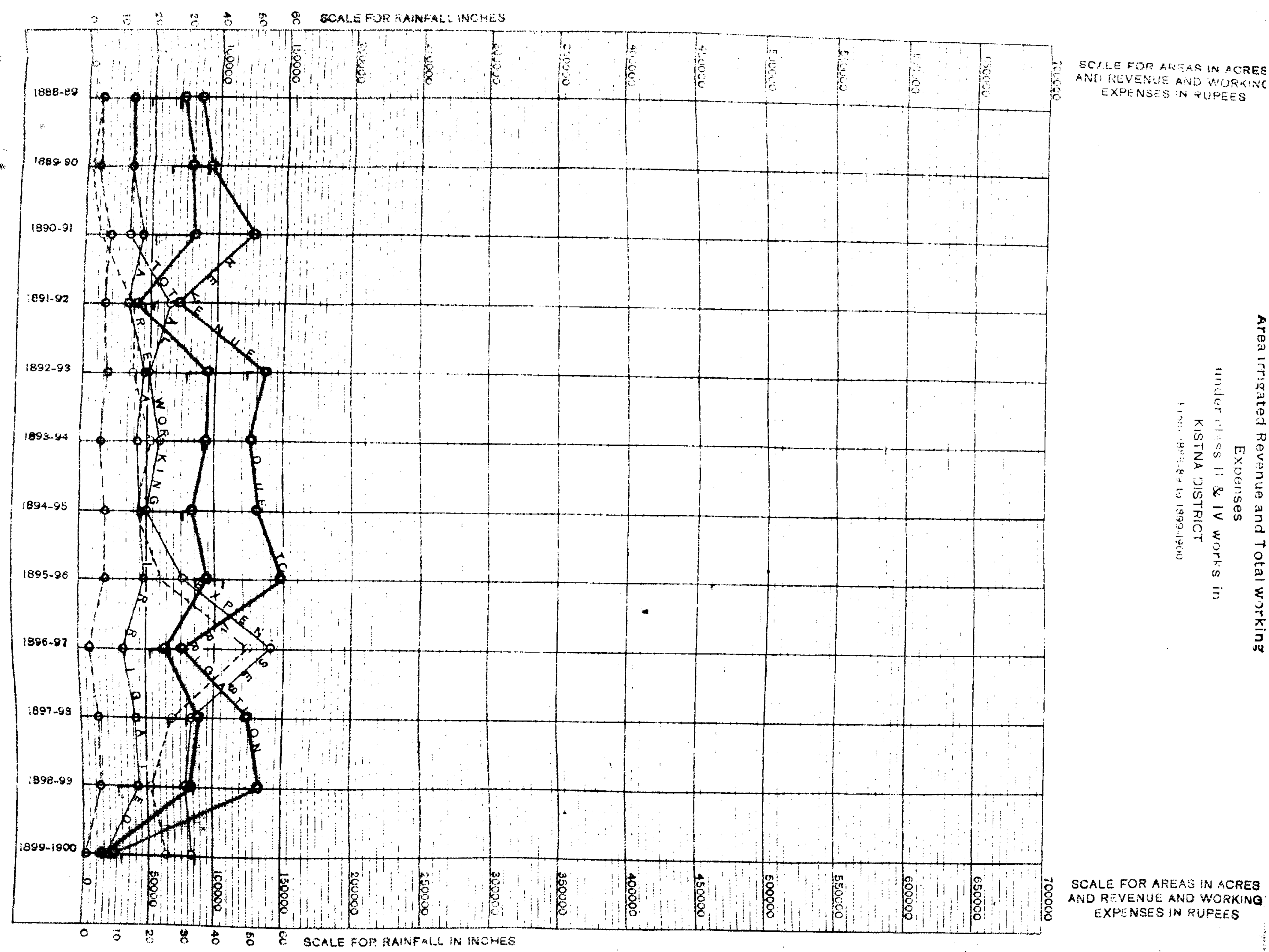
KISTNA DISTRICT.

For the purpose of this report this district may be considered as divided into two portions: the delta irrigated by the Kistna river, and the upland taluks of Nandigáma, Sattenapalle, Narasaraopet, Vinukonda, and Palnad. The Kistna delta system is dealt with separately; and this section relates principally to the upland taluks abovementioned.

2. Several streams of considerable size fall into the Kistna and the Gundlakamma passes through a portion of the district in the Vinukonda taluk.

3. The average rainfall of the district is 33·08 inches, the maximum being 39·27 at Masulipatam and the minimum 26·53 at Vinukonda.

4. *Existing Irrigation Works.*—There are 506 tanks in the district, of which 292 irrigate less than 50 acres. The accompanying statement shows the areas irrigated by minor works during the past ten years:—



Note.—The vertical lines at foot of diagram represent the rainfall of the different years in inches, the blue portions of the lines showing that due to the North-East monsoon and the red portions that due to South-West monsoon.

The lengths between the bottom of the diagram and the dotted lines represent areas irrigated, &c. for works in charge of the P. W. D. and between the dotted lines and the full lines of the same colour for works in charge of the Revenue Department. The total areas, &c., relating to works in charge of both Departments are therefore shown by the full lines.

It will be observed that the scales for the areas irrigated and for rupees (revenue & working expenses) are the same and a comparison of the lengths representing revenue with those representing area irrigated readily gives the receipts per acre irrigated. Thus if the lengths are as 2 to 1, this represents receipts of Rs. 2 per acre.

Photo. Print, Survey Office, Madras.

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STATEMENT showing the Ayacut areas and the areas cultivated during the past ten years (class I works excluded).

Works.	Ayacut area.		30th June 1892 (fasli 1301).	30th June 1893 (fasli 1302).	30th June 1894 (fasli 1303).	30th June 1895 (fasli 1304).	30th June 1896 (fasli 1305).	30th June 1897 (fasli 1306).	30th June 1898 (fasli 1307).	30th June 1899 (fasli 1308).	30th June 1900 (fasli 1309).	30th June 1901 (fasli 1310).	Average area irrigated.
			Area irrigated or charged as irrigated during the revenue year ending										
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Minor Works for which Capital and Revenue Accounts are kept.	ACS.		ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.
1. Muniyeru project ..	10,580	First crop.	..	..	..	..	..	..	..	2,623	878	2,351	1,951
		Second crop.	..	..	..	..	..	..	..	146	..	..	48
		Total ..	..	..	..	..	..	..	..	2,769	878	2,351	1,999
2. Dondapad project ..	1,680	First crop.	..	..	..	..	..	..	..	113	118	125	119
		Second crop.	..	..	..	..	..	..	..	..	..	..	..
		Total ..	..	..	..	..	..	..	..	113	118	125	119
Other Minor Works.													
3. Petty works in charge of the Public Works Department.	16,870	First crop.	15,015	17,009	14,190	18,400	18,159	8,262	13,183	13,804	1,431	11,749	13,120
		Second crop.	..	..	..	..	1	..	..	..	12	25	4
		Total ..	15,015	17,009	14,190	18,400	18,160	8,262	13,183	13,804	1,443	11,774	13,124
4. Petty works in charge of the Revenue Department.	23,823	First crop.	17,274	28,369	27,915	25,890	28,571	24,596	28,177	25,873	13,754	26,955	24,737
		Second crop.	405	977	637	251	342	218	541	388	160	982	490
		Total ..	17,679	29,346	28,552	26,141	28,913	24,814	28,718	26,261	13,914	27,937	25,227
Total of 3 and 4 ..	40,693	First crop.	32,289	45,378	42,105	44,290	46,730	32,858	41,360	39,677	15,185	38,704	37,857
		Second crop.	405	977	637	251	343	218	541	388	172	1,007	494
		Total ..	32,694	46,355	42,742	44,541	47,073	33,076	41,901	40,065	15,357	39,711	38,351

NOTE.—*Items* 1 *and* 2.—The areas shown represent actual cultivation.

Items 3 *and* 4.—Information as to the areas actually irrigated not being available for all the years, areas charged as irrigated have been entered.

5. The two systems for which Capital and Revenue accounts are kept and which have only come into operation in recent years are worthy of notice, as having proved so far unsuccessful.

Munneyeru Project—consists of an anicut across the Munneyeru river and a channel 26 miles long for irrigating 10,500 acres. The channel was opened for irrigation for the first time in 1897-98.

The small area of 878 acres that were irrigated in 1899-1900 was for the most part due to the small quantity of water available. Cultivation is slowly extending and the project will probably be successful in the long run.

Dondapad Tank.—This is a reservoir with a catchment of 85 square miles designed to irrigate 1,680 acres. Up to date the cultivation has been practically *nil*. This is due to two reasons—

(1) The supplies in the tank have been trifling.
(2) There is no low level sluice so that a considerable quantity of water which is stored cannot be utilised.

It is not surprising that when we find the Cumbum tank which is usually so successful receiving practically no water, this tank should have been up to date a failure. There seems no reason why it should not fill in most years in the future, though it may be that the run off may be less than was expected. If it does fill I believe that there will be no difficulty in getting the land cultivated. An estimate for constructing a low level sluice is under preparation and this should be pushed through at once.

6. *Area protected.*—The following is the area protected from famine :—

	Acs.
Protected in all seasons	*360,600
Percentage of area cultivated	17·76
Protected in ordinary seasons	*381,100
Percentage of area cultivated	18·77

*These figures are taken from Benson's Statistical Atlas. Since its publication the area of irrigation under the Kistna delta system has gone up by about 200,000 acres.

Only a portion of the district may be considered partly liable to famine. The accompanying statement shows the average numbers relieved since 1876 :—

Year.	Period.	Number of months.	On works.	Gratuitously.	Weavers.	Total.
1876-78 ..	December 1876 to September 1878.	22	2,808	2,044	..	4,852
1900 ..	March to August	6	1,237	..	..	1,237

N.B.—The maximum number on relief was 28,567 in September 1877.

7. During recent years a great deal has been done to improve the irrigation of the upland taluks of this district. Estimates for a large number of reservoirs have been prepared, some of which have been sanctioned and others are in various stages of preparation. Of the sanctioned estimates the following are the more important :—

(*a*) Constructing a supply channel to Peddakancherla tank. Estimate, Rupees 40,400. This has been carried out as a famine-relief work and is practically complete and likely to be successful.

(*b*) *Jangamaheswarapuram Tank.*—Estimate, Rs. 77,200. It is proposed to restore a ruined tank and irrigate 800 acres.

Several small estimates are also sanctioned.

8. Of the estimates under preparation the most important is the *Gundlakamma Reservoir Project.* The proposals are described at length in G.O., No. 262 I., dated 14th March 1901. It is intended to construct a concrete dam across the Gundlakamma river. The dam will be 99 feet high above the deep bed of the river and the waterspread will submerge an area of about 19 square miles. The total catchment area of the river at the site of the dam is 2,210 square miles. Of this the Cumbum tank has a drainage area of 430 square miles and the proposed Thokapalli Reservoir 280 square miles. The remaining 1,500 square miles is practically free catchment

though there are a few small tanks in it. The reservoir will have a capacity of 9,408 mills. cubic feet. The Chief Engineer for Irrigation has laid down 35,000 acres as the area to be provided for, but it will probably be better in such a work as this to have a comparatively high percentage of double crop lands and if this view is accepted such long distributaries will not be required. The country on the left bank below the dam slopes somewhat sharply to the river and there are many ridges so that a long and tortuous channel is required before any large area is commanded. There is little doubt that the land in the neighbourhood of Vinukonda would be readily taken up were water supplied. The country on the right bank is easier and channels could be constructed, but the boundary of the Kistna district is soon reached and the Venkatagiri zemindari entered on where it is doubtful if the landholders would take water even if it were offered to them. About 20,000 acres of ryotwari land can be found and this should suffice for the present.

The Momadavaram project, or as it is now called, the Gundlakamma reservoir project, as the village from which it took the former name is insignificant and will be submerged, was first brought forward by Captain Taylor in 1874. The site of the reservoir was examined in the following year and reported on by Major Hasted, who was then Superintending Engineer, as well as by the local officers. At that time the idea was to make a reservoir 90 or 100 square miles in area and provide water for irrigating 150,000 acres. It was assumed that three-fifths of the rainfall on the catchment would run into the reservoir. It does not appear on what grounds this very sanguine estimate was based or where such a large area of land was expected to be obtained. The chief difficulty in making the project remunerative was considered to be that due to the scantiness of the population. In the order on the reports (No. 1095, dated 19th April 1875), Government remarks: " . . . . the report of the Superintending Engineer shows that possibly such a reservoir might be constructed so as, under more favourable circumstances, to be not unremunerative. With, however, the scanty population of the country commanded, it is not at all likely that the water supply would be made full use of until after the lapse of many years; and as the Chief Engineer for Irrigation has pointed out, it is in contemplation to expend large sums within the next 20 or 25 years which will fully occupy the Public Works establishments and prove of much greater benefit than any reservoir, however large, could be, taking the population of the two localities into account." The opinion is added that further investigation of the proposed reservoir might well be postponed. In 1877 when work was required for famine relief, Major Hasted was asked to report on certain points previously left undecided and, in particular, whether it would not be possible to construct an earthen dam. He again examined the site and reported that the material obtainable was unsuitable or insufficient for an earthen dam and that the idea of constructing one as a famine-relief work could not be entertained. In the order on this report (No. 3004, dated 3rd December 1877), Government says: " It is to be hoped that this work or any other large work in this locality will not now be needed for relief purposes; but this site appears to be so favourable in many respects that it is a matter for consideration whether the investigation should not be completed on general grounds."

There the matter rested for nearly twenty years, the ordinary establishments having little time for the investigation of large projects, and the special officers who have been put on the investigation work from time to time as they could be spared, being engaged on work in other parts of the country. In 1897 Mr. Ussher, Executive Engineer, was placed on special duty with instructions to examine the Nellore district north of the Penner delta and prepare estimates for any projects which might be found feasible.

He had a survey of the lake-site made in sufficient detail to allow of an approximate estimate of the contents at different levels, but was transferred in December 1898 to ordinary duty before he could prosecute the investigation further. The work was then put in the hands of the Executive Engineer, Kistna Northern, by whom the latest approximate estimate has been submitted.

The hydrological data are not very accurate, but we have the rain-gauges at Cumbum, Giddalur and Markapur as a guide and we also have the example of the Cumbum tank before us, of which we have a continuous record for the past 16 years.

It is not necessary to delay the work in order to attempt to collect further data. At present the Gundlakamma flows to the sea without its water being utilised at all. No existing interests will therefore be interfered with.

The tract to be irrigated has the lowest rainfall in the Kistna district, and if rainfall is at all short there is always great scarcity of water. Owing to the proximity of the Kistna delta, relief works on a large scale are not often required; but in 1900 works of some size had to be opened in the immediate neighbourhood of Vinukonda.

The following is an abstract of the rough estimate as originally prepared by the Executive Engineer, Kistna Northern division :—

	Rs.
Constructing dam	7,58,000
Head sluice	20,000
Distributaries	3,00,000
Compensation for land	3,01,000
Total ...	13,79,000

N. B.—Charges for petty supervison and contingencies are included in the totals of the various estimates.

The above estimate will have to be modified very extensively and will probably be somewhat increased. The net return is estimated to be Rs. 1,22,500 giving a return of 6½ per cent. on capital outlay of Rs. 19,10,000 (adding indirect charges).

9. Other projects in various stages of preparation are—

Baggavam Tank Project.—A proposal to construct a bund across the Uravanivagu in Saltenapalle taluk, and to supplement the supply to the tank by diverting a portion of the Yeddavagu into it. It is proposed to irrigate 1,200 acres. The total estimate is Rs. 1,61,765. The land it is proposed to irrigate yields good dry crops and the ryots say that they do not wish for the tank. Its construction will submerge 801 acres of good lands for which compensation is estimated at Rs. 40,380, and the loss of revenue will be Rs. 900. The Collector recommends the inclusion of this work in the programme of famine-relief works. The taluk is one not ordinarily liable to famine and I consider that it should be struck out. The estimates have been sent to the Chief Engineer for Irrigation for sanction.

Bhrugabanda Tank Project is for a tank across the same Yeddavagu mentioned above. The catchment is 63 square miles. Capacity of tank, 256 mills. cubic feet. Ayacut, 1,500 acres. Compensation for land will be Rs. 16,130. A return of 4·5 per cent. is expected on the estimated expenditure of Rs. 95,200. Of this sum Rs. 62,000 will be available for famine labour. It is stated that the area it is proposed to irrigate will be readily taken up.

Boddalavagu Project.—It is proposed to form a tank across the Boddalavagu. It will have a catchment area of 100 square miles, but there are four tanks which will intercept a portion of the run off. It is proposed to supplement the supply by means of an anicut across the Ogeru and a channel to the tank. The catchment area at the site of the proposed anicut is 92 square miles. The rainfall at the nearest rain gauge station (Narasaraopet) is 30·33. It is proposed to irrigate 3,500 acres on the right bank of the Ogeru. The supply available and the capacity of the tank would warrant a larger area being taken up for cultivation, were there more land available. The total direct charges amount to Rs. 5,28,300. Estimated to give a return of 1·94 per cent. on total capital outlay (direct and indirect) of Rs. 6,31,300. It will probably be possible to irrigate a considerable proportion of double crop land. So this forecast may be exceeded. The amount available for expenditure on famine relief is approximately Rs. 2,25,000. The streams it is proposed to impound form the Guntur nullah which gives a good deal of trouble to the Commamur canal. The project will have the additional advantage of acting to a considerable extent as a flood moderator. The estimates are now under preparation in the office of the Executive Engineer, Kistna Northern division.

Melavagu Project.—This is a proposal to construct a masonry dam across the Melavagu (or Nagileru) to irrigate about 2,500 acres. The catchment is 100 square miles and a site for the masonry dam has been fixed. The project will probably cost about 2 lakhs and is stated to be a promising one.

Atmakur Project.—Estimate, Rs. 88,500. It is proposed to construct a new tank with a catchment of 105 square miles. The area to be irrigated is 1,160 acres with a possible increase to 1,170 acres. The capacity of the tank will be 163·67 mills. cubic feet or enough for 757 acres of single crop if once filled. 575 acres will be submerged and compensation amounting to Rs. 11,470 will be required for both the tank and distributaries. This work is situated in the famine zone of the Kistna district, and work to the value of Rs. 38,760 will be available for famine labour. The forecast of the area irrigable appears rather sanguine, but otherwise the project appears to be a good one.

9. It will be seen that the upland taluks have a good programme of works for the future. All the estimates are in various stages of preparation and, if the Kistna Northern division is relieved of the Gundlakamma project to be investigated by the Executive Engineer in charge of a special party in Nellore, the Executive Engineer, Kistna Northern division, can carry out to completion the remaining estimates.

10. *Pumping Scheme at Divi Island.*—Divi Island contains about 150 square miles of alluvial soil but is cut off from all the benefits enjoyed by the surrounding Kistna delta. For many years it was intended that it should be connected with the delta system by means of an aqueduct, and the facts that any such work would be both difficult and expensive, while there is abundance of land available elsewhere for irrigation, have caused the idea of connecting Divi Island with the anicut system to be abandoned. The island has now a precarious system of irrigation by means of small tanks which are filled by river channels; but these channels do not receive any supply unless the water rises to 12 feet on the Kistna anicut, and if it rises much above that level they are liable to be breached. In years of low freshes there is practically no cultivation and the average annual remissions are very considerable. The idea of supplying the island by pumping was mooted by Mr. Reid, Executive Engineer, in 1894, and a small experimental instalment is now working.

This minor project consists of three gwynne's centrifugal pumps worked by a 12-horse-power portable engine. The lift is about 6 feet, and 700 acres are now being irrigated. The ryots show great eagerness in making use of the water which is brought within their reach.

In the meanwhile Mr. Reid, the Executive Engineer in charge of the operations, has under preparation an estimate for carrying out the same work on a much larger scale. In this estimate he proposes to irrigate 50,000 acres of land by means of 6·48" centrifugal pumps. Each pump will supply 100 cubic feet per second or enough water for 10,000 acres and there will be one in reserve. Each pump will be worked by an engine of 150 horse-power. The approximate amount of the estimate may be detailed as follows :—

	Rs.
Engine shed, boiler-house and quarters	1,50,000
Machinery	6,50,000
Distribution at Rs. 4 per acre	2,00,000
Flood banks and drainage	50,000
Unforeseen items	20,000
Establishment and tools and plant	1,00,000
	11,70,000

The expected revenue (excluding percentage of sale on waste lands) amounts to Rs. 2,63,000 and the working expenses are estimated at Rs. 1,50,000, giving a net return of 9·6 per cent. on the capital outlay. The fuel will be coal and the estimates provide for a lock for bringing the coal alongside the engine sheds and for scouring arrangements to prevent silting in the channel.

The project is thoroughly appreciated by the ryots and there is no reason why similar installations, on a smaller scale perhaps, should not be started elsewhere.

General features.—The district is divided into three sections by the Erramalais and Nallamalais. The soil around the base of these hills and in the southern portion of the Pattikonda taluk is light and gravelly; elsewhere it is for the most part black cotton.

2. *Rainfall.*—The average rainfall of this district is 26 inches, the maximum (excluding the hills) being 35·36 at Nandyal and the minimum 17·73 at Ayaka (in Koilkuntla taluk). The western portion of the district is practically unaffected by the north-east monsoon, while west of the Nallamalais the rainfall in November is in some years considerable.

3. *Rivers.*—The district is bounded on the north by the Tungabhadra and Kistna. The Hindri is an important tributary of the former. Other important rivers are the Konderu and its tributaries, and the Gundlakamma which drains the eastern portion of the district.

1. *Existing irrigation.*—The Kurnool-Cuddapah canal, a major work, which is dealt with in its proper place, runs through the district. The accompanying statement exhibits the areas irrigated by minor works during the past ten years :—

STATEMENT showing the Ayacut areas and the areas cultivated during the past ten years (class I works excluded).

Works.	Ayacut area.		Area actually cultivated or charged as irrigated during the revenue year ending.										Average area irrigated.
			30th June 1892 (Fasli 1301).	30th June 1893 (Fasli 1302).	30th June 1894 (Fasli 1303).	30th June 1895 (Fasli 1304).	30th June 1896 (Fasli 1305).	30th June 1897 (Fasli 1306).	30th June 1898 (Fasli 1307).	30th June 1899 (Fasli 1308).	30th June 1900 (Fasli 1309).	30th June 1901 (Fasli 1310).	
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Minor Works for which Capital and Revenue Accounts are kept.	ACS.		ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.
(1) Cumbum tank system	5,746	First crop ..	4,862	5,338	5,376	5,579	5,449	5,441	5,557	5,588	4,240	5,473	5,290
		Second crop ..	563	4,113	4,166	3,983	3,764	1,327	3,876	4,875	117	1,525	2,826
		Total ..	5,425	9,446	9,542	9,512	9,213	6,768	9,433	10,463	4,357	6,998	8,116
Other Minor Works.													
(2) Petty works in charge of the Public Works Department.	20,572	First crop ..	14,354	21,406	22,670	22,919	22,801	14,580	21,193	20,872	14,621	22,249	19,766
		Second crop ..	2,859	7,984	5,124	6,310	4,705	3,130	5,061	4,364	3,577	4,642	4,776
		Total ..	17,213	29,390	27,794	29,229	27,506	17,710	26,254	25,236	18,198	26,891	24,542
(3) Petty works in charge of the Revenue Department.	27,303	First crop ..	20,518	30,201	29,993	28,460	28,101	21,980	30,036	26,571	19,483	25,977	26,132
		Second crop ..	2,950	7,927	5,216	4,271	3,710	2,585	4,512	3,976	2,101	2,869	4,012
		Total ..	23,468	38,128	35,209	32,731	31,811	24,565	34,548	30,547	21,584	28,846	30,144
Total of (2) and (3) ..	47,875	First crop ..	34,872	51,607	52,663	51,379	50,902	36,560	51,229	47,443	34,104	48,226	45,898
		Second crop ..	5,809	15,911	10,340	10,581	8,415	5,715	9,573	8,340	5,678	7,511	8,788
		Total ..	40,681	67,518	63,003	61,960	59,317	42,275	60,802	55,783	39,782	55,737	54,686

NOTE.—*Item* 1.—The areas entered represent actual cultivation.
Items 2 *and* 3.—The areas entered are those charged as irrigated. Information as to the actual areas cultivated is not available for all the years.

5. *The Cumbum tank.*—A work for which Capital and Revenue accounts are kept. It merits a short description as it may serve as a useful guide as to what results may be expected from similar works if constructed.

The Cumbum tank is formed by damming a gorge across the Gundlakamma river. It is an old native work said to have been constructed in the 14th century. It has a drainage area of 430 square miles and a capacity of 3,696 millions cubic feet. The average cultivation for the past ten years is 5,290 acres first and 2,826 acres for the second crop which gives a duty of 18·87 acres per square mile of catchment first and second crop. The accompanying statement taken from the registers shows the amount to which the tank filled in each year since 1884 :—

Year.	Month.	Gauge readings.	Number of days tank surplussed.	Remarks.
1884	November ..	26·83	..	
1885	December ..	26·63	..	
1886	October .. November ..	Full.	47	
1887	September .. October .. November	Full.	83	
1888	August ..	26·24		
1889	October ..	Full.	21	
1890	September ..	30·26	..	
1891	August ..	17·66	..	
1892	September October ..	Full	58	
1893 ..	September October .. November	Full.	82	
1894	September	32·60	..	
1895	October	26·90	..	
1896	August ..	21·30	..	
1897	September ..	23·10	..	
1898	November ..	29·30	..	
1899 ..	April * ..	* 23·20	..	* This was a slight rise on top of the remains of the previous year. The tank got practically no supply after April.
1900	October ..	17·86	..	

[illegible]

It will be seen that although during the ten years 1884–1893 the tank filled five times, during the past seven years it has not once filled and for the last two years has received hardly any supply at all. This shows that all reservoirs of this kind even with a large catchment area are liable to very great fluctuations according to the variations in the season. It should, however, be pointed out that in the famine of 1876–77 the tank was of the greatest service and enabled a large area to be cultivated. In consequence of the short supply for the past two years, many suggestions have been made for improving the supply to the tank, but I hope that this falling off is merely a passing failure and that with normal rainfall the tank will, in the future, as it has been in the past, more than suffice for the limited area which can be irrigated under it.

5. Excluding the Cumbum tank there are 524 tanks in the district, of which 339 irrigate less than 50 acres. There are also 236 other minor sources excluding wells.

6. ***Area protected.***—The following is the area protected from famine :

	ACS.
Area protected in all seasons	182,600
Percentage of area cultivated	10·5
Area protected in ordinary seasons	216,600
Percentage of area cultivated	12·4

7. ***Liability to famine.***—The whole district except the portions protected by the Kurnool canal and the Cumbum tank is liable to famine. Since the beginning of the century the district has suffered nine times from famine. It suffered severely in 1833 and to some extent in 1854. There were also relief works in 1866–67.

Diagram showing

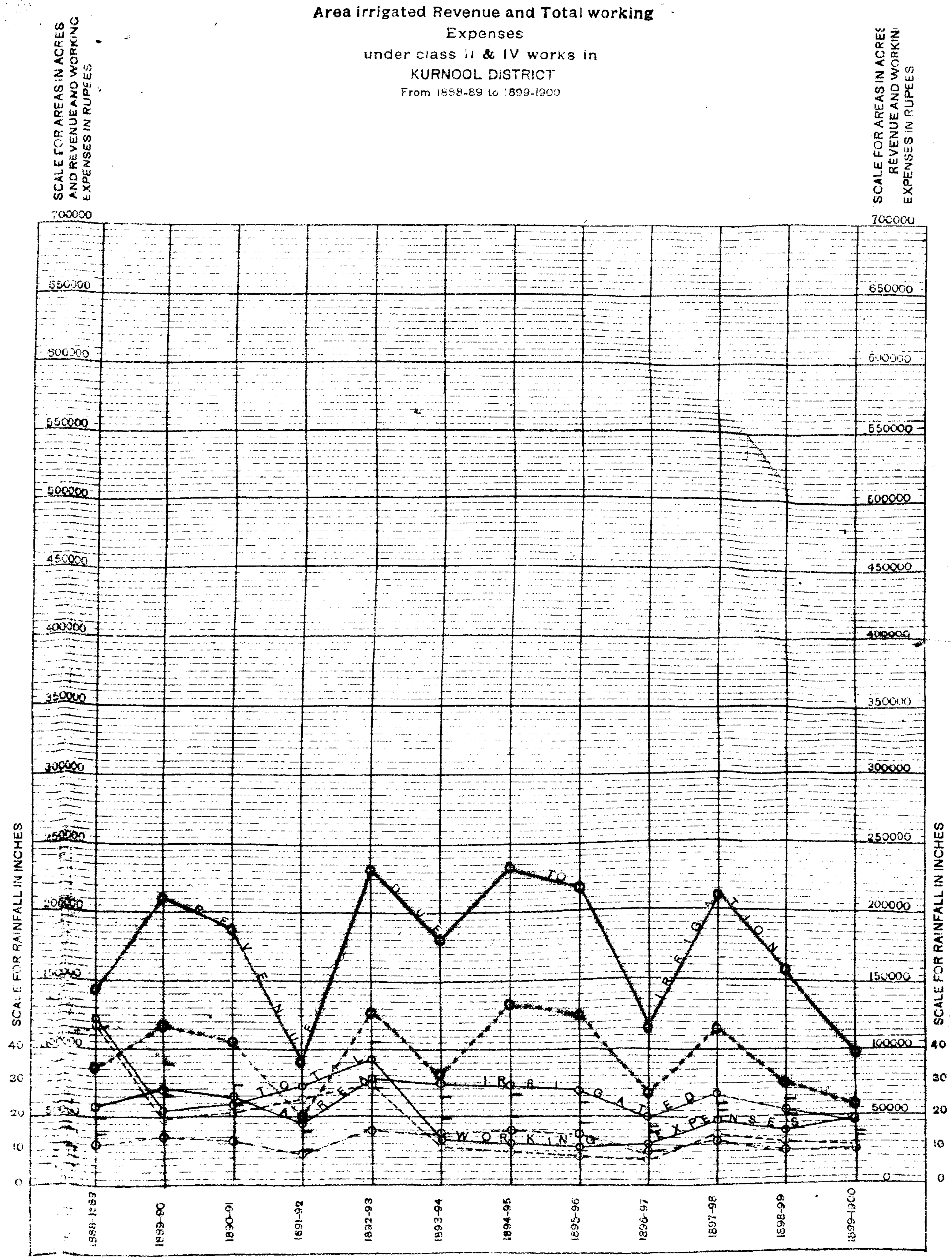
Area irrigated Revenue and Total working

Expenses

under class II & IV works in

KURNOOL DISTRICT

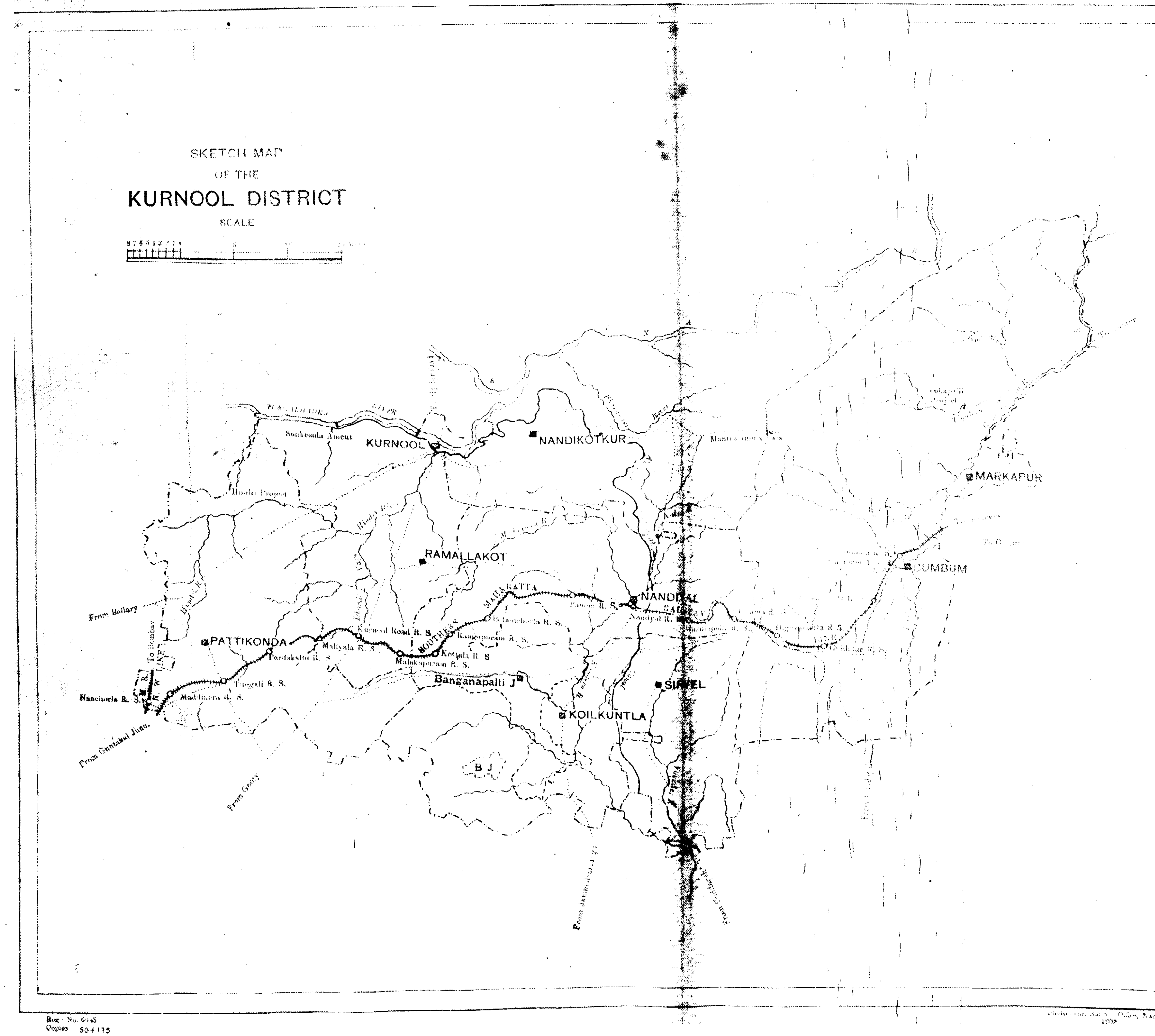
From 1888-89 to 1899-1900



Note.—The vertical lines at foot of diagram represent the rainfall of the different years in inches, the blue portions of the lines showing that due to the North-East monsoon and the red portions that due to South-West monsoon

The lengths between the bottom of the diagram and the dotted lines represent areas irrigated, &c. for works in charge of the P. W. D. and between the dotted lines and the full lines of the same colour for works in charge of the Revenue Department. The total areas, &c., relating to works in charge of both Departments are therefore shown by the full lines.

It will be observed that the scales for the areas irrigated and for rupees (revenue & working expenses) are the same and a comparison of the lengths representing revenue with those representing area irrigated readily gives the receipts per acre irrigated. Thus if the lengths are as 2 to 1, this represents receipts of Rs. 2 per acre.



The following statement shows the number of persons relieved since 1876 :—

Year.	Period.	Duration.	On works.	Gratuitous relief.	Weavers.	Total.
1876-77	December 1876 to September 1878.	22	107,069	32,956	..	140,025
1891-92	November 1891 to September 1892.	11	13,773	334	..	14,107
1896-97	November 1896 to October 1897.	12	52,736	12,789	*6,394	71,919
1900	March to August	6	2,389	..	..	*2,389

* For 8 months only.

N.B.—The maximum number on relief was 309,783 in August 1877.

8. *Possible extension of irrigation.*—Apart from the Kurnool-Cuddapah canal, which is dealt with separately, the principal project is the proposed Tokapalli reservoir. This is situated in the Markapur taluk. It is proposed to dam the Tagileru river, a tributary of the Gundlakamma, at a point where it passes through a gorge. The reservoir will be formed by a masonry dam, 65 feet high to F.S.L. above the bed of the river, and will have an effective depth for the purpose of irrigation of 40 feet. The catchment area of the stream is 283 square miles, and the reservoir will have a capacity of 2,478 millions cubic feet. The dam will be of concrete faced with masonry. The area proposed for irrigation is 6,000 acres, from which a net return of Rs. 24,800 is expected.

The site for the dam was discovered by Mr. Johnston, Executive Engineer, in 1874. The estimates are now nearly complete and are in the Superintending Engineer's office. They should by October be in the hands of the Chief Engineer for Irrigation. The catchment area is 283 square miles and the average rainfall may be taken as 25 inches. A run-off of about 1/5 may be expected, and the average annual supply will therefore be—

$$\frac{5}{12} \times 27,878,400 \times 283 = 3,287 \text{ millions cubic feet.}$$

The conditions are very similar to that of Cumbum tank, and when there is a succession of years with more or less complete failure of rain there is likely to be a very considerable diminution in the area irrigated. In an ordinary year there will be enough water to irrigate with double crop the whole of the area, 6,000 acres, now proposed to be taken up. In a bad year it will probably be possible to cultivate about 5,000 acres of first crop and hardly any second. With a succession of bad years this area may be seriously diminished.

There are no rain records in the catchment area itself, or none of sufficiently long standing to be of any use. The rainfall stations at Markapur, Cumbum and Giddalur give us a sufficient indication of what is likely to happen.

It would certainly not be advisable to delay the estimates in order to attempt to collect more data.

The construction of the work will in no way interfere with any supply to Native States or private individuals. The tract to be irrigated is very liable to famine and is at the present moment suffering from extreme drought. Land will be readily taken up under the tank. It is very hard to estimate the maximum area that such a work is likely to irrigate in a year of drought, but, assuming a single bad year, it is likely to irrigate from 4,000 to 5,000 acres single crop land. Wet assessment can be charged on the land irrigated and is estimated to amount to Rs. 24,810.

The following is an abstract of the cost of the project for which detailed estimates are nearly ready :—

	Rs.
Dam, sluices and surplus weir	2,90,550
Distributaries	1,27,270
Compensation	1,74,430
Sheds, contingencies and supervision	49,000
Unforeseen work	40,750
	6,82,000

Of this Rs. 1,28,000 will be available for famine relief.

9. *Hindri project.*—A proposal has been made to utilize the waters of the Hindri in Pattikonda taluk either by constructing an anicut and channel to supply Bellagal tank and perhaps forming another reservoir, or by making a reservoir on the river itself. No levels have yet been taken and the project is not in a sufficiently advanced state to form an opinion on, but it is likely to be found feasible. The catchment area of the stream at or near the site of the proposed anicut or dam is 500 square miles. The area it is proposed to supply is badly off for water, and water would be readily taken. In addition to the above it may be possible to form small tanks on the tributaries of the Konderu which flow from the Erramalais and Nallamalais. Sites may be found where they leave the hills, and there the soil is light and sandy and well suited for irrigation. It may also be possible to make small tanks in upper basin of the Hindri. For this purpose a party has been proposed. These tanks will undoubtedly run dry in really bad years, but they will add to the general prosperity of the ryots and will form excellent famine-relief works.

10. As regards the eastern taluk of Markapur which undoubtedly is in great need of irrigation works, I do not think that any expensive project besides the Tokapalli reservoir should be at present investigated. There are probably sites to be found on the Duvaleru, but as both the Tokapalli and Gundlakamma reservoirs will probably be constructed the waters of the Gundlakamma should be "ear-marked" for them. This does not apply of course to minor projects such as a supply channel to Markapur tank or one to Tripurantikam tank-works which are being investigated by the establishment of Kurnool division and which may be carried out in the ordinary way.

11. *Recommendations of Revenue officers.*—I interviewed the Collector, the late Canal Deputy Collector, the Head Assistant Collector and the Deputy Collector of Markapur. The recommendations of the first two officers were principally, with regard to the Kurnool canal which is dealt with elsewhere. The Collector is much dissatisfied with his famine-relief programme and considers that a party should be formed to prepare estimates for this purpose. I have above made proposals to this effect which will, I hope, meet his wishes, but I much doubt whether very many satisfactory works can be found. As I have stated elsewhere, I believe it to be worse than useless to form tanks in black-cotton soil, where the ryots do not want to irrigate and where the compensation for the land submerged is high.

BELLARY DISTRICT.

General Features.—The Bellary district is divided into two portions by the Ramandrug range. The eastern portion is black cotton soil and the western light red soils. There are, however, tracts of red soils in the Adoni taluk and western portion of Rayadrug, while in the Hadagalli taluk there are several tracts of black cotton soil. It is to be noted and remembered that, while water is readily taken for irrigation on the red soils, they are, as a rule, situated at a higher level than the black soils, being found at the base of the rocky hills (whether of granite or Dharwar schists) which abound in the district.

2. *Rainfall.*—The rainfall is very light, that in the central zone of the district having the town of Bellary approximately as its centre being nearly the lightest in the Presidency. The average of the district is 22·68 inches. The rainfall at Ramandrug 39·28 is excepted. The maximum is 26·08 at Adoni and the minimum 18·79 at Rayadrug.

3. *Rivers.*—The whole of the western and northern boundary of the district is formed by the Tungabhadra, a perennial river rising in the Western Ghâts of Mysore and Bombay. Its principal tributaries are the Chinna Hagari in the western and the Hagari in the eastern portion of the district. Both of these rivers are dry for the greater part of the year, but occasionally carry floods of considerable volume. The floods in the Chinna Hagari are of more frequent occurrence than those in the Hagari.

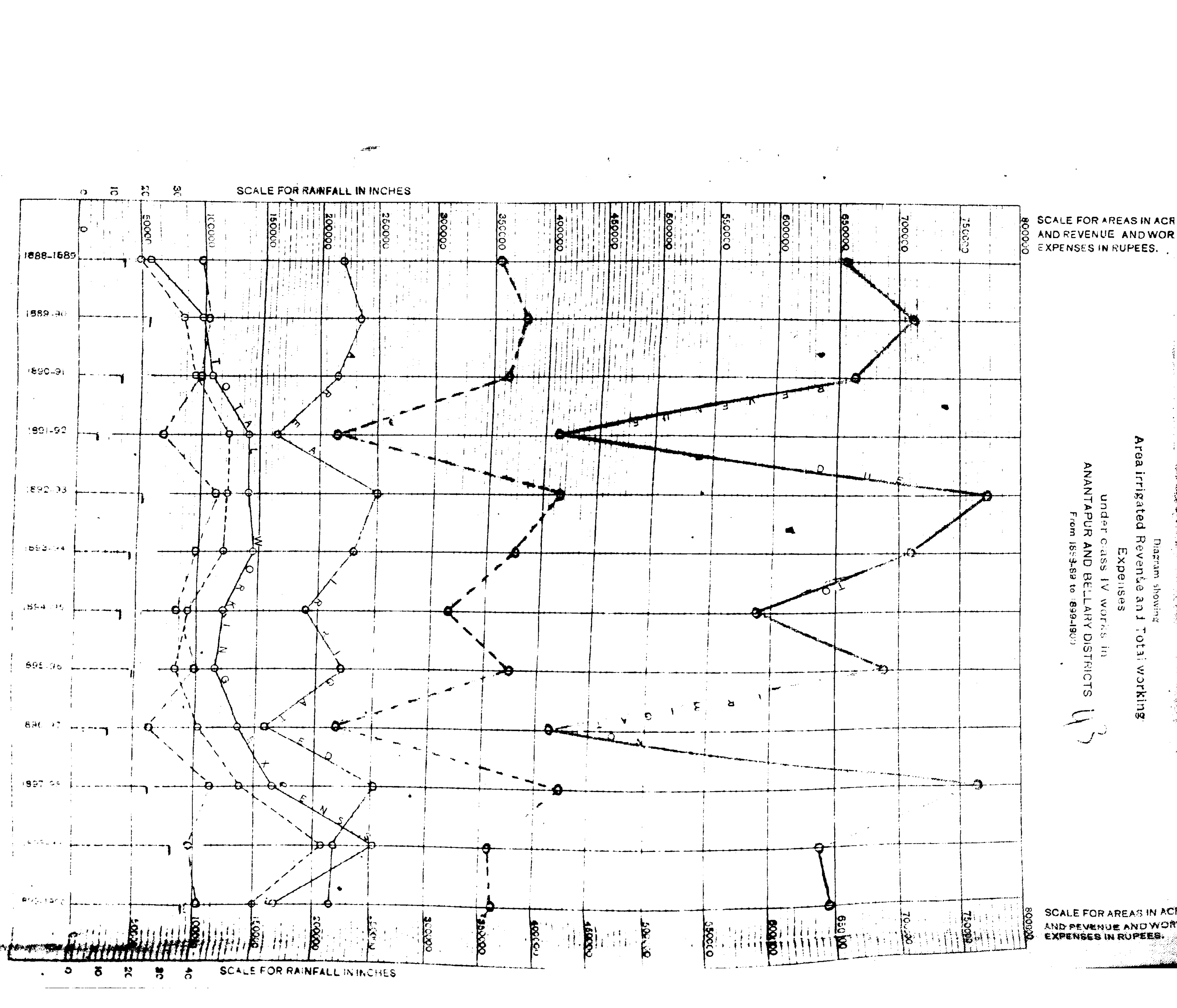
4. *Existing Irrigation.*—The most important irrigation in the district is from the eight channels taking off from the Tungabhadra. Their supply is almost perennial, and valuable crops—the most important of which is sugarcane—are grown under them. The channels do not irrigate large areas — the most important, the Roya channel, only irrigating about 2,900 acres. No large extension of these works is possible owing to the formation of the country. The Tungabhadra runs in a deep trough, and the transverse slope of the country towards the river is very steep. It is therefore almost impossible to get away from the river.

5. The tanks in the district are not numerous or of great importance. There are very few in black cotton soil and they are not, as a rule, made full use of, but there are exceptions, *e.g.*, at Kanekal in Rayadrug taluk and at Kottur in Kudligi taluk. The areas irrigated during the past ten years are shown in the subjoined statement.

STATEMENT showing the Ayacut areas and the areas cultivated during the past ten years.

Work.	Ayacut area.		30th June 1892 (fasli 1301).	30th June 1893 (fasli 1302).	30th June 1894 (fasli 1303).	30th June 1895 (fasli 1304).	30th June 1896 (fasli 1305).	30th June 1897 (fasli 1306).	30th June 1898 (fasli 1307).	30th June 1899 (fasli 1308).	30th June 1900 (fasli 1309).	30th June 1901 (fasli 1310).	Average area irrigated.
			Area charged as irrigated during the revenue year ending.										
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Works for which Capital and Revenue Accounts are kept.	ACS.		ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.
Nil.													
Other Minor Works.													
Petty works in charge of the Public Works Department.	36,006	First crop ..	26,585	30,958	30,834	30,020	30,597	25,356	32,179	31,332	31,475	32,432	30,177
		Second crop ..	6,355	7,887	7,535	6,363	7,574	6,308	8,227	8,349	7,644	7,469	7,371
		Total ..	32,940	38,845	38,369	36,383	38,171	31,664	40,406	39,681	39,119	39,901	37,548
Petty works in charge of the Revenue Department.	21,124	First crop ..	18,843	24,196	27,262	21,205	21,571	17,941	22,865	20,381	21,842	20,330	21,644
		Second crop ..	7,635	7,783	10,198	6,4	7,844	6,049	9,923	7,553	7,746	5,910	7,690
		Total ..	26,478	31,979	37,460	27,469	29,415	23,990	32,788	27,934	29,588	26,240	29,334
Total ..	57,130	First crop ..	45,428	55,154	58,096	51,225	52,168	43,297	55,044	51,713	53,317	52,762	51,821
		Second crop ..	13,990	15,670	17,733	12,627	15,418	12,357	18,150	15,902	15,390	13,379	15,061
		Total ..	59,418	70,824	75,829	63,852	67,586	55,654	73,194	67,615	68,707	66,141	66,882

Note.—Information as to the areas actually cultivated is not available for all the years. Hence areas charged as irrigated have been taken.



6. *Area protected.*—The following is the area protected from famine :—

	ACRES.
Protected in all seasons	32,000
Percentage of cultivated area	2·0
Protected in ordinary seasons	60,300
Percentage of cultivated area	3·9

7. *Liability of the District to Famine.*—The district suffered severely in the famines of 1824 and 1833. The famine of 1854 was also very severe. During the famine of 1866–67, a large number of people were relieved on works. The following table shows the average numbers relieved during and since the famine of 1876–78 :—

Date.	Duration in months.	On works.	Gratuitously.	Weavers.	Total.
December 1876 to September 1878	22	99,521	48,132	..	147,653
,, 1891 to ,, 1892	10	7,747	21	..	7,768
November 1896 to October 1897	12	61,063	9,800	881	71,744
March to June 1900	4	428	..	..	428

N.B.—The maximum number on relief was 461,914 in August 1877.

8. *Possible extension of Irrigation.*—A very large number of minor schemes have been suggested and some are now under consideration. A list of them is given in appendix C. Unfortunately it is believed that no inconsiderable number have already been condemned and will be again condemned when considered. Several of the breached tanks it is proposed to restore have so silted up that it would be folly to spend money on acquiring their valuable beds for such insignificant storage. As much time is often wasted in reinvestigating small projects of this sort, I would suggest that a duplicate register be kept—one in the Collector's and one in the Executive Engineer's office—in which the disposal of every project should be entered and that no project should be referred to the Executive Engineer for investigation without first seeing that it has not already been disposed of. If the Collector's establishment cannot find time to keep such a register, the Executive Engineer should certainly do so. There are, however, probably several sites available for new tanks in the western taluks of the district and these may prove very useful, as irrigation is there popular. It would of course be possible to form tanks in the black cotton soils of Bellary and Alur taluks and one has recently been sanctioned as a famine work at Kolur, 10 miles north of Bellary. It is, however, more than doubtful whether such works will be successful for the following reasons :—

(1) Experience shows us that the water in them is not likely to be fully utilized.

(2) As villages are situated along the margins of the jungle streams to be impounded, it would be very difficult to avoid heavy compensation for land occupied by village-sites.

(3) The construction and maintenance of the works will be expensive.

(4) They will silt up very quickly.

Still, if good sites are found, they will make good famine-relief works ; and some more estimates of the kind should be got ready.

9. A recent Executive Engineer of Bellary proposed two sites for tanks—one on the Chinna Hagari at Hagari Bommanahalli, and the other on a stream of some size near Hadagalli. These should be investigated, though it is possible that the compensation to be paid may render their execution prohibitive.

10. The consideration of a storage reservoir on the Tungabhadra itself has been considered separately.

ANANTAPUR DISTRICT.

General Features.—The whole district slopes from the south where it borders on the Mysore plateau to the north. A great part of the Gooty and Tadpatri taluks consists of black cotton soil, but the remainder of the district is composed of light and gravelly soils interspersed with rocky hills.

2. *Rainfall.*—The rainfall of the district is very light, the average being 22·81 inches. The heaviest is at Madakasira where it is 24·37 and the lightest at Dharmavaram where it is 20·28. The rainfall is not only light but often unequally distributed—a matter of great importance in a district where the light soils require frequent showers to prevent the failure of dry crops.

3. *Rivers.*—The Pennér traverses the whole district. Its only important tributaries are the Jeymangalam and Chitravati rivers.

4. *Existing Irrigation works.*—The accompanying statement shows the areas irrigated in the district during the past ten years :—

STATEMENT showing the Ayacut areas and the areas cultivated during the past ten years.

	Ayacut area.		Area charged as irrigated during the revenue year ending.										Average area irrigated.
			30th June 1892 (fasli 1301).	30th June 1893 (fasli 1302).	30th June 1894 (fasli 1303).	30th June 1896 (fasli 1305).	30th June 1897 (fasli 1306).	30th June 1898 (fasli 1307).	30th June 1899 (fasli 1308).	30th June 1900 (fasli 1309).	30th June 1901 (fasli 1310).		
1	2	3	4	5	6	7	8	9	10	11	12	13	14
	Acs.		Acs.	Acs.	Acs.	Acs.	Acs.	Acs.	Acs.	Acs.	Acs.		Acs.
Minor Works for which Capital an Revenue Accounts are kept.													
Nil.	..	..	..	..	..	..	..	..	..	..	..		..
Other Minor Works.													
2. Petty works in charge of the Public Works Department.	51,243	First crop ..	30,804	49,254	45,946	38,005	26,032	31,495	44,843	45,027	46,684		42,297
		Second crop ..	5,151	22,998	13,092	6,341	5,006	20,958	10,645	8,381	9,675		11,573
		Total ..	35,955	72,252	59,038	44,347	31,038	52,453	55,488	53,408	56,159		53,870
3. Petty works in charge of the Revenue Department.	78,490	First crop ..	53,321	78,957	69,562	62,621	53,120	77,961	70,242	70,690	74,222		67,626
		Second crop ..	15,418	31,091	24,291	19,528	18,876	31,621	23,269	22,192	23,065		23,835
		Total ..	68,739	108,048	93,853	82,049	71,996	109,176	93,511	92,882	97,287		91,461
Total of 2 and 3	129,733	First crop ..	84,125	126,211	115,508	100,627	79,152	109,049	115,085	115,717	120,806		109,923
		Second crop ..	20,569	54,089	37,383	25,869	23,882	52,579	33,914	30,573	32,640		35,408
		Total ..	104,694	180,300	152,891	126,496	103,034	161,628	148,999	146,290	153,446		145,331

NOTE.—Information as to the areas actually cultivated is not available for all the years. Hence areas charged as irrigated have been taken.

There are 942 tanks in the district, of which 550 irrigate less than 50 acres. There are also 1,759 other sources (excluding wells). Most of these are river and spring channels and are individually unimportant. There are 12 tanks in the district irrigating over 1,000 acres each, but it is to be noted that in this district it is very common to grow dry crops, principally ragi (*Elusine coracana*), under tanks and that therefore the areas served are considerably larger than they would be in districts where rice and garden crops alone are raised.

5. *Area protected.*—The following is the area protected from famine :—

	ACS.
Area protected in all seasons	32,500
Percentage of area cultivated	2·9
Area protected in ordinary seasons	113,300
Percentage of area cultivated	10·2

6. *Liability to Famine.*—The whole district is liable to famine. In 1803 there was scarcity amounting to famine; in 1823 famine was anticipated and relief works started; in 1832–33 both monsoons failed and the year was the worst on record up to that time; 1838 was almost a famine year; in 1843 the rainfall was small and unseasonable; in 1844 and 1845 the seasons were very bad; 1853–54 were famine years; in 1865 distress was anticipated and there was famine in 1866; from 1876 to 1878 famine raged; in 1884 relief works had again to be started; in 1891–92 the district narrowly escaped from severe distress. In 1896–97 there were extensive relief works and ever since that year the district has been on the verge of famine.

The following statement shows the number of persons relieved since 1876 :—

Period.	Duration in months.	On works.	Gratuitously.	Weavers.	Total.
December 1876 to September 1878	22	37,000	22,160	..	59,160
,, 1891 to July 1892	8	756	181	..	937
November 1896 to October 1897	12	23,750	5,431	340	29,521
March 1900 to August 1900	6	1,378	..	..	1,378

N.B.—The maximum number on relief was 137,347 in August 1877.

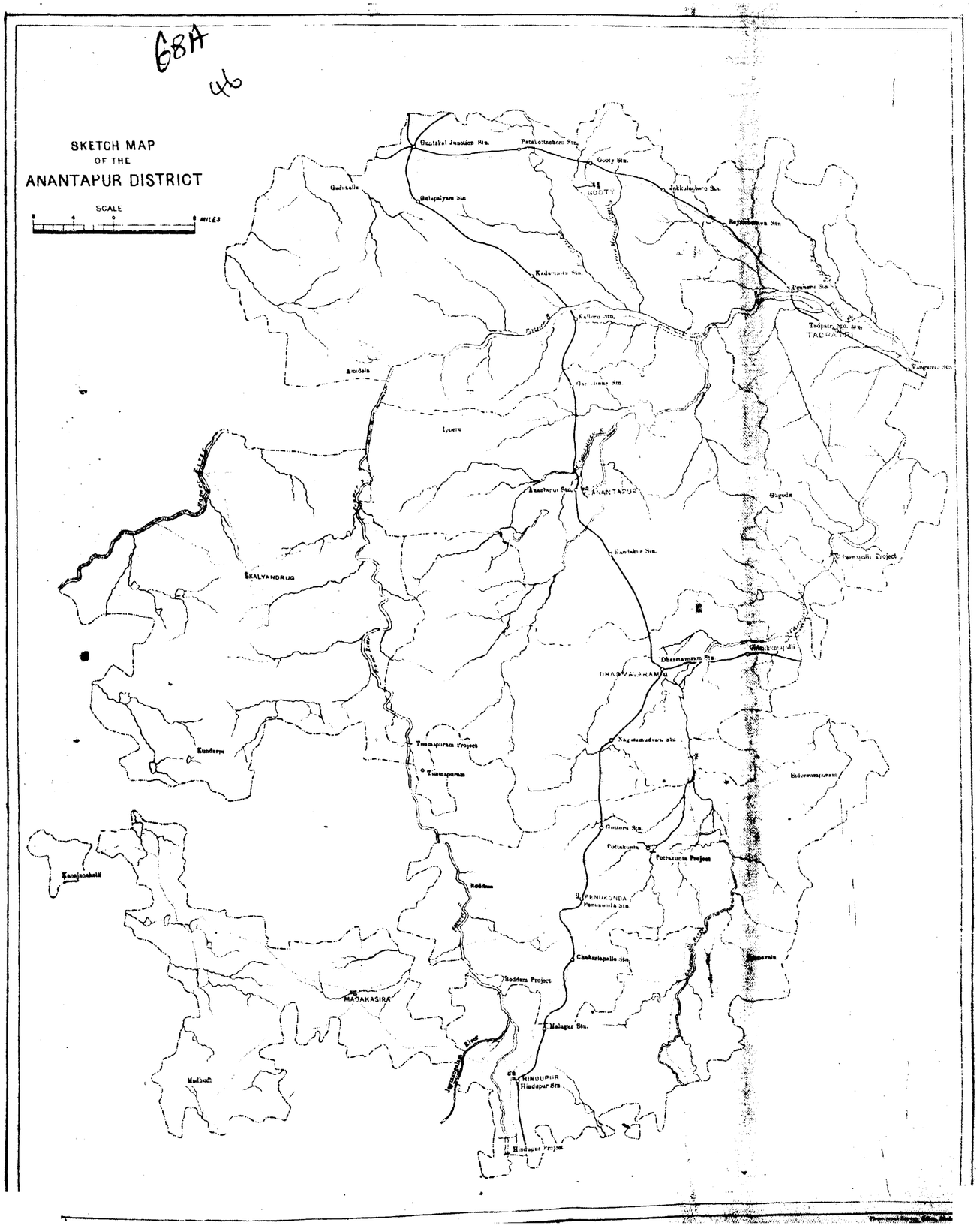
7. *Possible Extension of Irrigation.*—Numerous spring channels are taken off from the Pennér and the Chitravati rivers and form an important means of irrigation, but there are no anicuts on the Pennér. The Chitravati and its tributaries are dammed in several places forming the large tanks of Bukkapatnam, Dharmavaram, Anantapur and Singanamalla. A large portion of the upper waters of the Chitravati is therefore fully utilised in the Anantapur district.

8. The following projects have at various times been proposed :—

(1) *Parnapalli reservoir across the Chitravati.*—This was proposed by the Irrigation Company's officers in connection with the Kurnool canal. Surveys were made, the site appearing favourable for the construction of a large reservoir; but on borings being made nothing but sand and clay was found in the river-bed at depths of 35 to 72 feet, and in G.O., No. 123 I., dated 27th February 1879, the project was ordered to be abandoned. There was apparently no proposal to irrigate directly below the dam, and from the map it looks as though a channel would have to be taken some way to do so. Even if another site could be found, there is no prospect of a satisfactory project here. In ordinary years there would be little or no water, the greater part being absorbed by the tanks above mentioned and by the new Dorigallu project (*vide* Cuddapah district). At the same time there would always be the possibilities of large floods to be provided for.

(2) *Potlakunta Project.*—This is a proposal to construct a tank on a feeder of the Chitravati. The catchment area is 90 square miles and the supply was reported by Mr. Larminie, when Executive Engineer, Bellary, to be good. The estimated cost is Rs. 1,15,000, but this is probably too low. It was removed from the list of famine relief works as it was not likely to be financially a success; but a more valid objection is that it will cut off a greater part of the drainage of Dharmavaram tank. That important tank has an ayacut of 1,600 acres. Information received from the Revenue Department shows that during the past five years the tank has filled three times. There has been practically no surplus, and the full ayacut area has never been reached. I cannot therefore recommend the resuscitation of this project.

Although it may not be advisable to cut off so much of the drainage area of Dharmavaram tank, some smaller ones higher up would probably do a great deal of



good without appreciably affecting the larger tank below. The Head Assistant Collector recommends the investigation of such works and they should be enquired into.

(3) *The Hindupur Project.*—Estimates for this were prepared in 1868 by Mr. Gray and were scrutinised in 1882 by Mr. Garrett then in charge of the "C" Project division. The project consists in throwing an anicut across the Pennér river about 7 miles south of Hindupur and taking a channel to feed eleven tanks. The project was condemned (*a*) because of the comparatively small proportion of work suitable for famine relief and (*b*) because it was inadvisable to call into existence new claims on the waters of the Pennér which frequently prove insufficient to meet the duties now expected of them. In G.O., No. 695 I., dated 14th August 1899, it was however ordered that the project should be investigated and taken up as a famine relief work during the next famine, and plans are now under preparation. The objections to the project are: (*a*) There is no good site for an anicut, which will involve a large expenditure unsuited for famine relief. (*b*) The supply in the Pennér is very precarious and has undoubtedly been diminished during recent years owing to the improvement and probable extension of irrigation works in Mysore. In other respects the work is suitable for famine relief.

(4) *Roddam Project.*—This is a similar project submitted by Mr. Gray, about the same time, for an anicut across the Pennér river 2½ miles below its junction with the Jeyamangalam river, and about 14 miles below the proposed Hindupur anicut. From the anicut a channel was to be taken to fill five tanks; the cost was estimated by Mr. Gray at Rs. 1,03,220; but the Superintending Engineer puts the probable cost at Rs. 1,25,000 for works, and of this Rs. 65,000 would be suitable for famine relief. No orders appear to have been passed on this project.

It has obvious advantages over the proposed Hindupur project—

(*a*) The river at the site of the anicut will have a catchment area of 1,100 square miles against one of 215 at the proposed Hindupur anicut, and will have a chance of more frequent freshes as the showers which produce them are frequently local in character.
(*b*) It has a larger proportion of work suitable for famine relief.
(*c*) It is slightly nearer the area likely to be affected by famine.
(*d*) It may be possible to extend the channel for a considerable distance and take it through a ridge, thus diverting the water into the catchment of the Anantapur and Singanamalla tanks. This has not yet been levelled, and could only be carried out as a famine-relief work and water would probably only be available once in three or four years. The investigation of this project should not be neglected though I do not think it would be worth doing as an ordinary work.

(5) A somewhat similar project has been proposed by the Sub-divisional officer, Anantapur. His proposal is to construct an anicut across the Pennér at Thimmapuram village in Dharmavaram taluk and to lead the flood waters into a reservoir to be formed near Banukota village, the surplus to flow into the Anantapur minor basin and supply nine tanks there. This is estimated roughly to cost 6 lakhs and may be the best form for the project to take. It has the obvious advantage of avoiding Mysore territory altogether.

9. Other minor projects have been suggested and will be found in the list of works proposed in the Bellary division (Appendix C). There are numerous small streams on which the formation of tanks would be possible and I recommend that these should be systematically inspected, and wherever a site is found investigation should at once be made. The streams to which attention should be particularly directed are the minor affluents of the Pennér, the Hagari in Dharmavaram taluk and the streams draining into the former river in Tadpatri. Such reservoirs as it may be possible to construct on these local drainage channels would probably be dry or nearly dry in very bad years, but they would enable crops to be grown in most years over areas on which failure is the rule rather than the exception. In the light soils of Anantapur, irrigation is of supreme importance and every effort should be made to conserve in the district as much water as possible.

10. I consider this investigation is beyond the power of the Executive Engineer of the Bellary Division as he has his time fully taken up with other work. The works individually are not likely to be of great importance and I consider that a selected upper subordinate with two surveyors should be attached to the party I have proposed for Cuddapah and should work under the orders of the Assistant Engineer in charge of that party.

CUDDAPAH DISTRICT.

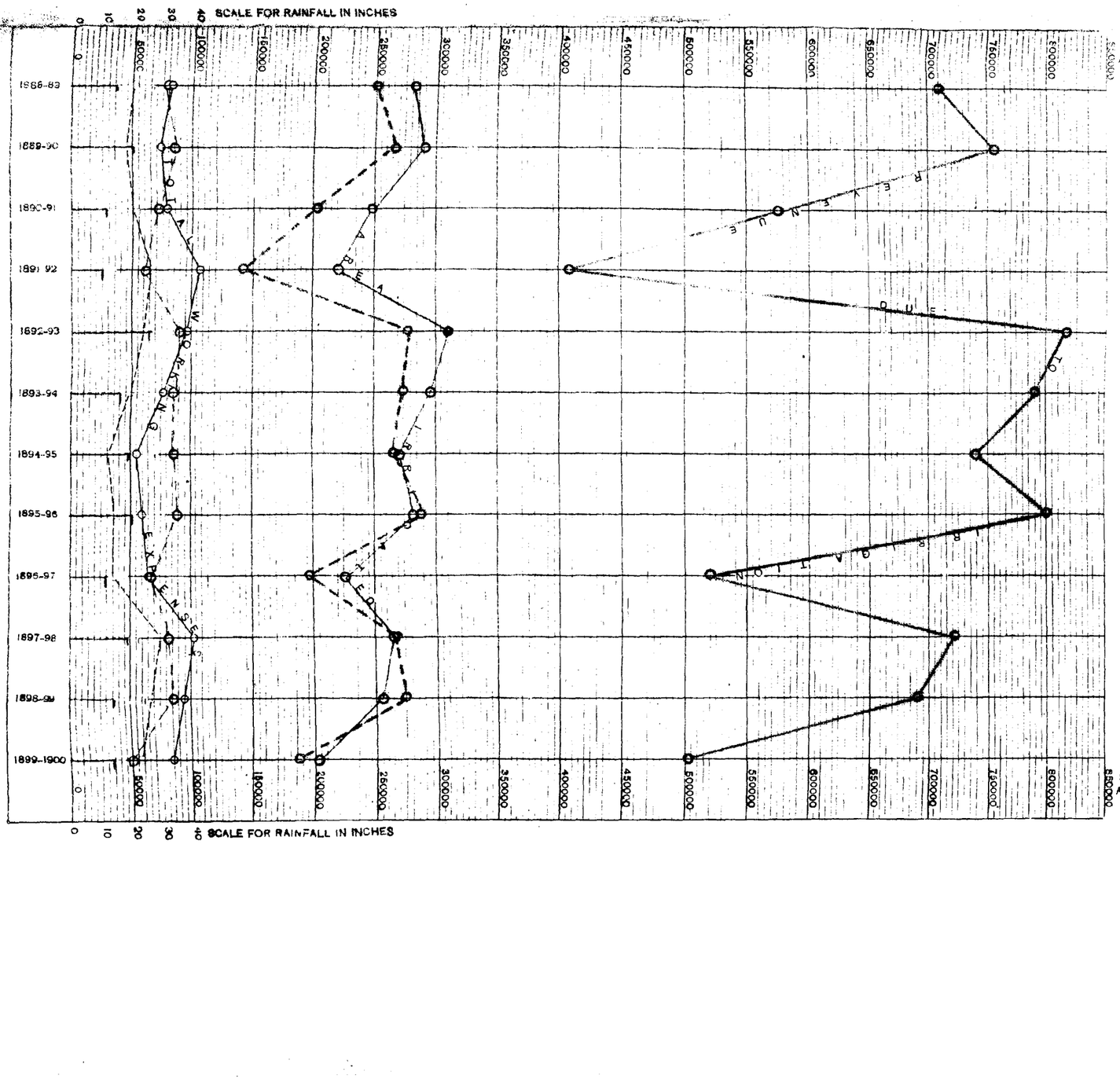
General features.—The greater part of the district is undulating with light and poor soils which need constant rain or artificial irrigation. In the northern portion of the district there are plains of black-cotton soil where good dry crops are grown in years of normal rainfall, but even in this area extension of irrigation would be welcomed.

2. *Rainfall.*—The average rainfall of the district is 27·84 inches, the maximum being 36·61 at Rajampet and the minimum 21·34 at Jammalamadugu. The average fall of 27·84 inches includes extremes as low as 8·2 inches in 1876 and as high as 50·38 inches in 1874.

3. *Rivers.*—The Penner runs through the district and is joined by its affluents the Chitrávati, Pápaghni and Cheyyéru on the south and the Kunder and Sagiléru on the north. Speaking generally these streams are dry for the greater part of the year, but occasionally carry large volumes of water for short periods.

4. *Existing irrigation works.*—The Proddatur and Cuddapah taluks are served by the Kurnool-Cuddapah canal which irrigates about 21,000 acres (first and second crops) in this district. The areas irrigated by minor works during the past ten years are shown in the following statement and diagram:—

Diagram showing
Area irrigated Revenue and Total working
Expenses
under class II & IV works in
CUDDAPAH DISTRICT
From 1888-89 to 1899-1900



Note.—The vertical lines at foot of diagram represent the rainfall of the different years in inches, the blue portions of the lines showing that due to the North East monsoon and the red portions that due to South West monsoon.

The lengths between the bottom of the diagram and the dotted lines represent areas irrigated &c. for works in charge of the P. W. D. and between the dotted lines and the full lines of the same colour for works in charge of the Revenue Department. The total areas &c., relating to works in charge of both Departments, are therefore shown by the full lines.

It will be observed that the scales for the areas irrigated and for rupees (revenue & working expenses) are the same and a comparison of the lengths representing revenue with those representing area irrigated readily gives the receipts per acre irrigated. Thus if the lengths are as 2 to 1, this represents receipts of Rs. 2 per acre.

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Photo. Prints, Survey Office, Madras.
1902.

STATEMENT showing the Ayacut areas and the areas cultivated during the past ten years (class I works excluded).

—	Ayacut area.	—	Area actually cultivated or charged as irrigated during the revenue year ending 30th June 1892 (Fasli 1301).	30th June 1893 (Fasli 1302).	30th June 1894 (Fasli 1303).	30th June 1895 (Fasli 1304).	30th June 1896 (Fasli 1305).	30th June 1897 (Fasli 1306).	30th June 1898 (Fasli 1307).	30th June 1899 (Fasli 1308).	30th June 1900 (Fasli 1309).	30th June 1901 (Fasli 1310).	Average area irrigated.
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Minor Works for which Capital and Revenue Accounts are kept.	ACS.		ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.
(1) Sagiléru project	5,693	First crop.	..	..	..	..	..	..	..	4,290	3,685	4,027	4,001
		Second crop.	..	..	..	..	..	..	..	2,623	234	546	1,134
		Total ..	..	..	..	..	..	..	..	6,913	3,919	4,573	5,135
Other Minor Works.													
(2) Petty works in charge of the Public Works Department.	56,009	First crop ..	41,592	56,942	56,698	56,925	60,203	47,768	57,190	58,861	46,103	54,540	53,682
		Second crop ..	18,548	33,138	29,966	27,530	29,293	22,587	25,285	27,529	22,305	23,330	25,951
		Total ..	60,140	90,080	86,659	84,455	89,496	70,355	82,475	86,390	68,408	77,870	79,633
(3) Petty works in charge of the Revenue Department.	137,066	First crop ..	119,928	157,428	154,421	141,612	147,017	117,146	139,136	128,662	110,715	133,352	134,941
		Second crop ..	41,109	62,888	56,284	46,780	47,488	37,829	43,309	41,716	32,031	39,978	45,641
		Total ..	161,037	220,316	210,705	188,392	194,505	154,975	182,445	170,377	142,746	173,326	180,582
Total of (2) and (3) ..	193,075	First crop ..	161,520	214,370	211,114	198,537	207,220	164,914	196,326	187,523	156,818	187,892	188,623
		Second crop ..	59,657	96,026	86,250	74,310	76,781	60,416	68,594	69,244	54,336	63,303	71,592
		Total ..	221,177	310,396	297,364	272,847	284,001	225,330	264,920	256,767	218,154	251,195	260,215

NOTE—*Item* 1.—The areas entered represent actual cultivation. The system came into operation in 1898-99.
Items 2 *and* 3.—The areas shown are those charged as irrigated. Information as to the areas actually cultivated is not available for all the years.

5. *Minor works.*—In the Badvel taluk is the Sagiléru anicut and channel. This was completed in 1898–99 and consists of a channel, 10 miles long, to supply a chain of tanks. The project has proved successful in so far that all land suitable for cultivation and commanded has been readily taken up. The probable total extension will, however, not exceed 5,693 acres unless the system is altered or improved.

6. *Other minor works.*—There are 4,671 tanks in the district, of which 4,142 irrigate less than 50 acres. There are also 1,389 other irrigation works, such as spring channels. The great majority of these are also very small.

The total occupied area of minor works, including the Sagiléru project, is 210,939 acres and the average area of first crop irrigated 192,624 acres.

7. *Liability of district to famine.*—The greater part of this district is liable to famine, the only portion which is protected being the area commanded by the Kurnool-Cuddapah canal. In the earlier years of the past century considerable distress prevailed in the district, and in the years 1823–24 and 1833 there was again famine. In 1865–66 although crops were scanty and prices very high no actual famine occurred; but in 1876—78 famine extended to all parts of the district, the southern section of it suffering most severely. Again in 1891–92 there was severe distress owing to the failure of crops in the eastern and southern sections. The latter portion of the district is always more liable to distress. The following statement shows the average numbers relieved since 1876 :—

Period.	Duration.	On works.	Gratuitously.	Weavers.	Total.
	MONTHS.				
December 1876 to September 1878	22	57,760	30,173	..	87,933
May 1891 to August 1892	16	3,472	16	..	3,488
November 1896 to October 1897	12	28,734	5,254	7,024	41,012
February 1900 to August 1900	7	3,229	...	3,076	6,305

NOTE.—There has also been a small number on relief works during the current year. The exact numbers are not at present available.

N.B.—The maximum number on relief was 297,502 in September 1877.

8. *Area protected*—

	ACRES.
Total area protected in all seasons	125,450
Percentage of area cultivated	8·2
Total area protected in ordinary seasons	297,900
Percentage of area cultivated	19·6

9. *Possible extension of irrigation.*—No works of a very extensive nature have been proposed and it is not probable that any will be found possible. From an inspection of the map it would appear as if one or more of the main streams might be dammed at one of the gorges through which they pass, but it is believed that deep sandy beds exist, which would render the sites unsuitable. Valuable dry lands would also in most cases be submerged.

10. Statement III in appendix II compiled from the water registers at the Nellore anicut shows that during the ten years ending with 1899–1900 an average quantity of 96,041 millions of cubic feet or enough to irrigate 384,000 acres of first crop have passed over the Nellore anicut to the sea, and that only in one year did no water escape beyond the anicut. It would of course be impossible to store the whole average surplus, but a determined attempt should be made to impound as much as possible. This can be most economically done by—

(1) forming new reservoirs across the tributaries of these rivers where the nature of the ground is favourable and where compensation for submergence will not be excessive;

(2) construction of anicuts and channels to feed existing tanks which may in some cases be enlarged.

These works will not in themselves be famine protective in the fullest sense of the word in that it will not be possible to cultivate the full area served by them in years of scarcity. They will, however, serve—

(*a*) for the cultivation in years of scarcity of smaller areas which would otherwise lie waste

(*b*) to improve the general prosperity of the cultivator and *pro tanto* increase his power to resist famine;

(*c*) to improve the supply from wells and springs situated near but not directly connected with the works. This is in this district an important consideration which should not be lost sight of in considering the value of any proposed reservoir.

11. A good deal has already been proposed in this direction and some schemes have been partially investigated, but it seems likely that a systematic inspection of all the rivers, one by one, would lead to the discovery of other sites for reservoirs and of anicuts with channels leading to tanks in the neighbourhood of the streams. From a number of projects in more or less complete shape in the Division office the following may be selected as samples :—

Vemala tank.—A proposed new tank; catchment, 15 square miles; capacity, 46·2 millions of cubic feet; area to be irrigated, 464 acres; estimate, Rs. 47,450; expected to pay a return of 3½ per cent. on outlay. A great deal of the work would be suitable for famine labour.

Vempalli tank.—A proposed new tank with a catchment area of 27 square miles; capacity, 223 millions cubic feet; area proposed to be irrigated, 800 acres; estimate, Rs. 1,38,000, of which Rs. 1,14,000 is suitable for famine labour; estimate submitted by the Executive Engineer.

Kanchalama tank.—Proposed restoration of a breached tank, catchment, 83 square miles, of which 21 square miles is free catchment; capacity, 91 millions cubic feet; area to be irrigated, 422 acres. The project is recommended by the local officers of the Revenue Department and is now being investigated. It would be suitable for famine labour.

Itodu project.—A proposal to make an anicut and channel from a stream coming from Mysore to supply a chain of 10 tanks near Kadiri; proposed increase of cultivation, 1,000 acres; estimated to cost Rs. 88,000, but the whole project requires further investigation.

Many more projects of this sort are probably feasible in this district.

12. *Dorigallu project.*—This is a promising project, the preliminary investigations of which have been made. I have myself visited the site of the dam and have inspected the lands proposed to be irrigated. The proposal is to construct an earthen dam with concrete core for a short length across the Muddeleru river, a tributary of the Chitrávati. The catchment area is 532 square miles, and though there are a good many existing tanks in the basin they are all small ones, so that a large proportion of the run-off will be available for storage in the new reservoir. The project was first proposed by Mr. J. N. Atkinson, then Sub-Collector of the district, in 1892; but surveys have only recently been made and they are by no means complete. I have also as the result of my inspection proposed sundry possible modifications which will render more field work necessary.

The country drained is principally in the Kadiri taluk, and the rain gauge at ia airi forms a very fair guide as to the amount of water available. The rainfall fluctuates very largely, the maximum being 70·84 inches and the minimum 8·23 inches. The average is 25·59. The whole of the catchment basin is composed of rocky quartzite hills with narrow valleys, and the percentage of run off should be high. It may be safely assumed to suffice for 20 acres* per square mile of catchment which would give enough water for 10,640 acres of first crop. There are, however, in the catchment basin already 5,877 acres of wet cultivation which have to be supplied, so that there should remain enough water for 4,773 acres.

* This is equivalent to a run-off of about 1/13 of the total fall.

Sub-Conductor Ulyett, who made the preliminary investigation, reports as follows regarding the supply :—"The Muddeleru is also said to be in fresh for about 3 days on an average during June, July and August of each year, and is also in fresh for an average of 6 days during October, November and December of each year, and the river is also said to have a continuous flow for about 8 months in the year (June to February). The river was in slight flow when the Tank Restoration Scheme party arrived at Dorigallu at the end of January 1897, the previous year 1896 being a year of very deficient rainfall."

In ordinary years I anticipate that there will be enough water for 5,000 acres and in years of scarcity it will probably be possible to irrigate from 1/5 of the area upwards according to the intensity of the drought. As explained below, it will probably be found that for some years to come more water will be stored than can be utilized and as long as this is the case the whole area taken up will be protected even in bad years, but as cultivation extends there will be a less assured supply to the lands first taken up. The valley in which the lands to be irrigated lie is fairly wide with good soil and there should be no difficulty in constructing distributaries. It is hard to state the precise area commanded, but it is considerably in excess of the area for which water is likely to be available. As above stated, I believe that we may work up to a maximum of 5,000 acres in course of time, but that, owing to the small number of inhabitants of the valley at present, it will take some time and half that area may be taken as the land likely to be cultivated in the immediate future.

The hydrological data available are not very thorough, but as far as they go are good. No useful purpose would be served by attempting more systematic observation.

The construction of the proposed work will not interfere with any work below. There are numerous spring channels on the Penner below its junction with the Chitrávati, of which the Muddelera is a tributary. These will in my opinion be benefited, if affected at all, by a large area of wet cultivation, the drainage water from which passes slowly back to the river. The Nellore irrigation is so far off that it need not be considered.

With regard to the liability to famine please see the general description of the district in this respect. The area commanded is more liable to famine than the average of the district.

The area likely to be irrigated in times of drought must vary with the rainfall in the catchment area. For some years to come it will probably be possible to protect 2,500 acres and eventually 1,000 acres as a minimum. There is no danger of irrigation injuring the soil or waterlogging it in any way.

Water-rate, amounting to about Rs. 3-4-0 per acre, can be charged on all lands taken up and irrigated. This is in addition to the dry assessment now charged which varies from 4 annas to 8 annas per acre.

Cost.—The site of dam not having been definitely settled and many other details requiring modification, it is only possible to form the roughest guess at the cost. The following may be taken as an approximate estimate :—

	Rs.
Earthwork for dam	1,80,000
Earthwork for distributaries	15,000
Concrete core wall	30,000
Revetment to dam	17,000
Surplus works	3,000
Four sluices	10,000
Masonry works on channels	20,000
Land compensation	15,000
Contingencies	30,000
Petty supervision	10,000
Total ...	3,30,000

Of the above the whole of the earthwork and a portion of the other work, such as collection of rough stone for revetment, breaking metal for concrete, say, in all, Rs. 2,20,000, could be made available for the employment of famine labour. The work is one for which detailed estimates should be prepared at once.

13. *Opinion of Revenue officers.*—I had a conference with the Collector and Sub-Collector. The Collector stated that he had no special projects to bring forward, but that from time to time small projects were suggested which he could not get investigated owing to the Executive Engineer having no staff. With regard to a suggestion I threw out that more river channels might be made from the Penner as famine works, he considers that most of the suitable sites have already been utilized but that there is room for a few in Jammalamadugu taluk.

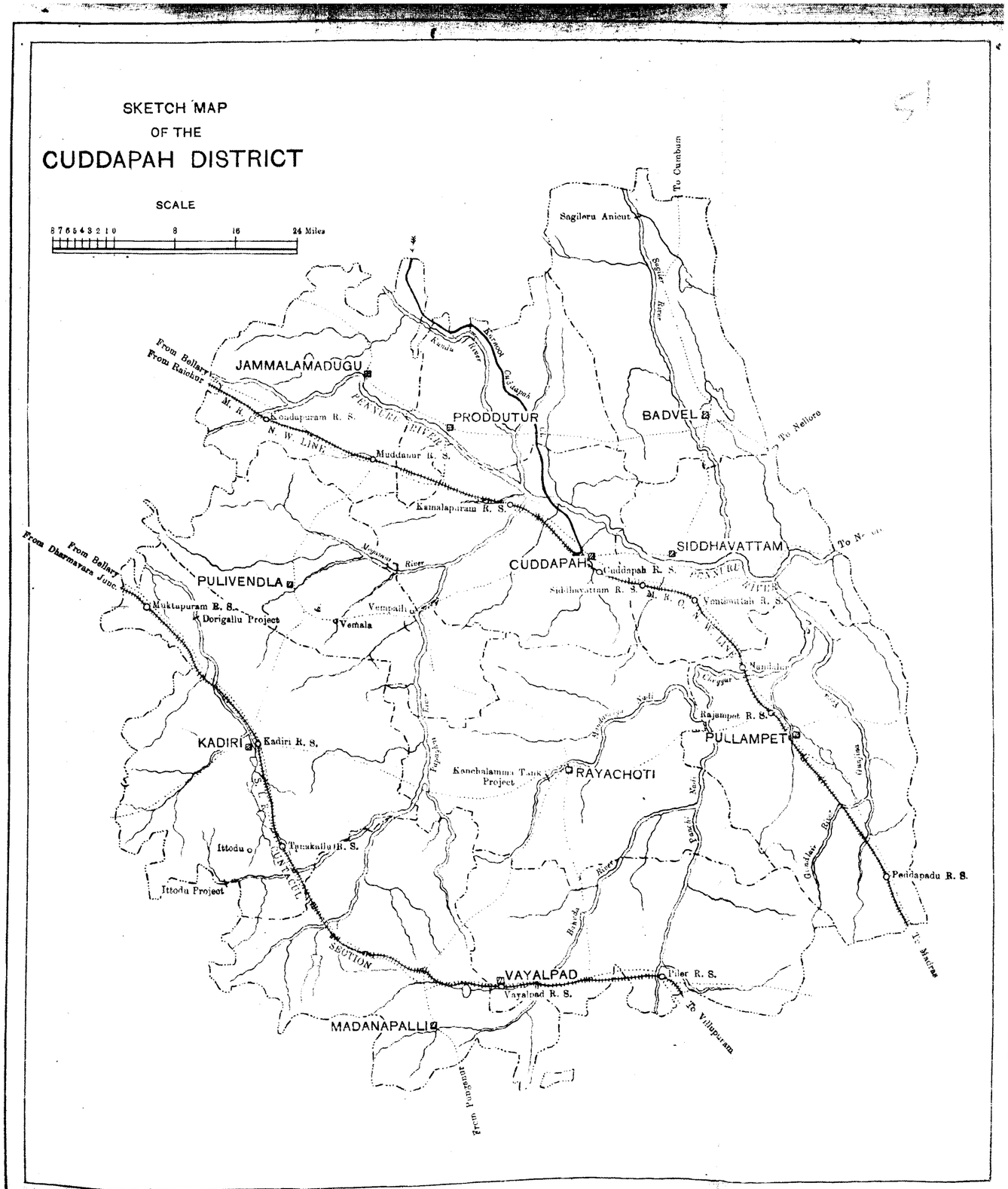

Photo-print Survey Office, Madras.

NELLORE DISTRICT.

General Features.—The whole district lies between the Eastern Ghâts and the sea. On the western side of the district the soils are poor and gravelly; but near the sea where the laterite formation is not found there are tracts composed of loam and clays of fair quality. In the extreme north there is a small area of black cotton soil.

2. *Rainfall.*- The average rainfall of the district is 34 inches; the months of heaviest rainfall being October and November. The heaviest average rainfall is at Tada in Venkatagiri zemindari and is 41·57, the lightest being 24·22 at Kanigiri.

3. *Rivers.*—The principal rivers which drain the district are the Penner, the Gundlakamma and the Swarnamukhi. Other streams, more or less torrential in character, are the Musi, the Paleru, the Manneru, the Bogeru (a tributary of the Penner) and the Kandleru.

4. *Existing Irrigation.*—The Penner river system is dealt with elsewhere. Apart from this there are a large number of tanks which are supposed to supply an area of 141,304 acres. The accompanying table and diagram show the areas irrigated during the past ten years:—

STATEMENT showing the Ayacut areas and the areas cultivated during the past ten years (class I works excluded).

Works.	Ayacut area.	—	Area charged as irrigated during the revenue year ending.											
			30th June 1892 (fasli 1301).	30th June 1893 (fasli 1302).	30th June 1894 (fasli 1303).	30th June 1895 (fasli 1304).	30th June 1896 (fasli 1305).	30th June 1897 (fasli 1306).	30th June 1898 (fasli 1307).	30th June 1899 (fasli 1308).	30th June 1900 (fasli 1309).	30th June 1901 (fasli 1310).	Average area irrigated.
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Minor Works for which neither Capital nor Revenue Accounts are kept.	ACS.		ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.
1. Petty works in charge of the Public Works Department.	74,579	First crop	39,587	84,368	86,305	85,303	82,190	91,517	65,993	93,217	70,715	87,149	78,668
		Second crop ..	1,346	11,332	7,886	7,331	5,388	7,280	6,309	7,755	7,710	7,4	6,981
		Total ..	40,933	95,700	94,191	92,634	87,578	98,797	72,302	100,972	78,155	94,931	85,649
2. Petty works in charge of the Revenue Department.	32,812	First crop	17,080	32,806	34,605	32,141	30,998	34,523	24,851	35,357	27,018	34,982	30,086
		Second crop ..	3,301	8,079	5,291	4,774	4,164	5,487	5,310	7,313	3,785	5,239	5,274
		Total ..	20,381	40,385	39,896	36,915	35,162	40,010	30,161	42,670	30,803	40,221	35,660
Total (1 + 2) ..	107,391	First crop	56,667	116,674	120,910	117,444	113,188	126,040	90,844	128,574	97,763	122,439	109,054
		Second crop ..	4,647	19,411	13,177	12,105	9,552	12,767	11,619	15,068	11,495	12,713	12,255
		Total ..	61,314	136,085	134,087	129,549	122,740	138,807	102,463	143,642	109,258	135,152	121,309

NOTE.—Information as to the areas actually cultivated is not available for all the years. Hence areas charged as irrigated have been taken

Diagram showing
Area irrigated Revenue and Total working Expenses
under class IV works in
NELLORE DISTRICT
From 1888-89 to 1899-1900

SCALE FOR AREAS IN ACRES AND REVENUE AND WORKING EXPENSES IN RUPEES

SCALE FOR RAINFALL IN INCHES

1888-89
1889-90
1890-91
1891-92
1892-93
1893-94
1894-95
1895-96
1896-97
1897-98
1898-99
1899-1900

Notice.—The vertical scales at foot of diagram represent the rainfall of the different years in inches, the brise portions of the lines showing that due to the North East monsoon and the remainder that due to the South West monsoon.

The lengths between the bottom of the diagram and the dotted lines represent areas irrigated, &c., for works in charge of the P. W. D. and between the dotted lines and the full lines of the same colour for works in charge of the Revenue Department. The total areas, &c., relating to works in charge of both Departments are therefore shown by the full lines.

It will be observed that the scales for the areas irrigated and for rupees (revenue & working expenses) are the same and a comparison of the tendencies representing revenue with those representing area irrigated readily shows the receipts per acre irrigated. Thus if the lengths are as 2 to 1, this represents receipts of Rs. 2 per acre.

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5. The following are the areas protected from famine :—

Protected in all seasons	...	...	...	...	...	33,800 acres.
Percentage of area cultivated	...	...	...	...	...	3·2
Protected in ordinary seasons		...	...	...	...	3,70,000 acres.
Percentage of area cultivated	...	...	...	...	...	26·1

The taluks south of the Penner which receive a fairly good rainfall and are well supplied by tanks are not so liable to famine as the northern taluks and especially the western portions near the hills. The district was visited by famine in 1807 and 1824. It suffered terribly in 1853. The following is a statement of numbers relieved on the works since 1876 :—

Year.	Period.	Number of months.	On works.	Gratuitously relieved	Total.
1876–78	Dec. 1876 to Sept. 1878 ..	22	40,826	11,877	52,703
1891–92	July 1891 to Aug. 1892 ..	14	6,302	36	6,338
1897–98	Dec. 1897 to Oct. 1898 ..	11	2,287	104	2,391
1900	Feb. to June 1900 ..	5	125	..	125

N.B.—The maximum number on relief was 97,678 in August 1877.

6. *Possible extension of Irrigation.*—At present no use whatever is made of the waters flowing to the sea through the country north of the Penner and but little use is made of the Kandleru and Swarnamukhi. In 1897–98 Mr. Ussher was placed on special duty to report on the possibility of forming reservoirs on these rivers. He fixed several possible sites and the investigation of some of these has been gone on with by the ordinary division. Owing, however, to want of special establishment and other duties, the investigation has not proceeded as rapidly as it might have. The investigation of these projects is not an easy matter. There are undoubted difficulties in the way of all of them. The rivers all flow in deep troughs rendering it difficult to find sites for reservoirs of sufficient capacity and making distributary channels long and expensive. The foundations for masonry dams also require careful inspection as solid rock is in many places hard to find, and in many cases the ground has so sloping a surface with so thin a layer of good soil that its preparation for irrigation will be both expensive and difficult. In such circumstances there is some chance of projects proving failures unless the greatest care is taken to select the best possible means of utilizing the flood waters which are now wasted. Mr. Wickham, Executive Engineer of this district from February 1897 to January 1899, has sent me a note on possible projects which is printed as appendix D.

I have myself made a tour through the northern portion of the district and have seen the sites of the more important proposed works.

7. *Gundlakamma.*—Beginning with the north the first river is the Gundlakamma. The proposed reservoir in the Kistna district which has already been described will utilize the greater portions of its waters. A proposal was made to construct an anicut at Annangi in connection with this project, but the idea may be abandoned as the lands which would be commanded grow exceptionally fine dry crops, and are very highly assessed. It is the *consensus* of all those most qualified to judge that there would be no demand for the water there.

Musi.

After the Gundlakamma comes the Musi river. No well-defined projects have been proposed here, but a few levels have been taken with the idea of forming a reservoir near Mailavaram in Ongole taluk. This site is the one alluded to by Mr. Wickham in his note as Pallikonda—*vide* appendix D. A dam about half a mile long between two hills would be necessary. The basin is a good one, but along the banks of the river there is a good deal of well cultivation which would be submerged. Mr. Wickham gives the catchment area as 350 square miles, but it is at least 450. There are however a considerable number of small tanks in the catchment. What the cultivation under them is is uncertain, but it may be put down at a guess as about 2,800 acres. They are all in the Venkatagiri zamindari. The rainfall over the catchment area averages about 25 inches and bears a striking similarity to that of Markapur and Cumbum, so

that a similar run off to that of the Tokapalli and Gundlakamma basins may be assumed and we may take 20 acres per square mile of catchment as a fair duty. We may expect therefore to irrigate about 6,500 acres under a tank here, and I think that one could be formed at a reasonable cost at the site selected. Rock is stated to be 6 or 7 feet below the river bed, but this has to be investigated. Should it be found that there are no good foundations for a masonry dam, an earthen bund could probably be formed. The surface layers of earth in the neighbourhood are very sandy, but probably it is quite suitable for forming a reservoir bank when the top layers are removed. The distributary could be on the left bank and would command good land which would be readily taken up.

8. As an alternative scheme it might be possible to form an anicut higher up the river and take water by a contour channel to a chain of tanks near Santalapad. This scheme should, however, only be adopted in case of the reservoir proving impracticable.

There is also a proposal to divert the waters of the Otlern (a tributary of the Musi) into Kondapi tank which should be greatly enlarged. Nothing has been done and this project should be investigated.

Paleru.

9. Next southward comes the Paleru, the upper waters of which flow through Kanigiri taluk which is frequently subject to famine and has a very low rainfall. Beginning at the upper end of the stream we have—.

10. *Hajipuram tank* for which an estimate amounting to Rs. 2,29,000 for works is already sanctioned. The catchment is 100 square miles, capacity 309 mills. cubic feet, ayacut area 2,900 acres or a duty of 29 acres per square mile of catchment. A weir is to be formed across the Donalera stream and water diverted by a wide channel to a neighbouring valley which is to be dammed up.

11. *Hajipuram tank*, a proposal to make a tank across a tributary. Catchment area 1½ square miles. Only a few levels have been taken. The site is a good one, but the catchment is very small; not more than 90 acres could be irrigated.

12. There is an excellent site on the *Makeru* about one mile above **Panagodu** village. Catchment about 57 square miles. This has not been investigated, though Mr. Wickham mentions it. It seems a very promising site as the gorge is only about 2,000 feet wide and spreads out into a fine basin covered with jungle.

13. *Palettipalli project.*—This is a proposal to form a reservoir on the main stream by the Paleru. Catchment 384 square miles, of which 100 square miles will be cut off of the Hajipuram tank. It is proposed to irrigate 7,500 acres. A preliminary estimate amounting to Rs 9,97,110 for works was framed, but the foundations had not then been examined. A trench has now been dug at the proposed site, and it reveals the fact that at one place it will probably be necessary to go to a very great depth, while all along no solid rock has been reached at a level of the river bed except in the deep bed of the river itself. The cost of a dam here would be prohibitive and another site may be looked for. Probably an earthen dam might be formed at a site about a mile higher up the river. In any case further investigation is necessary. Another objectionable feature of the project is that the land to be irrigated has a very steep slope and it is very doubtful whether the ryots would go to the expense of preparing their lands. Should, as seems probable, the idea of a reservoir here prove impracticable, there is no reason why an anicut should not be built and a channel taken into a neighbouring valley in which a tank or series of tanks might be formed. Another plan would be to form a reservoir at a suitable site, let the water about 10 miles down the river to Pedda Alwarpad where there is stated to be a suitable site for an anicut and flat land on the right flank. This could be brought under cultivation by means of a channel from the anicut. This may prove the best solution of the difficulty.

I think the Palettipalli scheme in its present form will have to be given up or anyhow held in abeyance until it is seen if something better cannot be devised.

14. Mr. Wickham also mentions a possible site on the Nerella vagu near Cherlopalli. Nothing further is known about this. The site requires investigation.

Maneru.

15. The Maneru was examined by Mr. Ussher in 1897 and he found three possible sites. That at Mopad was selected as the best, and a preliminary estimate has been formed, but will require modification as the foundations had not been examined. The catchment area at site is 248 square miles and the capacity of the tank 1,527 mills. cubic feet and it is proposed to irrigate 8,000 acres. This gives a duty of 32 acres per square mile of catchment which is probably too high as the nearest rain gauge station Udayagiri has an average rainfall of 28 inches. Probably a duty of 25 acres would be enough. It is now proposed to make a masonry dam with an earthen dam in continuation of it. A trench has been dug 10 feet deep in the river bed, but it is very doubtful whether the rock found at that depth is good enough to found a masonry dam on. Further examination is necessary. The rock is quartzite, more or less fissured; but as one gets down, the fissures tend to disappear. Although possibly not sound enough for a masonry dam, I think that an earthen bund with a masonry core might be tried. The height from top of bank will be about 80 feet for a distance of 350 feet. The rest of the bank will not be high. There is a very good site for a byewash at left flank and the capacity of the tank must be approximately fixed by that level. The total of the estimate is worked out to Rupees 5,92,000 and is shown to give a return of 3·75 per cent. on the capital outlay. The estimate needs revising and the return will probably be less than anticipated, as I do not think that more than 6,500 acres can be expected to be irrigated. The project, however, requires completion at an early date. The land to be irrigated is all zemindari, but it is understood that the ryots will gladly pay Rs. 4 per acre water-rate. The portion available for famine relief depends on the design adopted.

16. *Machavaram-Mopad Project.*—It is proposed to make an anicut across the Maneru below its junction with the Pillaperu to fill Machavaram *, Mopad, and other tanks. The Chief Engineer for Irrigation has given necessary instructions for the preparation of the estimates which are now complete. The estimates for works amount to Rs. 4,90,100 with a net revenue of Rs. 18,000, which gives a return of 2½ per cent. on the total capital outlay of Rs. 6,90,000, of which Rs. 1,08,000 will be available for the employment of famine labour.

* This Mopad is quite distinct from the village at which the reservoir described in paragraph 15 above is proposed to be formed.

17. *Supply channel to Kavali tank.*—At present there are no works on the Upputeru, a large tributary of the Maneru. A project was proposed for making a supply channel from this river to Kavali large tank and others near it. It was vetoed on purely financial grounds and deserves further investigation. These tanks receive a poor supply, remissions are constantly granted, and it would improve the outturn of crop even if it is not a paying project.

18. *Gandapaliem tank.*—This is an old tank across the Pillaperu, a tributary of the Maneru. The bund is very massive, but appears to have breached soon after construction owing to deficient surplus arrangements.

It is now proposed to close the breach with an earthen bund with puddle core (a masonry core would be better) and to enlarge the surplus escape and construct a new one at right flank. This will be somewhat expensive as the water will have to be prevented running down the toe of the bund. The capacity is 1,113 millions cubic feet. The catchment is 185 square miles. It is proposed to irrigate 5,000 acres. The maximum depth of water against the bank would be about 60 feet. A preliminary estimate amounting to about Rs. 2,00,000 has been submitted. This may want revising in some respects. The area to be irrigated is stated to be bad, but I have personally inspected a great deal of it and consider it very suitable. There are seven villages which will be benefited and the inhabitants professed themselves most eager for water. There is a difficulty about compensation for the bund; the zemindar of Kalahasti having claimed the value of the existing bund calculated on the basis of the value of the earthwork. The estate is now under the Court of Wards and there should be no difficulty in coming to a reasonable settlement. The country is very poor and liable to famine. The project is undoubtedly a good one and should be carried out as soon as possible.

19. In the Atmakúr taluk there are proposals to increase the supply to the Annasamudram tank and to the Anantasagaram tank. The estimate for the former is now under preparation by the Executive Engineer and is almost ready. The latter proposal has not been investigated. The river from which the channel is to be taken is the Bogeru. The construction of the channel would, it is said, involve deep and hard cutting, but the work if carried out would be of great utility. It should be investigated by the party working north of Nellore.

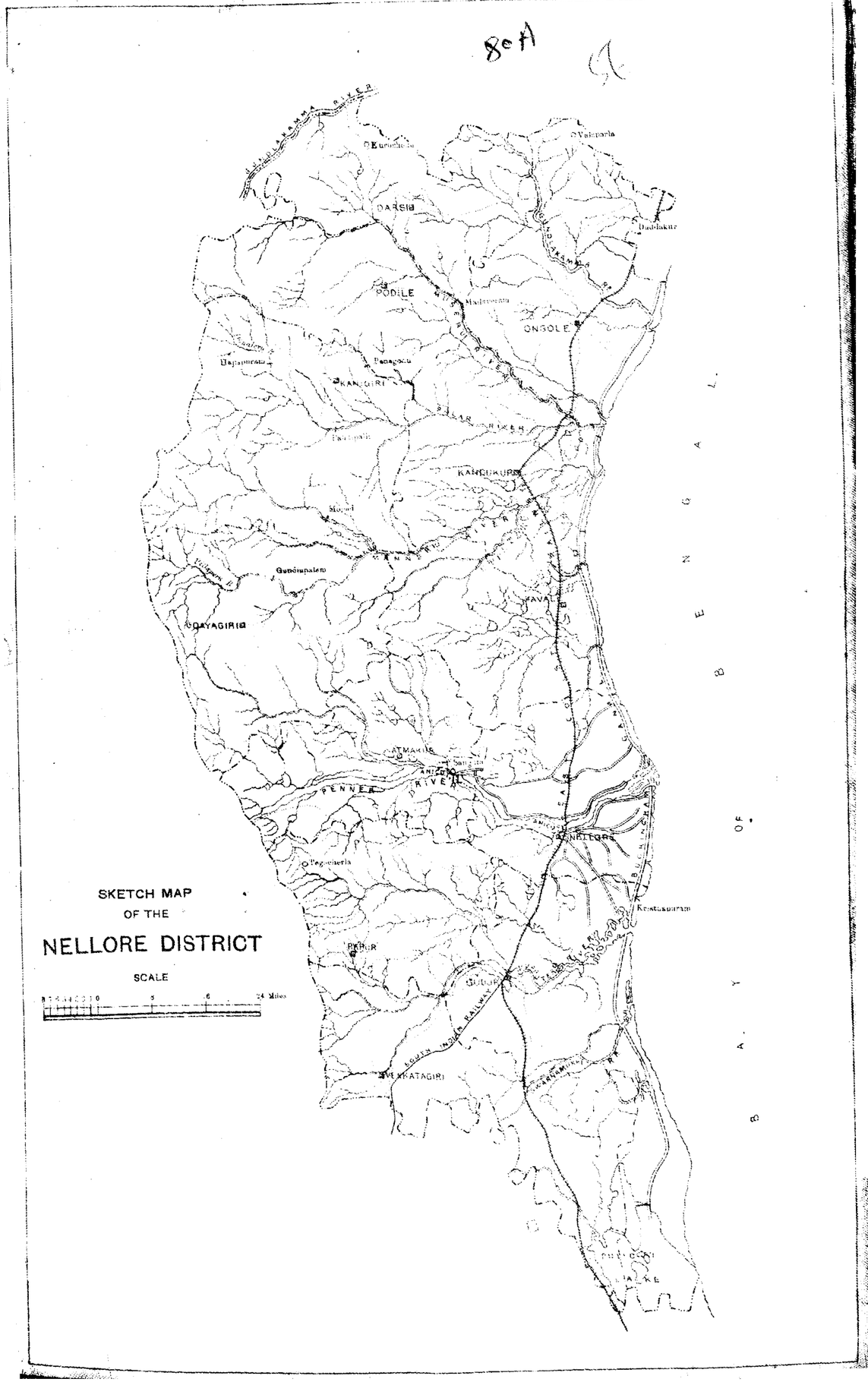
20. These are the principal projects to be investigated north of the Penner and they should be taken up at once. When they are completed there are possible sites for reservoirs on the Kandleru and on the Kolleru which are said to be promising, but no investigation has yet been made.

21. In all the reservoir projects above described, it will in a bad year probably be possible to irrigate half the full ayacut.

22. In many of the reservoir projects in this district there is a likelihood of there being some difficulty in getting ryots to incur the necessary expenditure on lands commanded to render them fit for irrigation. To render such projects successful loans should be freely granted at a low rate of interest under the Land Improvement Loans Act of 1883. Another way would be to exempt from assessment or enhanced assessment lands so improved for a term of years. As, however, capital, or money in hand, is what is required, the former plan would probably best meet the requirements of the case.

23. It is to be noted that in this district it is the custom in the earlier part of the year to grow dry crops, principally sazza (*Pennisetum typhoideum*) under tanks, the nature of the latter crop being determined by the subsequent rainfall. This is an excellent system in districts with light and precarious rainfall and it should be encouraged.

24. In this section no allusion has been made to the possibility of utilizing the waters of the Tungabhadra in this district. This is dealt with separately under the head of the Tungabhadra project.



CHINGLEPUT DISTRICT.

General Features.—The general aspect of the district is that of a nearly level plain, and the country is flat with a large extent of waste. The only hills of importance are those lying on the borders of North Arcot.

2. *Rainfall.*—The average rainfall of the district is 45·04 inches; but it is made up of extremes, such as 19·33 in 1876 and 73·08 in 1884. During the thirty years ending with 1899, the fall was below 35 inches in seven years.

3. *Rivers.*—The district is crossed from west to east by the Arni, Korttalaiyár and Pálár. The last receives within the district an important tributary, the Cheyáru, and is by nature capricious and uncertain, liable to heavy freshets and long periods of dryness. A number of irrigation channels are taken off from it. The Korttalaiyár is tapped to provide water for the Chembrambakkam, Red Hills and several other tanks.

4. *Existing Irrigation.*—The accompanying statement shows the areas irrigated by minor works during the past ten years:—

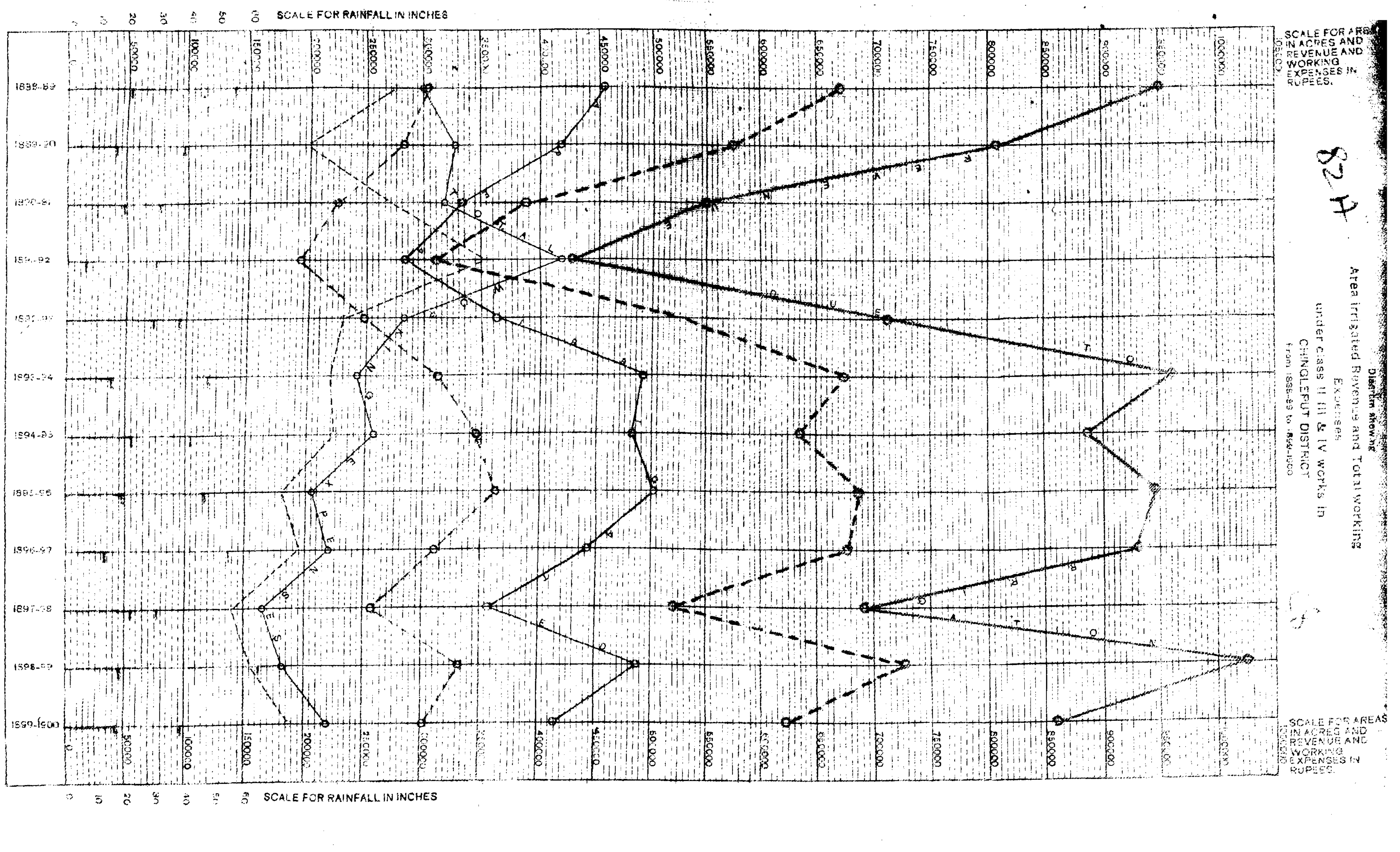
Statement showing the ayacut areas and the areas cultivated during the past ten years.

Works.	Ayacut area.	—	30th June 1892 (fasli 1301).	30th June 1893 (fasli 1302).	30th June 1894 (fasli 1303).	30th June 1895 (fasli 1304).	30th June 1896 (fasli 1305).	30th June 1897 (fasli 1306).	30th June 1898 (fasli 1307).	30th June 1899 (fasli 1308).	30th June 1900 (fasli 1309).	30th June 1901 (fasli 1310).	Average area irrigated.
			Area actually cultivated or charged as irrigated during the revenue year ending										
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Class II Works.	ACS.		ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.
1. Pálár anicut	Included in the statement for the North Arcot district. Distribution between the two districts of the areas cultivated is not available for all the years.												
2. Chembrambakkam tank	18,690	First crop ..	6,254	12,180	12,241	10,309	11,048	12,434	11,331	12,544	11,573	10,345	11,066
		Second crop ..	1,307	3,528	5,926	4,184	2,167	2,179	4,060	2,734	5,319	738	3,214
		Total ..	7,561	15,708	18,167	14,493	13,215	14,613	15,391	15,278	16,892	11,803	14,280
3. Madras Water-supply and Irrigation extension project.	9,352	First crop ..	6,441	7,110	7,042	6,990	6,997	6,883	7,197	7,028	7,127	6,636	6,945
		Second crop ..	1,381	1,325	1,978	2,630	2,260	2,341	2,846	2,371	2,983	970	2,109
		Total ..	7,522	8,435	9,020	9,620	9,257	9,224	10,043	9,399	10,110	7,606	9,054
4. Vallur anicut	5,216	First crop ..	3,322	4,183	3,337	4,207	4,455	4,337	4,449	4,457	4,401	3,629	4,078
		Second crop ..	91	225	188	188	131	94	247	242	209	210	182
		Total ..	3,413	4,408	3,525	4,395	4,586	4,431	4,696	4,699	4,610	3,839	4,260
5. Cheyáru anicut	Included in the statement for the North Arcot district.												
Class III Works.													
6. Madurántakam tank	..	First crop ..	5,131	6,021	6,931	4,379	5,866	5,932	5,401	6,165	6,013	5,839	5,768
		Second crop ..	164	1,237	1,431	1,204	1,206	799	917	1,406	1,527	899	1,079
Class IV Works.		Total ..	5,295	7,258	8,362	5,583	7,072	6,731	6,318	7,571	7,540	6,738	6,847
7. Petty works in charge of the Public Works Department.	235,868	First crop ..	155,343	187,751	223,022	223,027	231,499	233,343	192,098	231,954	217,446	220,508	211,599
		Second crop ..	12,606	31,064	47,357	37,690	48,211	38,720	25,481	65,206	30,065	23,509	35,991
		Total ..	167,949	218,815	270,379	260,717	279,710	272,063	217,579	297,160	247,511	244,017	247,590
8. Petty works in charge of the Revenue Department.	127,020	First crop ..	85,706	102,433	126,703	119,419	117,724	118,100	92,611	123,760	113,214	117,581	111,725
		Second crop ..	7,073	15,251	54,048	17,497	19,223	15,060	11,212	29,153	12,967	12,848	19,433
		Total ..	92,779	117,684	180,751	136,916	136,947	133,160	103,823	152,913	126,181	130,429	131,158
9. Total of class III and IV Works (6 + 7 + 8).	* 362,888	First crop ..	246,180	296,205	356,656	346,825	355,089	357,375	290,110	361,879	336,682	343,928	329,092
		Second crop ..	19,843	47,552	102,836	56,391	68,640	54,579	37,610	95,765	44,559	37,256	56,503
		Total ..	266,023	343,757	459,492	403,216	423,729	411,954	327,720	457,644	381,241	381,184	385,595

* Probably includes the ayacut area of the Madurántakam tank also.

NOTE.—*Class II Works.*—The areas shown represent actual cultivation.

Class III and IV Works.—Information as to the areas actually cultivated not being available, areas charged as irrigated have been entered.



For class II works vide foot note in the North Arcot diagram.

Notes.

The vertical lines at foot of diagram represent the rainfall of the different years in inches, the blue portions of the lines showing that due to the North East monsoon and the red portions that due to South West monsoon. The lengths between the bottom of the diagram and the dotted lines represent areas irrigated, &c. for works in charge of the P. W. D. and between the dotted lines and the full lines of the same colour for works in charge of the Revenue Department. The total areas, &c., relating to works in charge of both Departments are therefore shown by the full lines. It will be observed that the scales for the areas irrigated and for rupees (revenue & working expenses) are the same and a comparison of the lengths representing revenue with those representing area irrigated readily gives the receipts per acre irrigated. Thus if the lengths are as 2 to 1, this represents receipts of Rs. 2 per acre.

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5. There are 2,837 tanks and streams, of which 40 irrigate over 1,000 acres. A large area of land is usually cropped with "rain fed" paddy and this crop is more or less precarious. Thus it happens that though in ordinary years a considerable area is protected by irrigation works, they fail almost entirely to secure protection if the seasons be unfavourable. About 401,000 acres are protected in ordinary years, while the area protected in seasons of drought is only 61,100 acres.

6. *Liability to Famine.*—Since the beginning of the last century, the district has suffered from the effects of famine five times, viz., in 1807, 1824 and 1833, during the great famine of 1876–78 and lastly in 1891. It has also at other times, notably in 1867–68 and 1868–69, suffered from scarcity caused by deficient or irregular rainfall. The average numbers relieved since 1866 are—

Period.	Duration.	On works.	Gratuitously.	Total.
1866–67 ..	5 months.	..	242	242
1876–78 ..	22 „	11,965	27,902	39,867
1891–92 ..	12 „	5,360	643	6,003

N.B.—The maximum number on relief was 126,047 in September 1877.

7. *Possible Extension of Irrigation.*—Very little extension of irrigation is possible in this district. A project for improving the supply to Utramerur and Edamuchi tanks is under preparation. These tanks are at present supplied from the Cheyáru by means of a mud dam which is washed away and replaced annually. It is proposed to build an anicut with falling shutters, improve the existing channel to Utramerur tank and make a branch channel to Edamuchi tank. Utramerur tank is to be improved and rendered fit to hold its nominal full supply which it cannot do now, and Edamuchi tank will also be improved. The channels will also feed 36 other tanks. It is expected that these improvements will result in the extension of cultivation of 6,000 acres which will yield an annual return of Rs. 24,000. It is also proposed to sell certain tank-beds which will be superseded by the improved tanks. The cost of the project is estimated at Rs. 3,08,320.

8. *Madurántakam Tank.*—This is a fine large tank which is stated to surplus freely. It is proposed to enlarge it. The project has not yet been investigated and it has to be shown that the supply is good enough and that the amount to be paid for compensation is not prohibitive. If these two points are satisfactorily settled, the project should prove a successful one. Should it not prove feasible, some of the water of the Nelvoy madugu which supplies the tank may be utilised in supplying tanks throughout its course before it reaches Madurántakam tank.

9. These works will be disposed of by the existing staff of the division.

SOUTH ARCOT DISTRICT.

General features.—The Kalrayans, a group of hills, which is connected with the Shevaroys, and the Javidis separate the district from Salem. On the slopes of these hills there is a good deal of forest. The whole country is a flat and open plain except towards the west and north-west, where small rocky hills are found. In the valleys of the rivers that flow across the district, there is some alluvium, while considerable areas are under scrub jungle and along the coast extensive plantations, chiefly of casuarinas, have been formed.

2. *Rainfall.*—The average annual rainfall for the 30 years ending with 1899 is 43·20 inches ranging from 25·16 to 68·62; and in seven of these years the fall has been materially below the average. Owing to storms which occur from time to time, the rainfall near the coast is heavy, while in the inland tracts it is low.

3. *Rivers.*—The chief sources of irrigation are the Ponniar, the Gadilam, the Vellar with its tributary the Manimukta nadi, and the Coleroon. The Gingee in the north is also a river of some size.

4. *Existing Irrigation.*—All the rivers are more or less utilised for irrigation by means of anicuts thrown across them. There are also 4,817 tanks and streams irrigating a large area. The accompanying statement shows the actual cultivation for the past ten years:—

STATEMENT showing the Ayacut areas and the areas cultivated during the past ten years.

Name of work.	Ayacut area.		Area actually cultivated or charged as irrigated during the revenue year ending 30th June 1892 (fasli 1301).	30th June 1893 (fasli 1302).	30th June 1894 (fasli 1303).	30th June 1895 (fasli 1304).	30th June 1896 (fasli 1305).	30th June 1897 (fasli 1306).	30th June 1898 (fasli 1307).	30th June 1899 (fasli 1308).	30th June 1900 (fasli 1309).	30th June 1901 (fasli 1310).	Average area irrigated.
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Class II Works.	ACS.		ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.
1. Pelandurai anicut	* 6,887	First crop ..	7,526	8,517	8,054	8,564	8,494	9,011	9,774	9,342	9,854	9,258	8,830
		Second crop ..	90	101	219	191	111	168	322	375	697	445	272
		Total ..	7,616	8,618	8,273	8,755	8,605	9,179	10,096	9,717	10,551	9,703	9,111
2. Lower Coleroon anicut. { South Arcot ..	77,735	First crop ..	101,963	104,767	104,998	105,425	105,615	104,957	107,282	106,177	94,215	104,232	103,963
{ Tanjore ..	22,904	Second crop ..	4,704	4,273	6,215	4,850	4,210	1,887	3,985	5,517	5,086	6,336	4,689
Total ..	100,639	Total ..	106,669	109,040	111,213	110,075	109,825	106,844	111,267	111,724	99,301	110,568	108,652
3. Vriddhachalam anicut	5,501	First crop ..	5,724	5,299	5,876	6,277	5,790	6,061	6,012	6,592	6,068	6,508	6,021
		Second crop ..	264	211	367	247	204	225	401	678	387	579	356
		Total ..	5,988	5,510	6,243	6,524	5,994	6,286	6,413	7,270	6,455	7,087	6,376
4. Mehamattur anicut	4,075	First crop ..	2,598	2,396	2,517	2,829	3,369	3,480	3,910	3,761	3,771	3,749	3,238
		Second crop ..	23	52	82	55	76	59	105	155	294	367	127
		Total ..	2,621	2,448	2,599	2,884	3,445	3,539	4,015	3,916	4,065	4,116	3,365
5. Shatiatope anicut	25,930	First crop ..	26,580	28,133	27,023	27,629	28,239	28,838	28,982	27,613	26,141	26,330	27,582
		Second crop ..	1,995	2,919	3,075	3,538	3,757	3,391	4,755	5,775	5,009	4,492	3,870
		Total ..	28,575	31,052	30,098	31,167	31,996	32,229	33,737	33,388	31,150	30,822	31,452
6. Tirukkóyilúr anicut	20,717	First crop ..	21,650	22,111	23,182	22,298	22,404	21,870	22,534	22,054	21,207	21,500	22,081
		Second crop ..	1,996	2,610	4,356	3,536	2,656	2,884	3,096	2,883	4,172	2,524	2,957
		Total ..	23,646	24,721	27,538	25,834	24,460	24,254	25,630	24,937	25,379	24,024	25,038
7. Class III Works	..	First crop ..	12,093	11,891	12,101	12,472	12,586	12,585	12,842	12,225	12,855	12,646	12,432
		Second crop ..	3,494	3,125	2,983	3,161	2,695	3,189	3,273	3,390	3,851	4,030	3,320
Class IV Works.		Total ..	15,587	15,016	15,084	15,633	15,281	15,774	16,115	15,615	16,719	16,696	15,752
8. Petty works in charge of the Public Works Department.	†103,380	First crop ..	70,665	65,346	75,715	78,219	81,283	78,919	75,460	85,929	82,466	89,382	78,333
		Second crop ..	9,316	10,561	16,784	15,655	17,222	13,199	14,758	19,532	16,083	17,772	15,087
		Total ..	79,981	75,896	92,499	93,874	98,455	92,118	90,218	105,461	98,549	107,154	93,420
9. Petty works in charge of the Revenue Department.	185,125	First crop ..	185,977	168,993	198,144	196,094	207,913	204,731	193,954	208,972	181,697	183,511	193,279
		Second crop ..	23,653	31,166	48,910	39,111	42,848	34,010	40,227	50,885	45,615	45,111	40,157
		Total ..	209,630	200,159	247,054	235,205	250,761	238,741	234,181	259,857	230,342	228,425	233,436
10. Total of class III and IV Works ..	288,505	First crop ..	268,735	216,229	285,960	286,785	301,782	296,235	282,276	307,126	290,918	285,359	284,044
		Second crop ..	36,463	44,842	68,677	57,927	62,765	50,398	58,258	73,807	55,592	66,016	58,564
		Total ..	305,198	291,071	354,637	344,712	364,497	346,633	340,514	380,933	346,510	352,275	342,608

* The project was designed for 15,853 acres.

† Probably includes the ayacut area of Class III Works.

NOTE.—The areas shown against Class II Works represent actual cultivation.
In the case of Class III and IV Works, information as to the areas actually cultivated not being available, areas charged as

About 10,000 acres are irrigated by wells.

5. *Area protected.*—

	ACRES.
Area protected in all seasons	225,500
Percentage of area cultivated	17·0
Area protected in ordinary seasons	401,000
Percentage of area cultivated	30·1

6. *Liability to Famine.*—The district is slightly liable to floods and drought. Within the last century famine prices have prevailed ten times. In 1806–1807, relief works were opened and large remissions granted. There was distress in 1823–1825. Relief was again afforded in 1833–1834 and in 1866, while in 1877 the severest famine from which the district has suffered occurred. During this famine which lasted for a period of 20 months, 1,015 persons on an average were relieved on works and 21,556 gratuitously. The maximum on relief was 113,830. The western taluks in which the means of irrigation are the poorest are those which suffer most, and they march with the famine areas of Salem and North Arcot.

7. *Possible Extension of Irrigation.*—The Executive Engineer has given me a list of projects under investigation, but with the exception of the last, they are all of a comparatively small nature and would be carried out in ordinary course. I do not therefore think it necessary to allude to them in detail, but the list is printed as appendix E.

8. The exception referred to is the Toludur anicut project in the Vriddhachalam taluk. It is proposed to construct an anicut across the Vellar near Toludur where the Trichinopoly-Madras trunk road crosses the river, and to take from it two channels, that on the north or left bank 20 miles, and that on the right bank about 10 miles long. The area commanded on the right bank will be in the Trichinopoly district. By means of this channel about 50 major and minor tanks will be supplied. About ten of these tanks are at present supplied from the river by channels with open heads and "*Korambus*" or temporary sand leading channels

It is proposed to supply about 22,000 acres, of which 13,000 will be new cultivation. The cost of the project is roughly estimated at Rs. 6¾ lakhs. It is also proposed in connection with this project to make a new reservoir at Kilseruvai. This reservoir would have an independent catchment of 30 square miles and a capacity of 91·5 mills. cubic feet. It could be carried out as a famine work quite independently of the rest of the project.

Water registers have been kept for several years at the Pelandorai and Shatiatope anicuts and they show that there is a considerable quantity of water to spare, passing over the anicuts. The details as to the way in which the water should be utilised at Toludur without interfering with the supply to the systems lower down have not been settled; but as the proposed dam will be constructed with vents worked from a bridge, there will be no difficulty in framing rules as to when a supply may be taken to the new system. The supply to the Pelandorai anicut system will probably be assured by making a reservoir mentioned below. The returns from the project are estimated to be about Rs. 50,000.

It is stated that the greater portion of the excavation of the supply channel would be suited for famine labour. The construction of the Kilseruvai tank would also be a suitable work.

9. *Pakambadi Anicut Project.*—Eighteen miles high up the same river is a very good site for an anicut and it is proposed to build one and take off from the left bank a channel to supply two chains of tanks in the Vriddhachalam taluk. It is also proposed to enlarge Virabhayanakaram tank. The combined capacity of the tanks will be 432 mills. cubic feet, but it is considered that it will be possible to fill them several times. The increase of cultivation is estimated at 7,500 acres, giving a return of 25,000. Estimated cost of the projects is roughly 2¾ lakhs, of which about 1·5 lakhs would be suitable for famine labour. It is situated in a poor tract which is liable to suffer in times of scarcity. The project is worthy of investigation, but it is a little doubtful whether the surplus now available will serve for this project as well as the Toludur.

10. *Pelandorai Anicut System.*—The cultivated area under the existing system although extending slowly has never approached its ultimate area of 15,830 acres. The reason of this is said to be not defective water-supply but insufficient capacity to the tanks. It is therefore proposed to increase the capacity of Kannur Kalinganeri tank from 6¾ mills. cubic feet to 47¼ mills. cubic feet by raising the F.T.L. 5¼ feet. This question is now under discussion with the Chief Engineer for Irrigation.

11. Other projects not brought to notice by the Executive Engineer may be mentioned—

(1) *Pallayacheri Project.*—This is mentioned by Mr. R. E. Norfor in his letter printed with Irrigation G.O., No. 2416, dated 2nd October 1873. Of which the following is an extract:—

"* * * * *

The project is divided into two parts, the first comprises an anicut over the Trimaneemoottanuddy with two main channels, one on the north bank 7½ miles long supplying six tanks, another on the south bank 3¼ miles in length and intended to afford direct irrigation, there being no tanks or other means of storing supply; this is estimated to cost Rs. 60,000, including compensation, and a revenue of Rs. 15,000 is expected equal to 25 per cent. on outlay. The area to be irrigated is given as 3,000 cawnies at present punjah and waste.

* * * * *

The second part of this project is the extension of the channel on the north bank, 7½ miles, to supply 8 tanks, bringing under cultivation 1,000 cawnies of punjah and waste land, which will bring in a revenue (Cussur) of Rs. 5,000, but this extension is calculated to cost Rs. 80,000; I therefore do not recommend this, as there seems very little prospect of its paying.

* * * * * *"

The Sub-divisional officer of Vriddhachalam who is acquainted with the river says that there is now an anicut at Pallagacheri supplying a tank of that name and that he does not believe that any further extension is possible. I do not think that this project need be further investigated.

(2) *Cuthroyen Hills Reservoir.*—Several allusions have been made to a project of this name somewhere in the same neighbourhood as the above. The exact position is nowhere specified, but I believe that it must be at the foot of the hills about 2 miles to the west of Katcherapollium and 4 miles west of Kallakurchi. There is apparently a good site here. The drainage area is 105 square miles. The rainfall at Kallakurichi is 38 inches but it is probably much heavier on the hills. It should be possible to impound a considerable amount of water without interfering with existing irrigation lower down. This should be investigated.

(3) *Tiruvanamalai Taluk.*—This taluk is the poorest and most easily affected in an otherwise fertile district. Proposals have often been made to divert a supply from the Ponniar river to feed the tanks in this taluk, and the project if feasible would undoubtedly be a most valuable one. Various points have been suggested for taking off a channel; but the projector has invariably been confronted by a ridge mostly of rock of such a height to render the undertaking practically hopeless. Mr. Davidson when Executive Engineer enquired thoroughly into the subject and his reports are embodied in G.O., No. 1102 I., dated 15th December 1893. His conclusions are summed up as follows:—

"A reference to the map and levels shown will make it clear that the shortest method of getting the Ponniar into the Cheyyar would be to drop it into the big drainage at Pallyput. The bed of this drainage at Pallyput is the level of the crest of a 12 feet anicut at Ettiput, and between these points there is the ridge or rather table land on which Melravandavadi stands.

"The drainage stream at Pallyput drains directly into the Morayar river, which enters the Cheyyar about one mile below the Kottakalem anicut. Consequently the problem is really to bring a channel from the Ponniar into the Pallyput drainage; to do this a channel of some 15 miles, at the shortest, with an average depth of cutting 30 feet at the least, and this 30 feet virtually through rock, is required. As already stated the cost of such a channel will be very heavy; and I consider that any further investigation of the scheme will be time wasted".

(4) *Alangal Project.*—It is proposed to construct an open dam with lift shutters across the Ponniar near the head of the Alangal channel about 22 miles below the Perukkóilúr anicut. The object is to increase the supply to the Alangal channel and some adjacent minor channels on the north side and the Wallajah channel on the south. A supply can also be thrown into the north and south Mellatur channels

and the Sillangal odai into which the Alangal channel tails. It is not proposed to attempt to increase or encourage direct irrigation as the supply is not sufficiently continuous. Little or no increase of cultivation is expected, but a slight increase of second-crop area might result as well as cessation of remission. No estimate has been made of the probable cost of the project, but it would be considerable. Various objections have been raised by the French to the construction of the anicut, the principal one being that the early supply in the river which is now taken off into the many open headed channels in the French territory below the proposed dam will be cut off. If arrangements were made to pass on these low freshes, it would probably be found impossible to give any supply to the tanks to be connected with the channel except in times of heavy rainfall when the tanks are already full or nearly so from the rainfall in their own catchments. It is stated that it is impossible to increase the capacity of the tanks except at prohibitive expense. The further investigation of this project is not recommended.

Mr. Rajaratna Mudaliar who takes a keen interest in the irrigation of the district has also urged the construction of a channel on the south side or right bank of the river, but there are no existing tanks nor would it be possible to construct them. Owing to the uncertainty of the supply direct irrigation would be impossible, and I regret that I cannot recommend any such project. It will probably be found more economical to utilise the surplus waters of the Ponniyar higher up the river possibly in the Salem district.

12. *Recommendations.*—The Toludur project above mentioned should be at once investigated, and for this purpose a small special establishment working under the orders of the Executive Engineer is required. A proposition statement for the establishment he may find necessary may be submitted by the Executive Engineer himself.

The possibility of forming a reservoir near Kallakurichi should also be investigated, but no special establishment for this purpose is required.

NORTH ARCOT.

General features.—The natural aspects of the district are varied. The western portion lying above the eastern ghâts form parts of the Mysore plateau. East of this section the country is much broken up by hills. The south-eastern portion is open and plain-like, though a small portion of it is hilly.

Soil.—In the Gudiyáttam and Vellore taluks which occupy the northern and southern sections of the Pálár valley respectively, the soil in the valleys between the hills is generally rich, while in the more open country it is poorer. In the south-eastern taluks the soil is, for the most part, poor and the country open and cultivated.

Rainfall.—The average rainfall of the district is 37·08 inches, but is made up of extremes, such as 18·4 in 1876 and 52·4 in 1874. The greatest fluctuations occur during the north-east monsoon. The heaviest average is 45·01 at Wallajapet and the lightest 27·55 at Punganúru.

Rivers.—The chief sources of irrigation are the Pálár with its tributaries, of which the Poiney is the most important, and the Cheyáru. A portion of the Punganúru zemindari drains towards the north into the Bahudanadi, which, in its lower course in Cuddapah, goes by the name of the Cheyyáru. On the north the Swarnamukhi drains eastwards nearly the whole of the Chandragiri taluk and the Kálahasti zemindari.

Existing irrigation.—The following statement shows the areas irrigated by minor works during the past ten years :—

STATEMENT showing the Ayacut areas and the areas cultivated during the past ten years.

Works.	Ayacut area.	—	Area actually cultivated or charged as irrigated during the revenue year ending.										Average for nine years.
			30th June 1892 (fasli 1301).	30th June 1893 (fasli 1302).	30th June 1894 (fasli 1303).	30th June 1895 (fasli 1304).	30th June 1896 (fasli 1305).	30th June 1897 (fasli 1306).	30th June 1898 (fasli 1307).	30th June 1899 (fasli 1308).	30th June 1900 (fasli 1309).	30th June 1901 (fasli 1310).	
1	2	3	4	5	6	7	8	9	10	11	12	13	14
			ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.
Works for which Capital and Revenue Accounts are kept.													
(1) Pálár anicut*	74,697	First crop ..	63,492	68,186	69,178	69,741	70,269	65,114	69,767	71,882	60,681	54,231	66,254
		Second crop ..	1,114	23,552	23,826	21,059	25,623	21,622	21,215	27,187	15,012	10,845	19,106
		Total ..	64,606	91,738	93,004	90,800	95,892	86,736	90,982	99,069	75,693	65,076	85,360
(2) Cheyáru anicut.*	17,962	First crop ..	16,087	19,639	20,158	19,343	20,948	21,060	19,742	21,279	17,466	16,984	19,271
		Second crop ..	6,812	12,710	9,746	7,724	13,113	10,903	7,678	12,735	6,498	6,830	9,474
		Total ..	22,899	32,349	29,904	27,067	34,061	31,963	27,415	34,014	23,964	23,814	28,745
(3) Poiney anicut	21,628	First crop ..	18,810	21,166	22,140	21,854	20,007	18,861	20,978	22,161	13,934	12,286	19,220
		Second crop ..	1,880	5,931	5,585	4,773	4,887	3,894	5,497	6,922	3,267	2,091	4,472
		Total ..	20,690	27,097	27,725	26,627	24,894	22,755	26,475	29,083	17,201	14,377	23,692
Other Minor works.													
(4) Petty works in charge of the Public Works Department.	76,246	First crop ..	40,208	53,771	55,839	55,434	60,184	56,964	55,738	63,031	47,805	51,771	54,075
		Second crop ..	13,500	24,384	26,751	21,123	27,346	24,328	22,639	29,737	19,227	21,901	23,093
		Total ..	53,708	78,155	82,590	76,557	87,530	81,292	78,377	92,768	67,032	73,672	77,168
(5) Petty works in charge of the Revenue Department.	170,657	First crop ..	131,182	167,303	169,788	154,290	159,878	152,181	150,988	172,282	124,428	141,332	152,365
		Second crop ..	55,085	83,041	83,945	67,780	76,333	70,451	68,101	82,188	47,933	65,292	70,015
		Total ..	186,267	250,344	253,733	222,070	236,211	222,632	219,089	254,470	172,361	206,624	222,380
(6) Total of (4) and (5)	246,903	First crop ..	171,390	221,074	225,627	209,724	220,062	209,145	206,726	235,313	172,233	193,103	206,440
		Second crop ..	68,585	107,425	110,696	88,903	103,679	94,779	90,740	111,925	67,160	87,193	93,108
		Total ..	239,975	328,499	336,323	298,627	323,741	303,924	297,466	347,238	239,393	280,296	299,548

* The areas shown include the areas irrigated in the Chingleput district. Distribution between the two districts is not available for all the years.

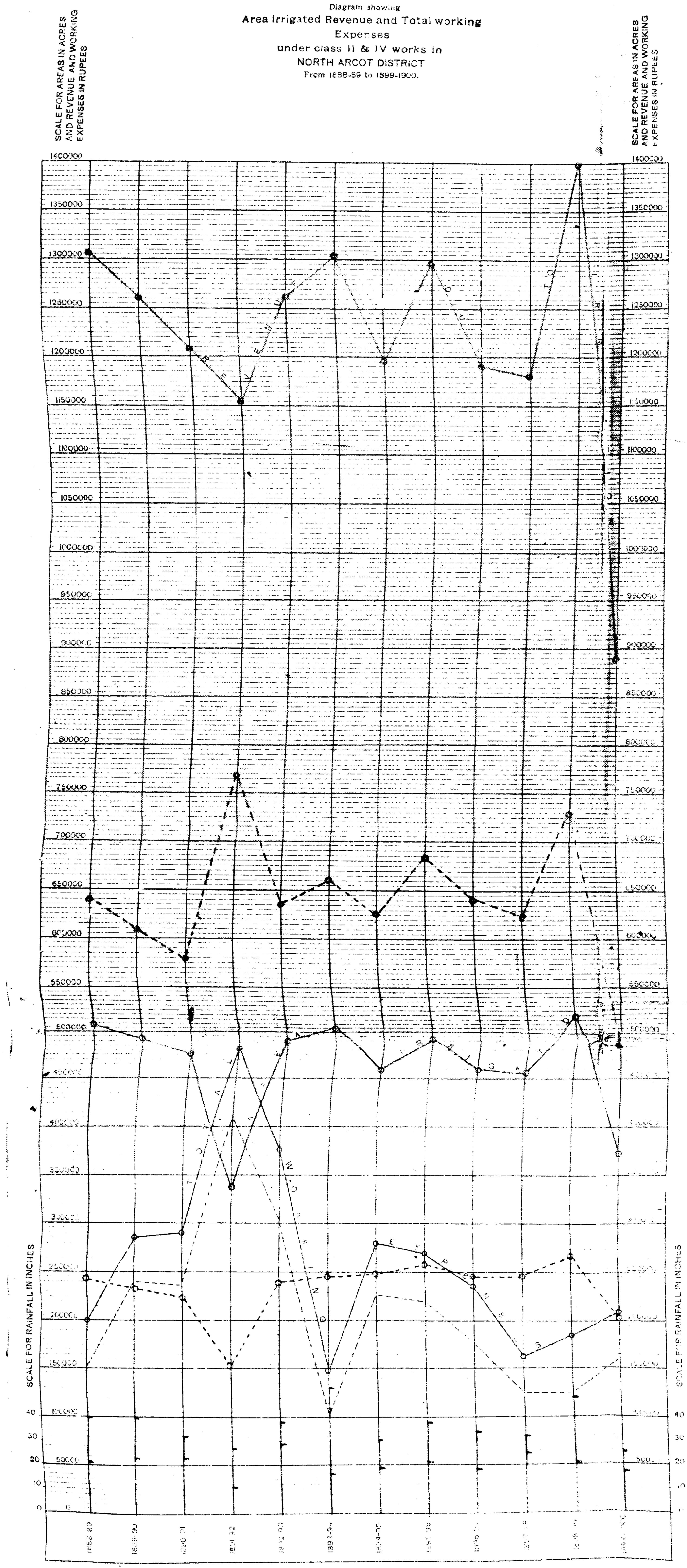
NOTE—*Items* 1, 2 *and* 3.—The areas shown against these items represent actual cultivation.
Items 4 *and* 5.—Information as to the areas actually cultivated not being available for all the years, areas charged as irrigated have been entered.

90A 64

Diagram showing

Area irrigated Revenue and Total working Expenses under class II & IV works in NORTH ARCOT DISTRICT

From 1888-89 to 1899-1900.



Note.—Includes the area &c. under the Palar anicut system in the Chingleput District there being no information showing the portion relating to the two Districts separately.

The vertical lines at foot of diagram represent the rainfall of the different years in inches, the blue portions of the lines showing that due to the North-East monsoon and the red portions that due to South-West monsoon.

The lengths between the bottom of the diagram and the dotted lines represent areas irrigated, &c. for works in charge of the P. W. D. and between the dotted lines and the full lines of the same colour of works in charge of the Revenue Department. The total areas, &c., relating to works in charge of both Departments are therefore shown by the full lines.

It will be observed that the scales for the areas irrigated and for rupees (revenue & working expenses) are the same and a comparison of the lengths representing revenue with those representing area irrigated readily gives the receipts per acre irrigated. Thus if the lengths are as 2 to 1, this represents receipts of Rs. 2 per acre.

There are 4,447 tanks and streams. Wells irrigate in ordinary years about 30,000 acres (first and second crops).

Area protected—

	Acs.
Area protected in all seasons	42,300
Percentage of area cultivated	5·9
Area protected in ordinary seasons	329,200
Percentage of area cultivated	46·3

Liability to famine.—The whole district is liable to famine and the portion lying above the ghâts is specially so. As in many other districts of Southern India, in North Arcot unfavourable seasons have in the past outnumbered favourable ones. In the earliest year, of which a record exists (1807), the season was unfavourable; in 1820, severe storms were followed by a failure of the rains; in 1823, there was prolonged distress and relief was administered; in 1832–33, the seasons were of unprecedented scarcity; in 1860 and 1861, the seasons were unfavourable; and in 1862, prices were almost at famine rates; in 1866, there was partial famine; in 1876—78 occurred the worst famine; and in 1891 and 1892, severe distress was felt in various parts of the district. The average numbers relieved since 1866 are—

Period.	Duration.	On works.	Gratuitously.	Total.
1866-67	8 months.	3,636	4,377	8,013
1876—78	22 ,,	34,383	35,073	69,456
1891-92	18 ,,	3,784	1,108	4,892

N.B.—The maximum number on relief was 227,280 in September 1877.

Possible Extension of Irrigation.—The district is already well provided with tanks almost everywhere, but in years of deficient rainfall there is difficulty in filling them. The construction of new reservoirs would cut off or tend to reduce the supply to irrigation lower down. It is not therefore advisable to make new works but to attempt where possible to improve the supply to existing works. The Collector in an interesting note on well irrigation, which will be found in its proper place, points out that even in the driest years there is sufficient rain to ensure dry crops being harvested over a very large area, and that when there is distress it is in areas where wet cultivation prevails and has failed. In such areas there are large numbers of labourers who are usually employed on paddy cultivation and who in bad years are thrown out of employment. In these circumstances the attempt to construct new works may be in this district given up. Unfortunately it does not appear to be likely that means will be found to supplement the supply to existing works.

A statement showing projects that have been proposed from time to time is printed in Appendix F, but it is unlikely that any of them would be successful. A possible exception to the above remarks may be made in favour of the Swarnamukhi river which, after flowing through the Chendragiri valley, enters the Kálahasti zemindari. It is believed that its waters are not at present fully utilized and if possible a new tank might be formed in the Chandragiri taluk. If no satisfactory site is available, the attention of the Court of Wards might be called to the possibility of utilizing more of the water than is at present taken from the Swarnamukhi within the zemindari.

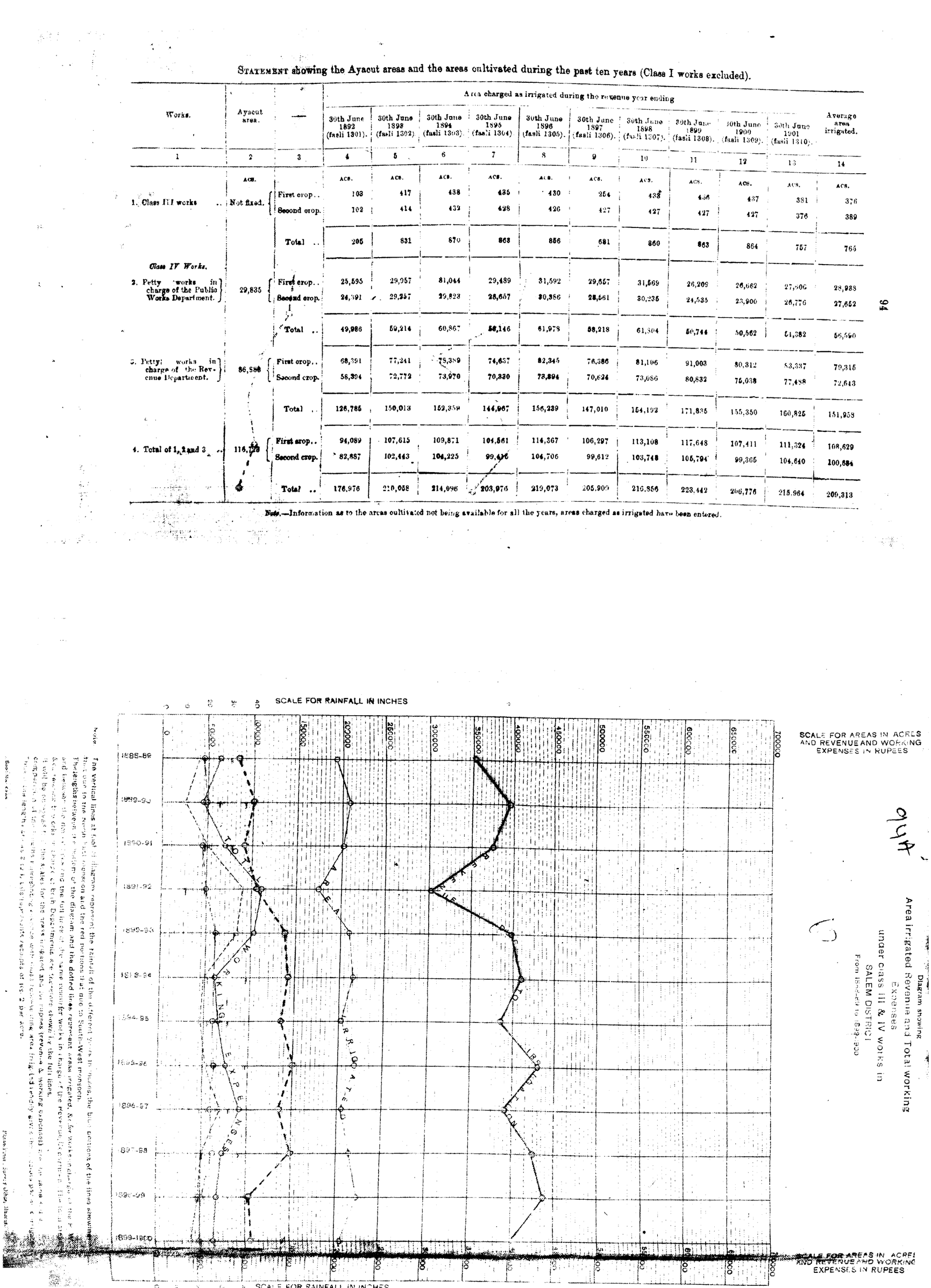
With regard to the other items in the list the following remarks are appended:—

Item 9.—Silt clearance from Kávéripák tank. The attempt to clear silt in the ordinary way from this great reservoir would be hopeless. It might however be possible to erect a light tramway and remove the spoil to waste land at some little distance from the land. It could here be spread two or three feet deep and terraced if necessary. Land so treated could be sold for the growth of dry crops and the returns from it would in some way set off the cost of the work. The extra storage given would be inappreciable.

Statement showing the Ayacut areas and the areas cultivated during the past ten years (Class I works excluded).

Works.	Ayacut area.		Area charged as irrigated during the revenue year ending 30th June 1892 (fasli 1301).	30th June 1893 (fasli 1302).	30th June 1894 (fasli 1303).	30th June 1895 (fasli 1304).	30th June 1896 (fasli 1305).	30th June 1897 (fasli 1306).	30th June 1898 (fasli 1307).	30th June 1899 (fasli 1308).	30th June 1900 (fasli 1309).	30th June 1901 (fasli 1310).	Average area irrigated.
1	2	3	4	5	6	7	8	9	10	11	12	13	14
	ACS.		ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.
1. Class III works ..	Not fixed.	First crop..	103	417	438	435	430	264	438	436	437	381	376
		Second crop.	102	414	432	428	426	427	427	427	427	376	389
		Total ..	205	831	870	863	856	681	860	863	864	757	765
Class IV Works.													
2. Petty works in charge of the Public Works Department.	29,835	First crop..	25,595	29,057	31,044	29,489	31,592	29,557	31,569	26,209	26,662	27,906	28,933
		Second crop.	24,391	29,257	29,823	28,657	30,386	28,681	30,235	24,535	23,900	26,776	27,652
		Total ..	49,986	59,214	60,867	58,146	61,978	58,218	61,804	50,744	50,562	54,682	56,590
3. Petty works in charge of the Revenue Department.	86,586	First crop..	68,391	77,241	78,389	74,657	82,345	76,386	81,106	91,903	80,312	83,337	79,315
		Second crop.	58,394	72,772	73,970	70,330	73,894	70,624	73,086	80,632	75,038	77,488	72,643
		Total ..	126,785	150,013	152,359	144,987	156,239	147,010	154,192	171,835	155,350	160,825	151,958
4. Total of 1, 2 and 3 ..	116,726	First crop..	94,089	107,615	109,871	104,581	114,367	106,297	113,108	117,648	107,411	111,324	108,629
		Second crop.	82,887	102,443	104,225	99,415	104,706	99,612	103,748	105,794	99,365	104,640	100,684
		Total ..	176,976	210,058	214,096	203,976	219,073	205,909	216,856	223,442	206,776	215,964	209,313

Note.—Information as to the areas cultivated not being available for all the years, areas charged as irrigated have been entered.



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Wells in this district are numerous and are responsible for over one-third of the total cultivation in ordinary years.

6. *Area protected*:—

Area protected in all seasons	60,400 acres.
Percentage of area cultivated	5·2.
Area protected in ordinary seasons	166,600 acres.
Percentage of area cultivated	14·5.

7. *Liability to Famine.*—The monsoon rains being very uncertain in this district, the failure of crops is by no means rare. There was severe famine in 1833 and 1876–78 and severe scarcity in 1866. Distress was again experienced in 1891–92. The average numbers relieved are :—

Period.	Duration.	On works.	Gratuitously.	Total.
1866–67	9 months.	420	3,345	3,765
1876–78	22 months.	37,375	59,634	97,009
1891–92	11 months.	4,505	206	4,711

N.B.—The maximum number on relief was 405,787 in September 1877.

8. *Possible Extension of Irrigation.*—The extension of irrigation in this district must be considered in conjunction with that of South Arcot, as all the streams which drain the district (with the exception of a few which fall into the Cauvery along the western boundary of the district) join the Ponniar and Vellar. As stated in the report on South Arcot district, there does not seem to be any satisfactory way of storing the surplus waters of the Ponniar in that district and we must look to Salem to find means of doing so. The two principal proposals in the Ponniar basin are the Krishnagiri and Vaniar reservoirs.

9. *Krishnagiri Reservoir.*—This is a scheme to extend irrigation in the Krishnagiri taluk of the Salem district by means of a large reservoir to be supplied from the Ponniar, the dam to impound the water to be constructed across the river about 5 miles south-west of the town of Krishnagiri. The project was investigated and reported on by Captain Romilly in 1884. It was to cost roughly 40 lakhs, to irrigate 50,000 acres in addition to the extent already irrigated, and to return 5 per cent. on the capital outlay.

Captain Romilly calculated that 15,428 millions of cubic feet of water would be available for storage and that this quantity would suffice for more than 50,000 acres. He suggested that the capacity of the reservoir be fixed with reference to this area and that storage be provided by a dam with F.T.L. at from 100 to 120 feet. The conclusion arrived at by him was that, in a year of ordinary rainfall, the supply would be ample for 50,000 acres and in a famine year probably for half that extent. He also made out that the existing irrigation below the site of the proposed dam would not be affected by the scheme.

The Government accordingly authorised the preparation of detailed plans and estimates, remarking at the same time that the tract in question had suffered greatly in times of scarcity and that the project would prove of immense benefit to that part of the country.

In July 1896 Mr. O'Connell, Executive Engineer, pointed out that Major Romilly overestimated the quantity of water available in the river and that this was due to his having taken into account the rainfall at some stations outside the catchment basin. Mr. O'Connell submitted an abstract of the discharges for the five years ending with 1895–96, as recorded at the Nedungal anicut which is 10 miles below the site of the proposed Krishnagiri reservoir. These discharges showed that the quantity of water available was 9,571 millions of cubic feet as a maximum, while it was only 483 millions of cubic feet in the famine year of 1891–92. The Executive Engineer concluded that there was not enough water to warrant the execution of the scheme and added that an inspection of the country showed that, if a dam were built, it would be very costly to distribute the water from it. He accordingly recommended that the investigation of the project be dropped, and the Superintending Engineer supported this recommendation.

Before accepting the proposal, the Government referred it to the Collector and the Board of Revenue for remarks. They pointed out that the condemnation of the scheme was mainly based on the calculation of the discharges of the river during the five years ending with 1895–96 and that, as these years were more or less exceptionally unfavourable to cultivation, they could not be taken as a safe guide in the matter. Assuming that the available quantity of water was not likely to be 15,428 millions of cubic feet, the Board urged that it might be large enough to admit of the scheme being carried out. They, therefore, considered that further investigation was necessary before abandoning the project, especially in view of the fact that the tract in question was one requiring additional facilities for irrigation.

The Government thereupon ordered that the scheme should not be finally abandoned, but should be taken up again when the Tank Restoration Scheme investigation of the Ponniar basin was completed.

The catchment area at the site of the reservoir is stated to be 950 square miles of British territory, but the total area is 1,892 square miles. No account has been taken of the area of 942 square miles in Mysore probably because it has been ascertained that in ordinary years all available water will be utilized in that province. The average rainfall at Hosur is 31·76 and at Kishnaghiri is 32·38.

We may therefore assume a run-off of 5 inches, which would give as available for storage 11,035 millions cubic feet. It would, however, be necessary to let down about 1,500 millions cubic feet for the Barur project, the anicut for the supply of which is about 10 miles below the proposed site. A further quantity would probably also have to be let down for the supply of tanks in South Arcot, but even after this there should be a considerable quantity available for storage. As above stated, Mr. O'Connell showed from registers at Nedungal anicut that there was no water available, but the accompanying statement for the last six years shows that a much larger quantity may be expected in ordinary years :—

Months.	1895-96.	1896-97.	1897-98.	1898-99.	1899-1900.	1900-1901.
April	..	..	..	71·31	129·41	..
May	90·89	11·81	..	23·84	6,454·94	..
June	..	96·97	153·28	..	..	..
July	..	..	..	..	..	11,585·42
August	..	..	178·30	..	..	..
September	852·19	2,258·91	16,389·36	2,318·51	17,807·33	14,205·15
October	6,137·23	637·94	11,695·55	2,504·92	1,946·90	35,068·65
November	2,141·37	47·27	..	16,331·08	..	..
December	..	281·47	..	3,183·26	..	..
January	..	..	..	..	..	..
February	..	..	62·02	..	..	..
March	..	..	..	..	..	..
Total ..	9,221·68	3,334·37	28,488·51	24,932·92	26,338·58	60,859·22

It will be seen that the minimum surplus is 3,334 millions cubic feet, while the maximum is 60,859 millions cubic feet. In 1899–1900, a year of exceptionally low rivers, the surplus was 26,338·58 millions cubic feet. I think, therefore, that we may set our minds at rest regarding the quantity of water available.

The next and more important question is that of land for irrigation and here I think there is more reason for doubt. The land to be irrigated is much the same as that under Barur tank and attention is invited to the remarks already made regarding that system. It appears to me very probable that there will be considerable difficulty in finding a large area of land suitable for cultivation without considerable expense and that however much water may be available, it is unlikely that more than about 15,000 acres would be taken up for cultivation. It is recommended that this matter should be enquired into by the Revenue and Public Works officers together.

In the meantime the following rough estimate is made on the basis of a reservoir for 15,000 acres. It is to be remembered that in this project it is proposed to pass

the surplus over or through the dam so that it could be made any height found suitable. Reservoir with F.T.L. at + 90, *i.e.*, about 84 feet above bed of river :—

	Lakhs.
Cost of dam	8·50
Compensation	1·00
Surplus works	3·00
Distributaries at Rs. 15 per acre	2·25
Sluice	·50
Unforeseen works	·75
Total lakhs ...	16·00

The return would be Rs. 5 per acre for 15,000 acres. The return, after making allowance for establishment, tools and plant and maintenance, would be less than 3 per cent., but still would pay a small percentage ; and a further investigation of the project is recommended especially with reference to the land commanded.

It may perhaps be found that a larger area than I expect would be eventually taken up. If this is the case it may be advisable to make the dam of sufficient section to permit of its being raised as irrigation extends. It may, on the other hand, be decided that no large extension of irrigation is possible owing to the difficulty of the country and the sparseness of the population. In this case the dam might still be constructed and used for extending cultivation in South Arcot.

9. *Vaniar Project.*—This is a proposal to form a reservoir in a gorge of the Shevaroy hills by damming the Vaniar. The project was originated by Mr. Lefanu, I.C.S., who was for many years employed in the Salem district. The locality was inspected by the Chief Engineer for Irrigation (Colonel Mullins) and the District Engineer (Major Ponnycuick) in October 1877, when sites for the embankment and the surplus weir were decided upon.

The investigation of the project was made by Captain Jackson, an Executive Engineer on famine duty in the Salem district. He submitted a survey of the proposed reservoir with a preliminary report. His scheme was to provide for a reservoir with a storage of about 324 millions cubic feet, which being filled twice in the year would irrigate 3,000 acres. The project was estimated to cost Rs. 1,75,000 and to return $6\frac{1}{4}$ per cent. net.

The charge of the work which was started for famine relief was in June 1878 transferred to Mr. David Scot, an Executive Engineer from Bengal on deputation for famine duty. The Chief Engineer for Irrigation in August of the same year inspected the work. In view of the doubtful character of the saddle over which the surplus water would have to pass, the Chief Engineer considered that it would not be proper to proceed with the work. Subsequently the famine subsided and the necessity for affording relief ceased.

The scheme was gone into by Mr. Scot, who submitted alternative proposals, one to cost Rs. 4,12,069 and to irrigate 6,166 acres and the other to cost Rs. 6,23,995 and to irrigate 9,100 acres. In commenting on the proposals, the District Engineer, Salem, was in favour of the latter scheme. He observed that the work should be carried out only as a famine relief work, as the anticipated return was small and as more remunerative projects remained uninvestigated. The papers were submitted to the Chief Engineer for Irrigation, through the Superintending Engineer, IV Circle.

On the reorganization of the department in 1881, the "B" Project division was formed for the investigation of schemes in the IV Circle. The papers connected with the Vaniar reservoir were returned to the Executive Engineer of that division in order that detailed plans and estimates might be prepared. These were prepared and submitted by Captain Romilly in July 1883. The Chief Engineer for Irrigation suggested certain modifications. The scheme, as finally decided upon, provided for a reservoir with a storage capacity of about 957 millions cubic feet with F.T.L. at 1,077 and for distributaries commanding 10,500 acres. The catchment of the stream is stated to be 35 square miles. The cost (including indirect charges) was estimated at 16 lakhs for concrete dam and at $9\frac{1}{2}$ lakhs for an earthen dam. It was anticipated that 8,702 acres would be irrigated, the return being 2 per cent. if a concrete dam

were adopted and over 3 per cent. for an earthen dam. The scheme was thus not remunerative, but its protective value was assured, the areas affected being liable to famine.

In 1897 Mr. O'Connell, drew attention to the fact that the irrigating duty of the project per square mile of catchment as worked out by Captain Romilly amounted to 343 acres. Thereupon the scheme was examined by the Chief Engineer for Irrigation, who thought there must be some errors in the observations made in 1882 and 1883. The whole matter was remitted to the Executive Engineer and the Superintending Engineer for careful reconsideration and early report. The local officers were also requested to inspect the site.

Mr. O'Connell after an inspection of the locality submitted a report. The gist of it was—

(1) The observations made in 1882–83 were fairly accurate, but they were exceptional years and could not be taken as a guide.

(2) The Vaniar being situated on the northern slope of the Shevaroys was not subject to the influence of the south-west monsoon which would fall on the southern slope, while the supply during the north-east monsoon (September to December) would be steady.

(3) The sites selected by both Captain Romilly and Captain Jackson were not suitable for a dam, as it was doubtful if sound rock would be found within a reasonable depth. [He does not however state that he has any reason to doubt the accuracy of the depths shown in the longitudinal section of the dam, trial pits for which were dug and are still existing.]

(4) The reservoir on account of its position would soon silt up and become useless.

(5) At 60 acres per square mile of catchment which is itself high for the locality, the scheme could irrigate only 2,100 acres of which the existing irrigation amounted to 692 acres.

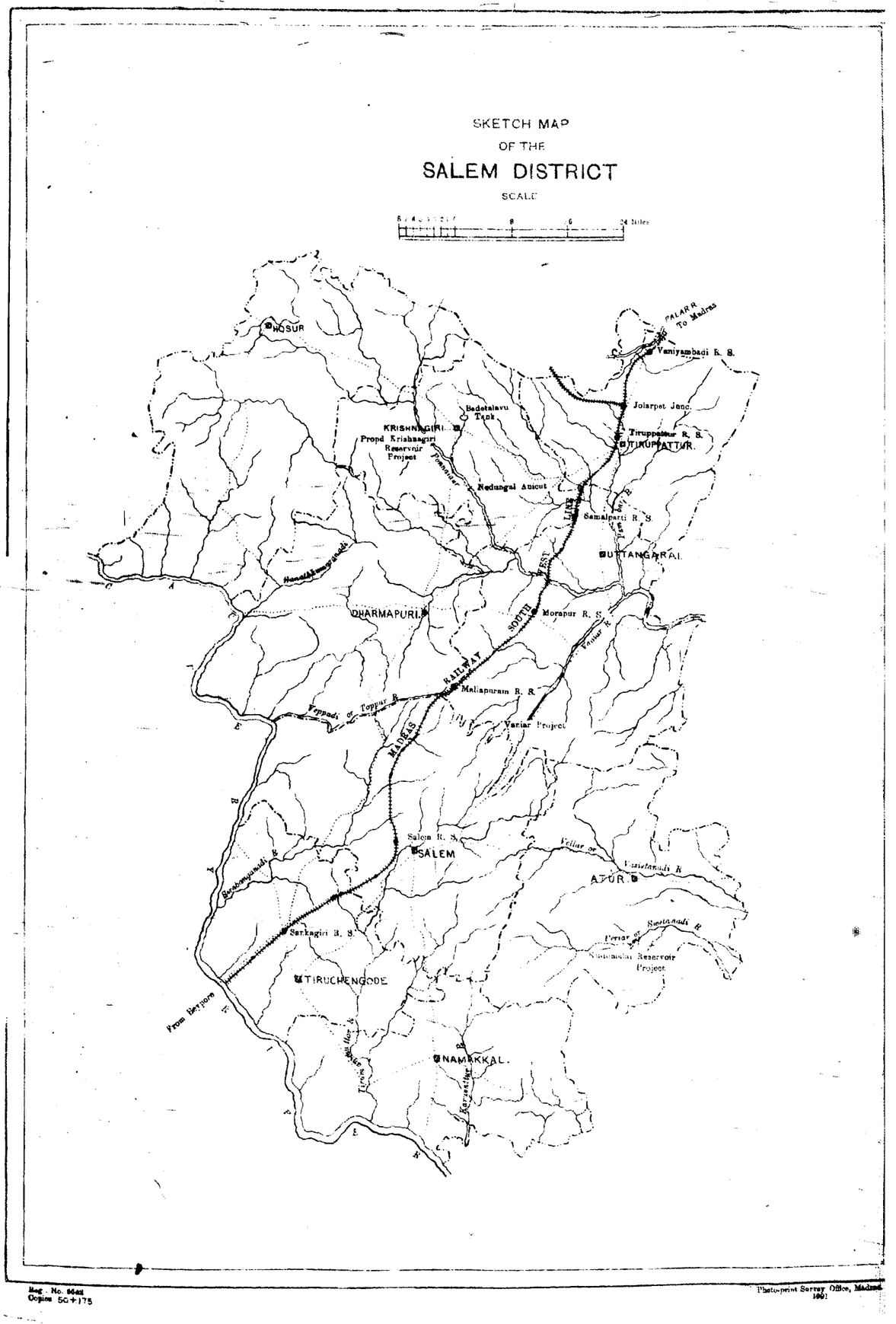
(6) There was no doubt that the soil was excellent and that crops could be grown on it.

On this, the Superintending Engineer remarked that the project was not one that could be recommended. The Chief Engineer for Irrigation also shared this view and the Board of Revenue was informed that the scheme could not be recommended.

It appears to me that a further consideration of this project is advisable. Captain Romilly from the observations in 1882 may have slightly overestimated the quantity of water available; but at the same time Mr. O'Connell appears to me to have underestimated it. The only rain gauge station which is of any use to us is that of the Shevaroy hills, where the average rainfall is 62·84 inches. It is probable that in the catchment area of the Vaniar the rainfall is lighter in the south-west and heavier in the north-east than at Yercaud. From the registers, 1882 does not appear to have been a very exceptional year, the total fall being 67·81 or about 8 per cent. above the average. The month of May, however, shows 11·28 inches, which is quite unusual, and may go far to account for the large supply in the earlier part of the year.

I must demur altogether to Mr. O'Connell's statement that 60 acres per square mile of catchment is a reasonable duty to expect. In the neighbouring district of North Arcot, I made careful enquiries some years ago and ascertained that with a district average of 37 inches the duty amounted to between 60 and 80 acres and I do not think that in this valley with a rainfall of 62 inches we shall err in putting the duty at 200 acres. This would give enough water for $200 \times 35 = 7{,}000$ acres. It is stated that for existing irrigation the Vaniar has to supply 692 acres. There is therefore enough water available for 6,300 acres, and I consider that the Vaniar project in one of its forms should be carried out as a Famine Protective Work. I would, on the score of economy, advocate the adoption of an earthen bund. It may be provided with masonry drains in rear where it crosses the deep bed of the river.

A careful search should, however, first be made to ascertain if there is sufficient earth within a reasonable distance to complete the bund.



10. The only other project in the Ponniar basin is a proposal to cut a supply channel to the Badatalab tank near Krishnagiri, from the Kurumbapalli river. The catch-area of the river at the point where it is proposed to construct the anicut is 650 square miles. The proposal is of ancient date but was finally condemned in 1891 as not being feasible. The reasons for this statement are not given. The tank to be supplied is stated to be a good one and if a supply channel could be made at reasonable cost the advantage would be undoubted. The matter might be again investigated to set the question at rest.

11. *Gudumalai Reservoir.*—This project has been comtemplated for many years past. The construction of an anicut at the site of the reservoir subsequently proposed was sanctioned in 1863, and funds were provided in the budget of 1867-68. Soon after the work was commenced, it was stopped as fears were entertained that the anicut would prejudice the supply to the existing irrigation below. The question, however, remained unsettled. In 1878, Major Pennycuick, then District Engineer of Salem, in reporting on the matter, suggested the idea of constructing a reservoir on the river itself. He then submitted a preliminary report on the scheme. The Government considered that the project was worthy of further investigation and directed that a good surveyor should be placed at the disposal of the District Engineer.

Nothing is heard of the project until 1893, when the Superintending Engineer, IV Circle, submitted a proposition statement for the entertainment of survey establishment for the investigation of the scheme. This was sanctioned. The project was worked out by Mr. O'Connell who submitted in 1896 plans and approximate estimates amounting to Rs. 4,70,500. It was reported that the site selected possessed certain natural advantages for the construction of a dam; that the supply of water available was ample for irrigating 5,200 acres of fresh lands in addition to the existing irrigation of 2,800 acres; and that the return would be 4·4 per cent. on the outlay.

The Chief Engineer for Irrigation, however, did not approve of the scheme for the following reasons:—

(1) The capacity of the proposed reservoir was sufficient to hold only one month's supply and somewhat less than 1 inch of run off over the whole catchment basin.

(2) It could not be assumed, as was done by the Executive Engineer, that the reservoir would be full at the end of May, as the run off in the months of April and May when the ground is dry and the local rainfall small would be inappreciable.

(3) No account was taken of the interests of irrigation in the Trichinopoly district lower down the river.

The assumption of a universal run-off of one-sixth is erroneous. There would be practically none in April, May and June and possibly more than one-sixth in October and November. What is required is a larger reservoir and this should be looked for.

From enquiries made it appears that there is an ample and nearly continuous supply of water in the river.

The statement of surplus discharges at the Shatiatope anicut (Statement V, Appendix H) shows that there is plenty of water available and it is not considered that the interests of the Trichinopoly ryots will be injured by the construction of this reservoir. The project should be reinvestigated.

COIMBATORE DISTRICT.

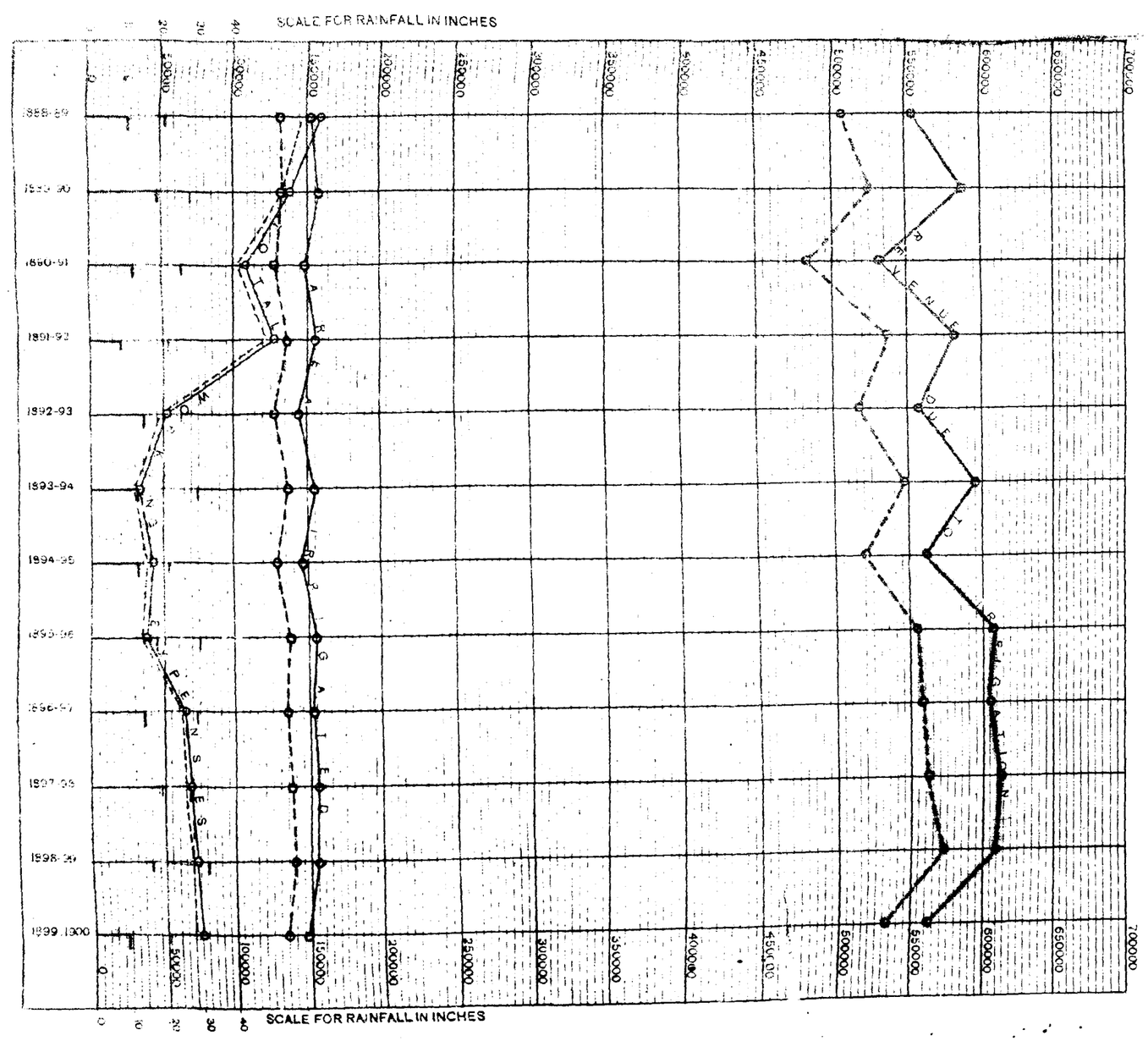
General Features.—The district is divided into two sections by the ghâts which fringe the Mysore plateau. The Kollegal taluk lying above the ghâts is well afforested hill country. The other taluks form an undulating plain bounded by hills, which, with the exception of a small area in the extreme west, slopes gradually to the east and south-east.

2. *Soil.*—Gneiss forms the bottom rock of the whole area. The soils are chiefly sands and gravels, although some loams and a considerable tract of black clay (cotton soil) exist.

3. *Rainfall.*—The average rainfall of the district is 25·82 inches, the maximum being 34·68 at Kollegal and the minimum 20·17 at Dhárápuram. The central plain is extremely dry and is, next to the centre of the Bellary district, the driest tract in the Presidency.

4. *Rivers.*—The chief rivers are the Cauvery and its affluents—the Bhávani, the Noyel and the Amravati. Two small streams—the Palar and the Aliyar—which drain part of the Udamalpet and Pollachi taluks flow westwards.

5. *Existing irrigation.*—The following statement shows the areas irrigated by minor works during the past ten years:—



Note— The vertical lines at foot of diagram represent the rainfall of the different years in inches, the blue portions of the lines showing that due to the North-East monsoon and the red portions that due to South-West monsoon

The fengine between the bottom of the diagram and the dotted lines represent areas irrigated & for works in charge of the P. W. D. and between the dotted lines and the full lines of the same colour for works in charge of the Revenue Department. The total areas, &c., relating to works in charge of both Departments are therefore shown by the full lines.

It will be observed that the scales for the areas irrigated and for rupees (revenue & working expenses) are the same and a comparison of the heights representing revenue with those representing area irrigated recently gives the receipts per acre irrigated Thus if the heights are as 2 to 1 this represents receipts at Rs 2 per acre.

STATEMENT showing the Ayacut areas and the areas cultivated during the past ten years.

Works.	Ayacut area.		Area actually cultivated or charged as irrigated during the revenue year ending 30th June 1892 (fasli 1301).	30th June 1893 (fasli 1302).	30th June 1894 (fasli 1303).	30th June 1895 (fasli 1304).	30th June 1896 (fasli 1305).	30th June 1897 (fasli 1306).	30th June 1898 (fasli 1307).	30th June 1899 (fasli 1308).	30th June 1900 (fasli 1309).	30th June 1901 (fasli 1310).	Average area irrigated.
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Class II Works.	ACS.		ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.
(1) Thadapalli channel ..	13,364	First crop..	14,130	14,076	14,165	14,058	13,936	14,523	14,197	14,228	14,218	14,262	14,179
		Second crop.	569	609	465	458	590	319	558	720	560	613	554
		Total ..	14,699	14,685	14,630	14,516	14,526	14,842	14,755	14,948	14,778	14,955	14,733
(2) Nokkanda channel ..	3,756	First crop..	4,032	4,050	4,018	3,999	4,003	4,071	4,101	4,114	4,216	4,233	4,084
		Second crop.	70	60	46	91	44	43	29	51	65	31	53
		Total ..	4,102	4,110	4,064	4,090	4,047	4,114	4,130	4,165	4,281	4,264	4,137
(3) Kalingnoyan channel	8,856	First crop..	11,233	11,253	11,199	11,229	11,181	11,216	11,269	11,324	11,335	11,400	11,264
		Second crop.	10,464	10,217	9,587	9,991	9,666	9,320	9,185	9,197	8,795	8,842	9,526
		Total ..	21,697	21,470	20,786	21,220	20,847	20,536	20,454	20,521	20,130	20,242	20,790
(4) *Class III works* ..	..	First crop..	26,350	24,144	26,430	25,371	26,661	26,379	26,393	26,450	23,816	26,661	25,873
		Second crop.	20,111	19,096	21,026	19,837	21,279	20,872	21,173	19,205	20,858	21,744	20,550
		Total ..	46,761	43,240	47,456	45,008	47,940	47,251	47,566	45,655	44,744	48,405	46,423
Class IV Works.													
(5) Petty works in charge of the Public Works Department.	* 59,231	First crop..	31,800	30,350	34,591	30,921	34,957	34,705	35,333	38,722	33,919	38,986	34,428
		Second crop.	17,445	13,437	14,517	13,117	13,585	13,501	13,981	13,971	15,849	19,659	14,906
		Total ..	49,245	43,787	49,108	44,038	48,542	48,206	49,314	52,693	49,768	58,645	49,334
(6) Petty works in charge of the Revenue Department.	8,830	First crop..	12,443	12,317	13,438	12,489	13,349	13,667	14,038	11,650	9,391	12,045	12,483
		Second crop.	5,412	4,566	4,901	4,151	5,130	4,390	4,607	4,735	4,290	5,820	4,800
		Total ..	17,855	16,883	18,339	16,640	18,479	18,057	18,645	16,385	13,681	17,865	17,283
(7) Total of class III and IV works [(4)+(5)+(6)].	94,035	First crop..	70,593	66,811	74,459	68,781	74,967	74,751	75,764	76,822	67,196	77,692	72,784
		Second crop.	43,268	37,099	40,444	37,105	39,994	38,763	39,761	37,911	40,997	47,223	40,256
		Total ..	113,861	103,910	114,903	105,886	114,961	113,514	115,525	114,733	108,193	124,915	113,040

* Probably includes the ayacut area of class III works.

Note.—The areas shown against class II works represent actual cultivation.
In the case of class III and IV works, information as to the areas actually cultivated not being available, areas charged as irrigated have been entered.

The number of tanks and streams is only 289. The district is noted for its large number of wells, which irrigate about three-fourths of the total area cultivated.

6. *Area protected*—

	ACRES.
Area protected in all seasons	177,600
Percentage of area cultivated	8·1
Area protected in ordinary seasons	367,300
Percentage of area cultivated	16·9

7. *Liability to Famine.*—The district is one of exceptional dryness. During the past century not less than two-thirds of the seasons have been unfavourable. The most noticeable of them were 1804–1805 and 1806–1807; 1810–1811 in which there was scarcity, desolation and disease; 1836–37 and 1857, a very dry and unfavourable year; 1861 and 1866 in which there was partial famine; 1875, a year of scanty rainfall, followed in 1876 by a failure of both monsoons; 1877 in which there was famine, sickness and death; and 1891–92 in which there was heavy loss of crop necessitating State relief. The average numbers relieved since 1866 are:—

Period.	Duration.	On works.	Gratuitously.	Total.
1866-67	8 months ..	575	1,227	1,802
1876-78	22 ,, ..	24,903	34,150	59,053
1891-92	14 ,, ..	1,762*	* 172	1,934

* For five months only.
N.B.—The maximum number on relief was 214,483 in September 1877.

8. *Possible extension of irrigation.*—The most promising project in the Coimbatore district is the proposed reservoir on the Amravati where it issues from the Anamalai hills. The catchment at the proposed site is 267 square miles. The rainfall over this area is assumed to be 40 inches. There are no data to go on and it is probable that on some of the higher slopes the fall is considerably more, while over the greater part of the basin it is possibly rather less. In making a preliminary estimate a run off of 20 inches has been assumed giving a total run off of 1,206 mills. cubic feet. This is probably excessive. The proposed F.T.L. of the reservoir is to be 73 feet above the bed of the river. The area of contour at that level is 143 mills. square feet and the capacity will be 3,767 mills. cubic feet. This will suffice for 18,800 acres of single crop supposing the reservoir to fill once. Arrangements for supplying existing channels on the Amravati would have to be made. These channels are 22 in number, but they only irrigate 25,000 acres. The catchment area of the Amravati at Pallapoliam, the lowest anicut on the river, is 1,883 square miles of plains and 427 square miles of hills. During the south-west monsoon the supply in the river comes from the hills and arrangements would have to be made to pass on a supply to existing irrigation.

The approximate cost of the project has been estimated as follows, but the data on which this estimate has been made are not given. The estimate is a very rough one and probably too liberal.

	LAKHS.
Masonry dam	2·00
Earthen dam	2·00
Two head sluices	1·00
Waste weir	1·00
Compensation for lands	4·50
Distributary channel	5·00
	15·50

The returns are estimated to be Rs. 60,000 if 15,000 acres are cultivated, and Rs. 80,000 if 20,000 acres are cultivated; taking the former figure the return would be only 3·9 per cent. on the capital outlay, excluding establishment, tools and plant and indirect charges. The project is a promising one as it will supply an area where the rainfall is very low and irrigation is much needed; it will also tend to equalize the supply to the direct irrigation lower down the river. It will be noted that the item Compensation for land is a very heavy one. It might be possible to decrease the cost by selecting a site above the Kallapuram anicut whereby the submergence of the wet

land under it would be avoided. This should be looked into, when further investigations are made, by a special party if necessary. The Superintending Engineer has directed that further investigation of the project as an ordinary work should be deferred as it is not likely to pay the required percentage on the capital outlay.

9. *Muthikulam Project.*—This is a proposal to divert a portion of the Siruvani, a tributary of the Bhavâni, into the Noyil river and thereby supplement the supply to existing irrigation and extend it. The project was considered by Government in 1888 and condemned on the recommendation of Mr. G. T. Walch, then Chief Engineer for Irrigation.

The project was again reopened in 1889 and again condemned in 1890. Further investigation was, however, ordered and in 1897 Mr. Malet submitted a scheme. His proposals were to construct a dam 70 feet high to impound the catchment of 7 square miles and to divert the water through a tunnel 4,500 feet long into the Bolampatti valley. The above-mentioned dam would not create any storage reservoir worth mentioning. He therefore proposed to construct, in the Bolampatti valley, a reservoir with a catchment of 16 square miles and a capacity of 2,000 mills. cubic feet. With the above works he proposed to effect the following results:—

(1) To irrigate 8,000 acres for 10 months in the year.
(2) To afford a water-supply of from 6 to 8 gallons per head per diem for 50,000 people in the town of Coimbatore. The estimate for the rest of this work was as follows:—

	Rs.
Tunnel and cutting	3,65,500
Masonry dam	3,15,000
Reservoir in Bolampatti valley	2,25,000
Unforeseen works	69,500
Temporary buildings	19,000
Total for works ...	9,94,500
Establishment and tools and plant	2,43,750
Leave and pension allowances	29,250
Land compensation	32,500
Total ...	13,00,000

His data for available supply from the 7 miles of catchments were taken from gaugings and water-registers which were maintained at Muthikulam from June 1896 to April 1897. It is, however, improbable that they were at all correct. Mr. Garrett, the present Superintending Engineer, on his visits to the site, detected several inaccuracies and considers that no faith can be placed in the results.

Mr. Malet estimates that the 7 square miles of catchment wil yield in a normal year 2,552 mills. cubic feet equivalent to a run off of over 13 feet which seems impossible. The Bolampatti reservoir is expected to obtain 14,106 mills. cubic feet from its own catchment. This is taken as $\frac{1}{3}$ average rainfall for April and $\frac{1}{2}$ for the rest of the year, the rain fall at Vellapatti being assumed as an average. At this station in 1895 and 1896 the rainfall was 137·24 and 96·73 respectively. Since Mr. Malet wrote his report, Mr. Burlton reported that there was no good site for a reservoir in the Bolampatti valley. It is also to be remembered that the whole of the discharge from the 16 square miles of catchment, which Mr. Malet proposed to impound, is already absorbed by the numerous anicuts on the Noyil river.

It will be seen that there is considerable difference of opinion about the water-supply available, and if it should be considered that there is *primâ facie* a good case for the further investigation of this project more observations should be taken.

The project is however largely dependent on the decision which it is to be arrived at with regard to the Bhavâni reservoir. If it is decided to utilize that reservoir to supplement the supply to Tanjore, the Muthikulam scheme should be abandoned. For it is then on the horns of a dilemma. The 7 square miles of catchment either yield a large quantity of water or they do not. If they do, that amount cannot be spared by the Bhavâni reservoir; but if they do not, it is out of the question going to the great expense of constructing a dam and tunnel for so small a supply.

It may, however, be decided not to attempt to store water on the Bhaváni for utilization in Tanjore. In that case the whole of the upper waters of the Bhaváni should be investigated to see which is the most economical place to make reservoirs to supply Coimbatore district. It appears to me that it is probable that more satisfactory sites can be found than that proposed at Muthikulam.

10. *Walayar Project.*—It was proposed to form a reservoir about 10 miles south of Coimbatore in the Palghat taluk of the Malabar district, but on preliminary investigation it was found that all the land commanded would lie within Cochin territory. The project was therefore abandoned. It appears to me that the Cochin Durbar should be consulted, and, if prepared to pay a suitable water-rate for lands irrigated, the project should be fully investigated. The rainfall on the catchment is probably very good, and, if the ryots will take the water, there is no reason why the project should not be a paying one.

11. *Reservoirs on the Aliyar and Uppar.*—The consideration of this question arose out of a proposal of the Collector of Malabar to divert some of the water of the Aliyar into the Devanur river and to irrigate 25,000 acres in Palghat taluk. Some correspondence on the subject ensued and the main facts evolved are that there are already 7,000 acres directly irrigated from anicats on the Aliyar and that any further extension of direct irrigation would be impossible. It would seem, however, as though with storage, some extension of irrigation would be possible and the matter is now engaging the attention of the Superintending Engineer.

12. *Dhali Reservoir.*—This is a project recommended by the Revenue Department and local residents. The Executive Engineer however reports that—

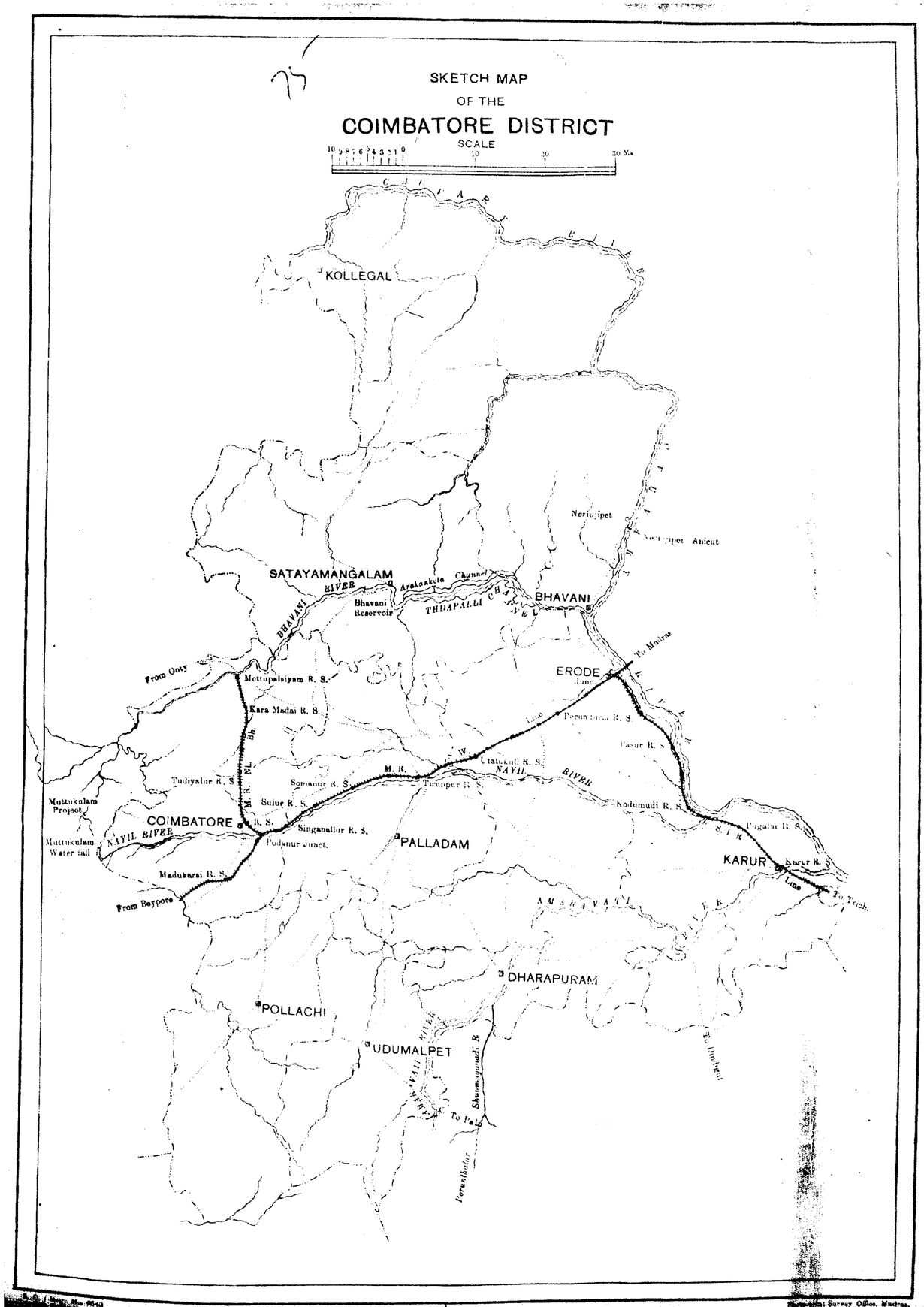
(1) The impounding of waters on the Pálár would interfere with the supply to Cochin, and

(2) The catchment of the river above the proposed site is only 22 square miles, the rainfall being 23 inches per annum. There is already an anicut from which water is taken to feed eight tanks and no further extension of irrigation can be expected. The scheme may therefore be abandoned.

13. *Improvement and extension of the Kalingayogen Channel.*—This scheme has been under consideration since 1850. It was worked out in detail by the late "B" Project division, and plans and estimates were submitted in 1887 for (1) the improvement of the existing channel with a view to securing a full supply to the present ayacut, and (2) the extension of the channel for utilizing the surplus water by bringing an additional area of 15,000 acres under irrigation. The proposals subsequently underwent revision, and the project as finally drawn up was estimated to cost Rs. 8,71,000 inclusive of indirect charges and to yield 6·31 per cent. on the capital outlay. The anticipated return was sufficient to admit of the expenditure being charged against Loan funds. The scheme received the sanction of the Secretary of State for India in 1891; but the work was not commenced for want of funds.

The sanction of the Secretary of State having expired on the 30th January 1896, it was necessary to apply for an extension of the term. Before doing so, the Superintending Engineer, IV Circle, was asked to report whether, owing to the prevailing rates for labour and materials or other causes, any modifications were necessary in the sanctioned estimates for the project.

Mr. Hannan in reply stated that the estimates required revision. He remarked that if the Bhaváni project was to be sanctioned, the present scheme should be given up. He also expressed doubt as to the possibility of passing water down to the end of the channel. The extension of sanction was however applied for. But the Government of India pointed out that in view of the remarks of the Superintending Engineer they were not prepared to sanction the application without further explanation on the matters involved. They said that in the meanwhile the estimate for resluicing the channel might be sanctioned by the Local Government and charged to 43. Minor Works and Navigation, Provincial, the outlay being written back to the project estimate in the event of its sanction being extended. The work of resluicing is still in progress and its results are not known.



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TRICHINOPOLY DISTRICT.

General features.—In the north-western corner of the district are the hills known as the Pachiamalais, which contain a fair amount of jungle and, in parts, large areas of good forest with valuable trees. The country towards the southern borders is broken up with rocky hills covered mostly with scrub jungle. Elsewhere the general character of the district is one of an undulating plain divided by a strip of alluvium lying on the banks of the Cauvery. The plain north of the river consists of black-cotton soil, while in the south the soils are poor and are generally of a gravelly or sandy nature.

2. *Rainfall.*—The average rainfall of the district is 34·20 inches. The fall is usually much heavier in the northern than in the southern parts.

3. *Rivers.*—The most important river is the Cauvery which about 11 miles west of Trichinopoly divides into two branches. The northern branch is called the Coleroon, while the southern branch retains its name of Cauvery. Nearly the whole district drains into the Cauvery with the exception of a small portion in the north, the drainage of which flows into the Vellar.

4. *Existing irrigation.*—Besides the Upper anicut there are minor channels taken off from the Cauvery and the Coleroon. The channels from the Amaravati irrigate a small area in the Kulittalai taluk. There are also 1,669 tanks and streams, the bulk of which irrigate less than 50 acres. The accompanying statement shows the areas irrigated during the past ten years:—

STATEMENT showing the Ayacut areas and the areas cultivated during the past ten years (class I works excluded).

Works.	Ayakat area.		Area actually cultivated or charged as irrigated during the revenue year ending 30th June 1892 (fasli 1301).	30th June 1893 (fasli 1302).	30th June 1894 (fasli 1303).	30th June 1895 (fasli 1304).	30th June 1896 (fasli 1305).	30th June 1897 (fasli 1306).	30th June 1898 (fasli 1307).	30th June 1899 (fasli 1308).	30th June 1900 (fasli 1309).	30th June 1901 (fasli 1310).	Average area irrigated.
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Class II works.	ACS.		ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.
1. Nandyar channel	4,532	Irrigation under this channel was transferred from class IV to class II in 1895-96. The areas cultivated have been included under class IV.											
Class IV works.													
2. Petty works in charge of the Public Works Department.	71,372	First crop ..	86,718	85,110	88,517	85,902	84,858	84,142	83,478	84,989	80,905	79,618	84,404
		Second crop ..	36,572	36,803	42,200	37,044	34,561	28,207	32,243	4,777	31,977	32,434	34,682
		Total ..	123,290	121,913	130,717	122,946	119,419	112,349	115,721	119,766	112,882	112,052	119,086
3. Petty works in charge of the Revenue Department.	36,140	First crop ..	47,950	45,739	50,458	42,854	43,791	41,884	46,623	47,900	45,469	46,598	45,926
		Second crop ..	14,744	14,645	20,181	14,273	15,021	15,710	18,134	22,337	12,068	14,616	16,173
		Total ..	62,694	60,384	70,639	57,127	58,812	57,594	64,757	70,257	57,537	61,214	62,099
4. Total of 2 and 3	107,512 or 112,044 inclusive of Nandyar channel.	First crop ..	134,668	130,849	138,775	128,756	128,649	126,026	130,101	132,889	126,374	126,216	130,330
		Second crop ..	51,316	51,448	62,381	51,317	49,582	43,917	50,377	57,114	44,045	47,050	50,855
		Total ..	185,984	182,297	201,156	180,073	178,231	169,943	180,478	190,003	170,419	173,266	181,185

Note.—Information as to the areas actually cultivated not being available for all the years, areas charged as irrigated have been entered.

Note.—The vertical lines at foot of diagram represent the rainfall of the different years in inches the blue portions of the lines showing that due to the North-East monsoon and the red portions that due to South-West monsoon.

The lengths between the bottom of the diagram and the dotted lines represent areas irrigated, &c. for works in charge of the P. W. D. and between the dotted lines and the full lines of the same colour for works in charge of the Revenue Department. The total areas, &c. relating to works in charge of both Departments are therefore shown by the full lines.

It will be observed that the scales for the areas irrigated are for rupees (revenue & working expenses) are the same and a comparison of the lengths representing revenue with those representing area irrigated readily gives the receipts per acre irrigated. Thus if the lengths are as 2 to 1, this represents receipts of Rs. 2 per acre.

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1902

5. *Area protected—*

Area protected in all seasons	116,400 acres.
Percentage of area cultivated	12·5
Area protected in ordinary seasons	211,800 acres.
Percentage of area cultivated	22·8

6. *Liability to famine.*—In common with other districts, this district suffered in 1805, 1833, 1866 and 1876. The numbers relieved during the last two famines were —

Period.	Duration.	On works.	Gratuitously.	Total.
1866-67	9 months ..	57	*2,495	2,552
1876-78	22 ,, ..	2,318	2,105	4,423

* Only for four months.
N.B.—The maximum number on relief was 17,929 in September 1877.

7. *Possible extension of irrigation.*—The Ponnéri project is described in the note on the Cauvery delta system and is now being investigated by a special party.

Reservoir across the Kulittalai Katuvari.—Beyond the Ponnéri project nothing of importance has been suggested. The largest project mooted is the formation at Panjapatti in Kulittalai taluk of a reservoir across the Kulittalai Katuvari (jungle stream). The catchment at the site of the proposed reservoir is 90 square miles. The capacity of the tank is to be 274·88 mills. cubic feet; assuming a run off of 5 inches from the whole catchment the yield would be 1,045 mills. cubic feet. A larger reservoir would be advisable if other circumstances permit. It is apparently proposed only to irrigate 1,000 acres. This area might with a larger reservoir be increased. Only preliminary investigations have yet been made and the question of compensation for submerged lands has yet to be considered.

Supply channel from the Aganda Cauvery.—Proposed supply channel from the Aganda Cauvery to Murugakolathur and Nagayanallur tanks. A suggestion was originally made to cut a direct supply channel from the river, but this was found impracticable. It is now suggested that water should be taken from the tail end of the Rajavoikal channel in Salem district which now discharges into Tirumanimuthu nadi by a channel about 6½ miles long. By this means it is stated that four tanks in Salem and four in Trichinopoly could be supplied and the cultivation of 3,000 acres of land in the latter district would be assured. The lower end of the channel would have to be widened to enable it to feed the tanks. It is stated that there is surplus water available in July. The matter is one which may be investigated by the ordinary staff of the Salem division and the Executive Engineer's notice has been called to the matter.

Kaduvai Project.—A proposal to form a reservoir at south-east corner of the Kulittalai taluk. The bund to be about one mile north of Nadupatti in a tract liable to be affected by famine. No investigation has yet been made.

Ladapuram Project.—A proposed tank at the foot of the Pachiamalai hills. Old surveys exist showing that the proposal has been considered for some time but nothing definite is known. The catchment area is very small. The project might form a useful little work and should be investigated.

A channel from the Cauvery.—A proposal has been put forward by the officers of the Revenue Department to cut a channel from the Cauvery near Kalavai to fill tanks in the Illupur Mahanam of the Trichinopoly taluk. No levels have been taken to see if the proposal is feasible, but in any case I do not think it advisable to investigate any more flood channels from the Cauvery until the question of the Ponnéri and Pattukkóttai projects is settled. It was brought to notice that there are a large number of minor irrigation works either ruined or in bad order, notably on the Iyar river. This would indicate the advisability of deputing a Tank Restoration Scheme Party to work in this district at an early date.

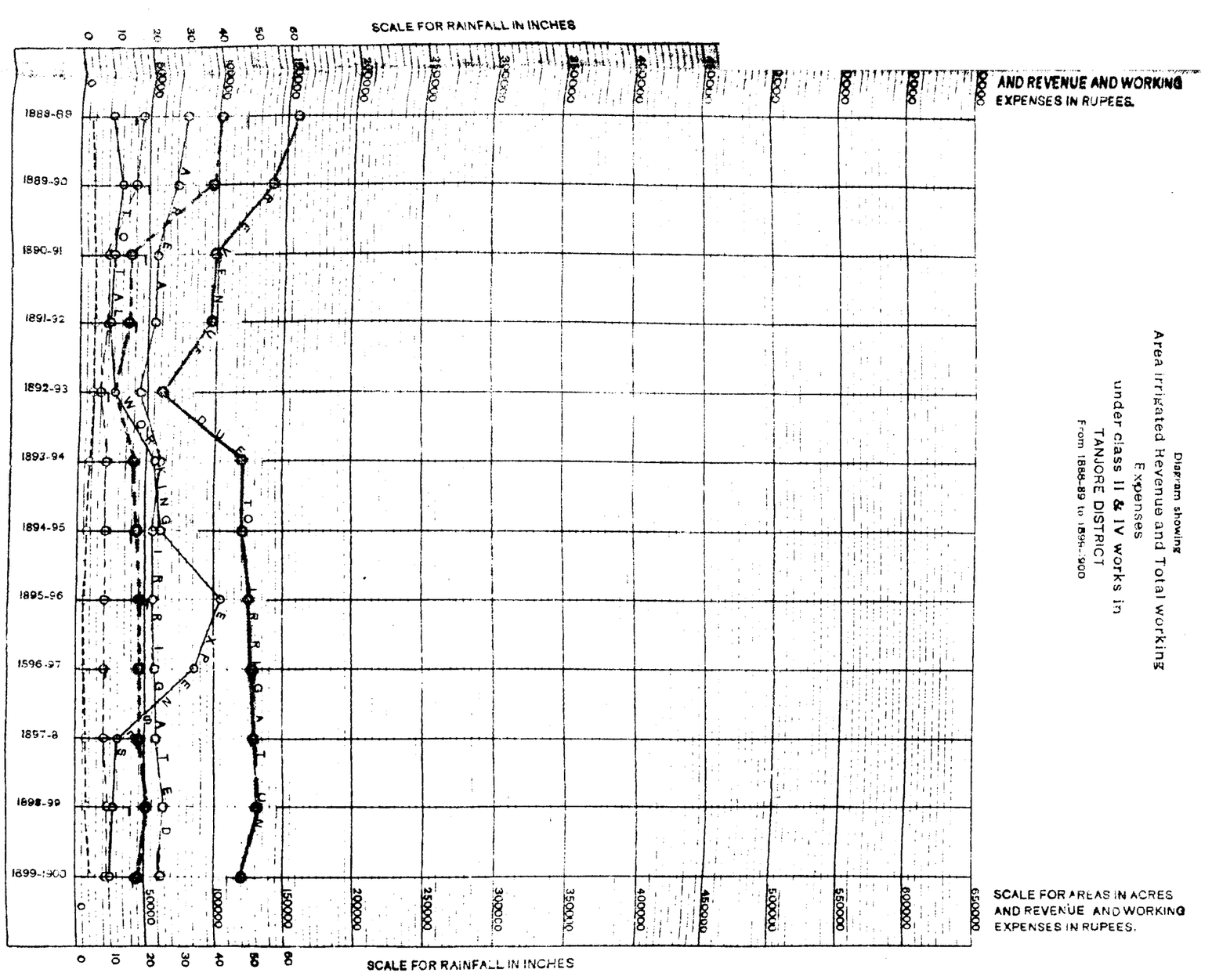
8. A special party is now at work on the Ponnéri project and beyond this there is nothing in the district that the ordinary staff cannot cope with.

TANJORE DISTRICT.

General features.—The district may be divided into (1) the delta and (2) the non-deltaic or upland portion. The former is a wide alluvial plain gently sloping to the sea. It is irrigated by a network of irrigation channels formed by the several branches into which the main stream of the Cauvery splits up soon after it enters the district. The non-deltaic portion is occupied by sedimentary rocks, chiefly laterite. The soil is in parts exceedingly poor.

2. *Rainfall.*—The average rainfall of the district is 44·40 inches, of which more than one-half is brought by the north-east monsoon. The delta, however, depends chiefly on the fall on the Western Ghâts during the south-west monsoon, which causes freshes in the Cauvery. The inland tract is much the driest and comprises the non-deltaic parts of the district.

3. *Existing irrigation.*—Besides the Cauvery delta system which is dealt with in part I, there are channels taken off at the lower anicut across the Coleroon, which irrigate about 20,000 acres of first crop in the Shiyali, Máyavaram and Kumbakónam taluks. There are also 1,039 tanks and other sources (excluding wells) which are met with chiefly in the non-deltaic taluks. The accompanying statement shows the areas irrigated by minor works during the past ten years :—



Note.—Excludes the area &c. under the Lower Coleroon anicut system class II works, wide foot note in the diagram for the South Arcot district.

The vertical lines at foot of diagram represent the rainfall of the different years in inches, the blue portions of the lines showing that due to the North East monsoon and the red portions that due to South West monsoon.

The lengths between the bottom of the diagram and the dotted lines represent areas irrigated &c. for works in charge of the P. W. D. and between the dotted lines and the full lines of the same colour for works in charge of the Revenue Department. The total areas &c. relating to works in charge of both Departments are therefore shown by the full lines

It will be observed that scales for the areas irrigated and for rupees (revenue and working expenses) are the same and a comparison of the lengths representing revenue with those representing area irrigated readily gives the receipts per Acre irrigated. Thus if the lengths are as 2 to 1, this represents receipts of Rs. 2 per acre.

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STATEMENT showing the Ayakat areas and the areas cultivated during the past ten years (Class I works excluded).

Works.	Ayacut area.		Area charged as irrigated during the revenue year ending.										Average area irrigated.
			30th June 1892 (fasli 1301).	30th June 1893 (fasli 1302).	30th June 1894 (fasli 1303).	30th June 1895 (fasli 1304).	30th June 1896 (fasli 1305).	30th June 1897 (fasli 1306).	30th June 1898 (fasli 1307).	30th June 1899 (fasli 1308).	30th June 1900 (fasli 1309).	30th June 1901 (fasli 1310).	
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Class II Works.	ACS.		ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.
1. Lower Coleroon anicut system ..	Included in the statement for the South Arcot district, distribution between the two districts of the areas irrigated not being available.												
Other Minor Works.													
2. Petty works in charge of the Public Works Department.	23,024	First crop ..	18,208	14,307	16,297	17,676	17,906	18,007	18,027	19,863	18,254	17,265	17,581
		Second crop..	1,503	1,260	4,219	1,299	1,278	1,618	1,700	2,577	1,651	2,146	1,925
		Total ..	19,711	15,567	20,516	18,975	19,184	19,625	19,727	22,440	19,905	19,411	19,506
3. Petty works in charge of the Revenue Department.	36,658	First crop ..	31,938	25,783	35,086	35,837	36,411	36,635	35,977	34,564	34,245	37,570	34,391
		Second crop..	2,613	1,821	4,724	1,630	1,903	2,073	2,696	3,051	2,742	4,191	2,738
		Total ..	34,516	27,604	39,810	37,467	38,314	38,708	38,673	37,515	36,957	41,761	37,129
4. Total of 2 and 3	59,682	First crop ..	50,111	40,090	51,383	53,513	54,317	54,642	54,004	54,427	52,499	54,835	51,972
		Second crop..	4,116	3,081	8,943	2,929	3,181	3,691	4,396	5,628	4,393	6,277	4,663
		Total ..	54,257	43,171	60,326	56,442	57,498	58,333	58,490	59,955	56,892	61,112	56,635

Note.—Information as to the areas actually cultivated not being available for all the years, areas charged as irrigated have been entered.

Wells are almost exclusively found in the non-deltaic Pattukkóttai taluk, which in point of irrigation is the poorest.

4. *Area protected.*—

		ACS.
Area protected in all seasons ..	... ...	685,600
Percentage of area cultivated ...	... ...	54·8
Area protected in ordinary seasons	... ...	816,200
Percentage of area cultivated ...	... ...	65·2

5. *Liability to famine.*—In 1805, there was a general failure of crops as in other districts, and the scarcity of 1807 was partially felt. Relief works were necessary during the famines of 1866–67 and 1876–78. The average numbers relieved during these two famines are:—

Period.	Duration	On works.	Gratuitously.	Total.
1866–67	7 months ..	...	3,141	3,141
1876–78	3 ..	1,726	11,376	13,402

N.B. The maximum number on relief was 54,518 in August 1877.

The southern portion of the district is liable to suffering, but the people there can find ample employment in the deltaic tract and in towns. The district cannot, therefore, be regarded as one liable to famine.

6. Any extension of irrigation must depend on the utilization of the surplus waters of the Cauvery which is considered when treating of that system.

MADURA DISTRICT.

General features.—The district consists of a section of the plain stretching from the eastern slopes of the western ghâts to the sea. It comprises seven Government taluks and two large zamindaris. Very little information is on record regarding the latter.

2. *Soil.*—The prevailing soil over a considerable portion of the Ramnad zamindari and the Tirumangalam taluk is black cotton with allied soils. This black cotton soil differs from the cotton soil of the Ceded districts, in that it is more friable, less retentive of water and more suitable for irrigation. A small area of similar soils exists in all the other taluks; but in most of them gravelly and sandy soils are the more common. Madura and Periyakulam both show over 35 per cent. of loamy soils and Palni 27 per cent.

3. *Rainfall.*—Omitting the hill station of Kodaikánal, the average rainfall of the district is 30·19 inches, of which more than one-half is registered during the north-east monsoon. The annual fall ranges from 18·6 in 1876 to 47·41 inches in 1877. In that section of the district which adjoins Tinnevelly, the rainfall is much below the average, while in the central and eastern parts it is comparatively heavy.

4. *Rivers.*—The principal rivers are the Vaigai with its tributaries, the Varashalai and the Gundu. These rivers are extremely uncertain and are rarely in fresh for more than a few days at a time. The supply in the Vaigai has, however, been made more assured by means of the Periyár project. The drainage of the northern portion flows into the Amarávati and the Shunmuganadi.

5. *Existing irrigation.*—The Periyár project is dealt with in part I. Besides this, there are 5,948 tanks and channels, of which 5,057 irrigate less than 50 acres. The areas irrigated by these works during the past ten years are shown in the following statement:—

STATEMENT showing the Ayacut areas and the areas irrigated during the past ten years (Class I works excluded).

Works.	Ayacut area.	—	Area charged as irrigated during the revenue year ending 30th June 1892 (fasli 1301).	30th June 1893 (fasli 1302).	30th June 1894 (fasli 1303).	30th June 1895 (fasli 1304).	30th June 1896 (fasli 1305).	30th June 1897 (fasli 1306).	30th June 1898 (fasli 1307).	30th June 1899 (fasli 1308).	30th June 1900 (fasli 1309).	30th June 1901 (fasli 1310).	Average area irrigated.
1	2	3	4	5	6	7	8	9	10	11	12	13	14
			Acs.	Acs.	Acs.	Acs.	Acs.	Acs.	Acs.	Acs.	Acs.	Acs.	Acs.
Class IV Works.													
1. Petty works in charge of the Public Works Department.	46,894	First crop ...	73,768	32,604	74,613	75,215	49,874	46,747	46,001	38,831	44,016	57,447
		Second crop...	33,846	27,732	43,713	24,418	19,128	24,921	19,181	20,982	24,259	26,005
		Total ...	101,614	78,316	118,326	99,633	68,502	70,668	65,182	58,813	68,275	83,452
2. Petty works in charge of the Revenue Department.	61,465	First crop ...	105,797	83,209	110,967	102,532	112,943	90,219	78,147	85,859	52,491	89,447
		Second crop...	23,054	17,900	33,883	18,937	24,227	17,217	17,982	22,300	18,267	20,065
		Total ...	128,851	101,109	144,850	121,469	137,170	107,429	96,129	108,159	65,758	109,512
3. Total ...	127,462	First crop ...	179,565	135,813	185,580	173,883	188,168	139,566	124,864	124,690	91,292	117,873
		Second crop...	56,940	45,632	77,596	43,355	43,355	41,808	41,163	43,282	42,529	46,050
		Total ...	236,835	177,485	263,076	220,711	231,523	181,374	166,027	173,981	124,631	163,502

N.B.—When the Periyar project was brought into operation in 1896-97 certain works under Class IV were transferred to that project. This partly accounts for the decrease in the areas cultivated under Class IV from 1897-98 to 1899-1900. The year 1896-97 was an unfavourable year.

Note.—Information as to the areas actually cultivated not being available for all the years, areas charged as irrigated have been entered.

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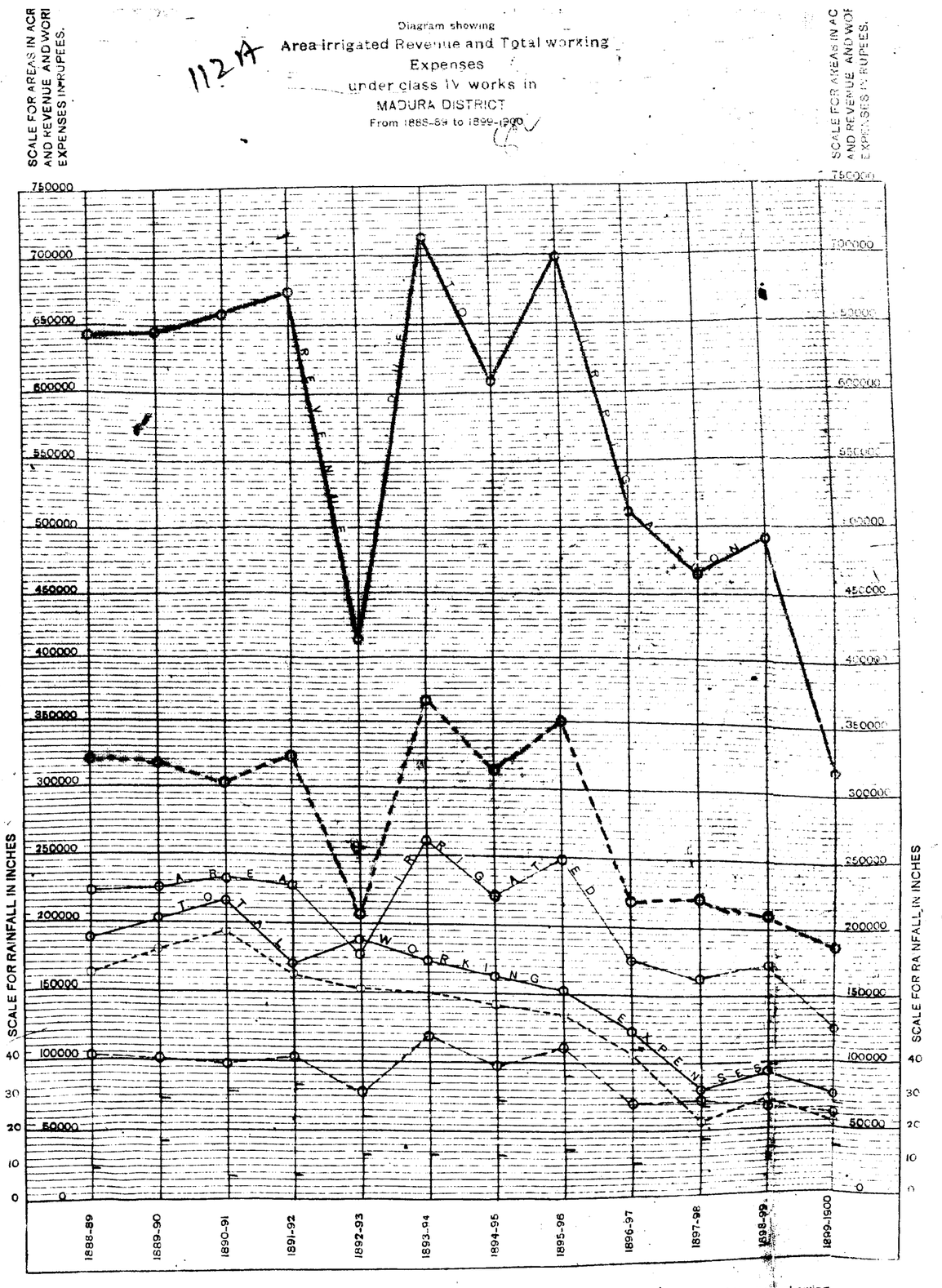
Diagram showing
Area irrigated Revenue and Total working Expenses
under class IV works in
MADURA DISTRICT
From 1888-89 to 1899-1900



Note.— The vertical lines at foot of diagram represent the rainfall of the different years in inches, the blue portions of the lines showing that due to the North-East monsoon and the red portions that due to South-West monsoon.
The lengths between the bottom of the diagram and the dotted lines represent areas irrigated, &c. for works in charge of the P. W. D. and between the dotted lines and the full lines of the same colour for works in charge of the Revenue Department. The total areas, &c., relating to works in charge of both Departments are therefore shown by the full lines.

It will be observed that the scales for the areas irrigated and for rupees (revenue & working expenses) are the same, and a comparison of the lengths representing revenue with those representing area irrigated readily gives the receipts per acre irrigated. Thus if the lengths are as 2 to 1, this represents receipts of Rs. 2 per acre.

There are 24,902 wells irrigating 83,766 acres.

6. *Area protected—*

	ACS.
Area protected in all seasons	* 90,100
Percentage of area cultivated	9·3
Area protected in ordinary seasons	* 203,700
Percentage of area cultivated	20·9

* The figures are from Benson's Statistical Atlas. Since its publication the Periyár project has been completed, by which an area of about 100,000 acres is protected in all seasons.

7. *Liability to famine.*—The district does not appear to have been affected prior to 1865. The famine of that year was very severe. It again suffered in the great famine of 1876—78. The numbers relieved are—

Famine.	Period.	On works.	Gratuitously.	Total.
1866-67	11 months.	1,378	2,912	4,290
1876—78	19 do.	7,884	19,714	27,598

N.B.—The maximum number on relief was 112,048 in September 1877.

8. *Possible Extension of Irrigation—Porandalar Project.*—The project consists of a scheme for impounding the waters of the Porandalar and Pálár in Palni taluk, a short distance above their junction. With a view to ascertain the supply available, gauge readings have been taken on the Porandalar, Pálár and Patchyar rivers. The points at which the gauge readings were taken are in each case a short distance below the site of the proposed dam. But as the last-named stream enters the Pálár between the site of the dam and the point of gauging on the Pálár, the discharge of the Patchyar must be deducted. Readings have been taken for a total period of 35 months. The combined discharge of the Porandalar and Pálár amounted to 19,958·32 millions of cubic feet and the discharge of the Patchyar to 1,789·79 millions cubic feet, giving a net result of 18,168·53 millions or an average of 519·1 per month or an average of 6,229·2 per annum. Assuming that 2 millions cubic feet is the quantity required for 10 acres, the supply is apparently sufficient for 31,146 acres. But there are several reasons which render it advisable to make certain deductions from the total discharge. In the first place the anicut crests are all broad and the coefficient of discharge used in arriving at the discharges was ·66 which seems unduly high. Secondly, the rivers discharge spring water at the point of gauging when the upper anicuts are dry. Thirdly, the gaugings include discharge from a small catchment not within the catchment of the proposed reservoir. If we make a deduction on the first count of 10 per cent., and $6\frac{1}{2}$ per cent. on the other two, we arrive, after rounding off the figures, at a total available supply of 5,200 millons of cubic feet which at 10 acres to 2 millions is sufficient for 26,000 acres.

In his report Mr. Garrett arrived at the conclusion that 5,760·55 millions of cubic feet were available for storage purposes. In making this calculation he took the rainfall at 67 inches over the catchment area of 94 square miles and assumed a run off of $\frac{1}{2}$. From this he deducted the amount drawn off by the Iyempalli channel. In arriving at the figure 5,200 above, no deduction is made on this latter account, because the water is drawn off above the point of gauging. There is thus a difference of 560·55 millions, between the result now arrived at (after making certain *arbitrary deductions* from the results given in paragraph 1) and those arrived at by Mr. Garrett. The arbitrary deductions now made are merely a matter of opinion and are open to argument, especially as regards the last item. If this last deduction of $6\frac{1}{2}$ per cent. is omitted the amount available for storage becomes 5,600 millions of cubic feet after rounding off the figures; that is, taking the full deduction made, the difference is upwards of 11 per cent., but if the last item is neglected the difference is only slightly over 3 per cent. The approximation of the results is significant.

9. The proposed dam is intended to be of earth, but the section is not a suitable one and may be redesigned. The capacity of the reservoir as originally proposed was 3,452 millions cubic feet. It has been suggested that a smaller reservoir should be formed; but in view of the results of the gaugings, it would be wrong to decrease its capacity.

The estimate submitted for the project was as nearly as possible 11 lakhs of rupees. The Executive Engineer thinks that this is somewhat low, and that the project would cost at least 13 lakhs if not more, also that the estimate requires thorough and careful overhauling. Assuming a total cost of 14 lakhs and a yield of Rs. 3-8-0 per acre from 20,000 new acres, the return would be 5 per cent. Assuming a yield of Rs. 3-8-0 from 16,000 new acres, the return would be 4 per cent.; and assuming a yield of Rs. 3-8-0 from 10,000 new acres, the return would be 2½ per cent.

It is not possible to state with certainty what the effect of the project would be on the Amarávati irrigation. When the Shanmuganadi is low, nothing passes into the Amarávati, and it is stated that, when the latter is in flood, the absence of water from the Shanmuganadi is not felt. It has also been suggested that reservoirs should be constructed on the Amarávati and that their construction will obviate any injury to the Amarávati irrigation that might be caused by the construction of the Porandalar reservoir. The area commanded is one which is much liable to be affected by drought, and there is no doubt that the scheme would greatly benefit the Palni taluk.

As far as present available figures go, the scheme is likely to return a revenue that would cover the interest on the capital outlay; but it requires further investigation. I think that there is a good prospect of its paying the interest on the capital cost and that the estimate and plans should be overhauled and the alignment of the distributary channels settled and a detailed ayacut map made. For this purpose some addition to the staff of the district is required. The extra staff may work under the orders of the Executive Engineer who is willing to take up the investigation.

10. *Suggestions of the Collector.*—The Collector of the district has in a note suggested certain small projects, many repairs which are either under investigation by the Executive Engineer or are for sufficient reason pronounced impracticable. They are all very small and need not be detailed here.

11. The greater part of this district has been dealt with by Tank Restoration Scheme Parties. There is however a portion which was not taken up presumably because it was believed that the tract would be affected by the Periyár project. This area in the Melur taluk should be completed. A Tank Restoration Scheme Party will be sent there very shortly.

TINNEVELLY DISTRICT.

General Features.—The district is shut in on the west by the Western Ghâts which are well clothed with forest between the elevations of 1,500 and 5,000 feet. In the deep recesses of this range rise numerous rivers and streams which flow through the plain country, of which the district chiefly consists, until they reach the sea on the east.

2. *Nature of Soil.*—Along the banks of the Tambraparni and its affluents lies a rich alluvial belt of irrigated land. To the north and north-east of the district there are wide level plains of cotton soil, black and bare in the dry season; further south approaching the Tambraparni valley are wide areas of undulating sandy country studded with numerous tanks.

3. *Rainfall.* The district receives very little of the rainfall of the south-west monsoon, though parts of it are watered by streams which rise in the hills and receive large supplies at that season. The north-east monsoon sets in about October; but the rainfall brought by it is irregular, though general over the whole district and often heavy. Contrary to the experience of other parts of the Presidency, the early months of the year are not rainless. The average rainfall for the thirty years ending with 1899 amounts to nearly 27 inches. The fall was less than 20 inches in five years, while in nine years it exceeded 30 inches. The maximum average fall is 38·32 at Tenkási and the minimum 21·21 at Tuticorin.

4. *Rivers.*—The most important river of the district is the Tambraparni. It has an almost perennial stream. It is crossed by eight anicuts, all feeding irrigation canals. Its principal affluent is the Chittar. The Vaipar with its tributaries the Arjunanadi and the Satur river is a stream of some size.

5. *Minor Works.*—On the Tambraparni above the Srivaikuntam anicut system, which is dealt with elsewhere, are the Marathur and six other anicuts. There are also a large number of tanks fed by rivers and streams. The ayacut areas of these works and the areas irrigated by them during the past ten years are as shown below:—

STATEMENT showing the Ayacut areas and the areas irrigated during the past ten years (class I, works excluded).

Name of work.	Ayacut area.	—	Area actually irrigated or charged as irrigated during the revenue year ending: 30th June 1892 (fasli 1301).	30th June 1893 (fasli 1302).	30th June 1894 (fasli 1303).	30th June 1895 (fasli 1304).	30th June 1896 (fasli 1305).	30th June 1897 (fasli 1306).	30th June 1898 (fasli 1307).	30th June 1899 (fasli 1308).	30th June 1900 (fasli 1309).	30th June 1901 (fasli 1310).	Average area irrigated.
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Class II Works.	ACS.		ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.	ACS.
1. Maradur anicut ..	17,920	First crop ..	17,086	14,829	17,274	17,164	17,107	17,056	17,080	17,097	17,022	17,236	16,891
		Second crop..	13,629	10,885	13,281	12,379	11,608	13,524	14,133	13,855	13,241	14,933	13,147
		Total ..	30,715	25,714	30,515	29,543	28,715	30,580	31,213	30,952	30,263	32,169	30,038
2. Class III works (six anicuts across the Tambraparni).	..	First crop ..	36,649	36,473	36,646	36,739	35,736	36,943	37,096	37,318	37,332	36,764	36,876
		Second crop..	34,111	33,521	33,868	33,933	35,031	34,178	34,459	34,640	35,081	34,552	34,231
		Total ..	70,760	69,994	70,514	70,672	70,767	71,121	71,555	71,958	72,413	71,316	71,107
Class IV Works.													
3. Petty works in charge of the Public Works Department.	* 100,850	First crop ..	55,319	34,154	52,100	41,464	52,792	55,185	54,360	63,789	56,409	64,640	53,012
		Second crop..	31,754	25,799	33,753	23,884	31,883	33,090	33,841	42,247	36,773	43,289	30,639
		Total ..	87,073	59,953	85,853	65,348	84,675	88,275	88,201	106,036	93,182	1,07,929	83,651
4. Petty works in charge of the Revenue Department.	86,405	First crop ..	91,715	56,471	86,963	63,167	89,020	91,348	84,130	82,576	71,947	84,385	80,196
		Second crop..	43,700	37,763	46,165	32,065	47,368	50,936	45,384	42,559	31,405	45,434	42,602
		Total ..	135,415	94,234	133,128	95,232	136,388	142,284	129,514	125,135	103,352	1,29,819	1,22,798
5. Total of class III and IV works (2 + 3 + 4).	187,255	First crop ..	183,683	127,098	175,709	141,370	177,548	183,477	175,586	193,963	165,688	1,85,789	1,70,078
		Second crop..	112,565	97,083	113,786	89,822	113,282	118,204	113,684	119,826	103,259	1,23,273	1,10,478
		Total ..	295,248	224,191	289,495	231,192	291,830	301,681	289,270	303,789	268,947	3,09,064	2,80,556

* Probably includes the ayacut area of class III works.

NOTE—*Item* 1.—The areas entered represent actual cultivation.
Items 2, 3 *and* 4.—Information as to the areas actually cultivated not being available, areas charged as irrigated have been entered.

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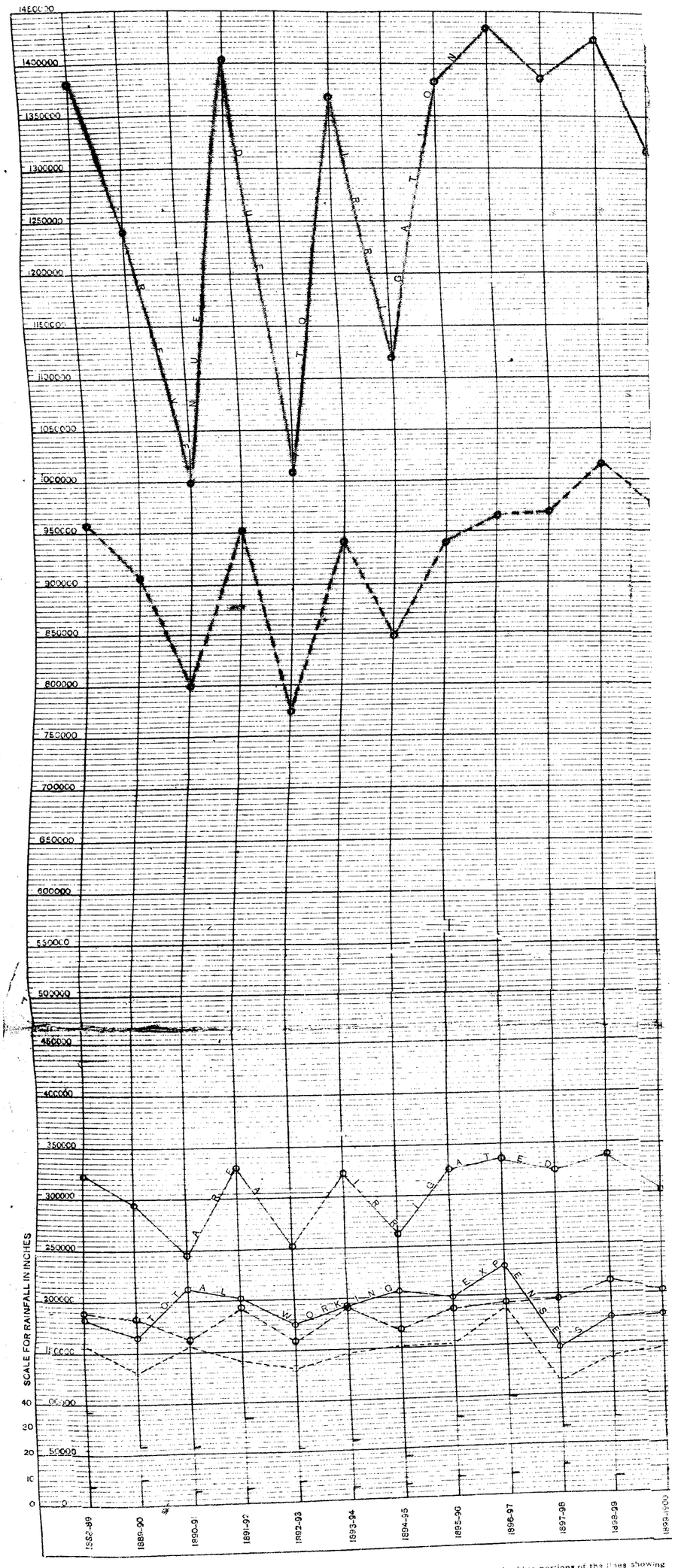
Diagram showing
Area irrigated Revenue and Total working Expenses
under class II III & IV works in
TINNEVELLY DISTRICT
From 1888-89 to 1899-1900



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6. *Area protected*—

Area protected in all seasons	146,100 acres.
Percentage of area cultivated	12·1.
Area protected in ordinary seasons	255,800 ,,
Percentage of area cultivated	21·2.

7. *Past Famines.*—In the great famine of 1876—78 a small number of people were on relief; whilst early in 1891 there was some distress and a few works were started to afford relief to the labouring poor.

The numbers relieved are —

Period.	Duration.	On works.	Gratuitously.	Total.
1876—78	15 months.	1,740	3,386	5,126
1891–92	6 ,,	876	.. ..	876

N.B.—The maximum number on relief was 24,492 in September 1877.

8. *Liability to Famine.*—The district is so situated that the labouring population finds an easy outlet to the planting districts of Ceylon and to Travancore, where the demand for labour is usually great. Consequently the labourers suffer but little in an unseasonable year.

9. *Ghiriar and Kullar Projects.*—There are two projects for diverting streams known as the Ghiriar and the Kullar which now flow to the west. They both involve the construction of a tunnel and other expensive works. As the amount of water to be diverted is very small, the cost would be out of proportion to the possible increase of revenue. The works are not likely to be useful in the way of famine relief, and further investigation of them is not recommended.

10. *Irrigation from Vaipar.*—The Vaipar river is a stream of considerable size which does not at present contribute as much as it might to the prosperity of the country. In 1895 possible sites for reservoirs at Khansahibpuram near Watrap (Varratirayiruppu) and Rajapolium were investigated by the Executive Engineer but were thrown out on the score of expense. An estimate has also been submitted by the Executive Engineer recently for making a supply channel from the river to Vilatikulam. It is not, however, proposed to construct an anicut. The whole basin of this river appears to require investigation to see if reservoirs cannot be formed on it and its tributaries, or whether it would be better to construct anicuts to supply chains of tanks in its neighbourhood. There are already three anicuts, but they can only take off a very small portion of the water which is now wasted.

11. Proposals for utilising the surplus waters of the Nambiar were made by Mr. Caldwell as long ago as 1869, and they were investigated by Mr. S. D. Grant. The project consisted of the improvement of the existing Kovankulam anicut, the lowest on the river, the excavation of a channel therefrom and the construction of a new tank to be supplied by it and to irrigate 2,000 acres. The project was roughly estimated to cost Rs. 1,87,000 and to yield a return of Rs. 10,000.

It was given up on the following grounds :—

(1) The return was small.

(2) The water-supply was precarious and was found to pass Kovankulam anicut only about seventeen days in the year.

(3) Difficulty in the diversion of a large drainage stream that drains into the Tharuvai, the land about which it was proposed to cultivate.

(4) The existing works were not in good order and remissions on them were granted. It was considered advisable to put them in order first.

It is stated that these works have now been put in order and investigation may be made to see if there is any surplus water available. If so, the best method of storing it may be enquired into.

12. *Reforming Sivalaperi and Parakramapandian Tanks.*—These are two breached or incomplete tanks. The latter, the Parakramapandian tank, is formed by damming the Upodai, a tributary of the Chittar. The catchment area of the stream is 270 square miles, but it has numerous tanks in its basin. The Sivalaperi tank is also breached.

It would get its supply from left flank of the Parakramapandian tank. The tanks are shallow and the beds are under cultivation. Levels are now being taken to form estimates for their restoration. They would form suitable famine works although they are situated in a portion of the district not much liable to famine.

13. Estimates for other minor works suitable for famine relief are under preparation by the Executive Engineer and need not be here alluded to.

14. I understand that there are no spring channels from rivers in Tinnevelly district, such as exist in numbers in the Arcots and Cuddapah. The Vaipar and Chittar rivers look very suitable for such channels which form excellent famine relief works and in future famines an attempt might be made to introduce them. The channels should, however, be maintained by *kudimaramat*, *i.e.*, by the ryots themselves, and this should be made a condition of their construction. These channels are very valuable and generally yield an unfailing supply of water all the year round. Their introduction into the district should be seriously considered.

THE TANK RESTORATION SCHEME.

The importance of the Minor Irrigation works of the Madras Presidency.—The important feature which characterises the irrigation works of the Madras Presidency is the enormous number of small works (for which neither capital nor revenue accounts are kept) which, though comparatively unimportant individually, are nevertheless the means by which more than half the irrigation in this Presidency is effected. The importance of this feature will be appreciated when it is stated that these small works number upwards of 50,000 and irrigate nearly 3 million acres of land. These works, which consist chiefly of tanks and channels, were constructed by native rulers in order to store and utilize local rainfall and the waters of small rivers at times of sudden storms, and to prevent the rapid flow of water to the sea. Such is the nature and extent of the rainfall in this Presidency that the construction of these small works has been attended with marked success. The waters of the large rivers of the Presidency have been utilized more profitably in their deltas.

2. *State of disrepair of Minor Irrigation works prior to the inauguration of the Tank Restoration Scheme.*—In 1832 Sir A. Cotton wrote of these works: "The irrigation works in general are so far from being in good order, that the revenue actually derived from them at present is by no means a full measure of their value." In 1851 the Commission appointed by Government to enquire into the system of public works in this Presidency arrived at the conclusion that all the works in the country with a few exceptions were in a state that might be called "below par"; that is, they were below their state of full efficiency and incapable of effecting their proper amount of irrigation. The few exceptions referred to were in the Tanjore and Trichinopoly districts, where even to this day local cesses are levied for the purpose of carrying out repairs. As a result of this Commission the Public Works Department was organized and entrusted with the maintenance of all irrigation works. From this time forward help from the ryots, which under the name of "kudimaramat" or customary labour had been enforced while the works were under the Revenue Department, gradually ceased, and the cost of maintenance thrown on the Government was consequently enhanced. In 1870 another Commission was appointed to report on the working of the Public Works Department. In their report they say: "Evidence shows that the works are not in that state of efficiency in which they require to be placed and that treating the works as a whole, the expenditure of money on them has not been sufficient. A percentage of the revenue from irrigation should be devoted to the maintenance of the works to be treated as a first charge on the revenue. We recommend that this charge be fixed at 8 per cent. on the revenue, and that the sum so obtained be devoted entirely to the maintenance of such of the irrigation works of the several districts as are not otherwise provided for, including under the head of maintenance, such minor improvements, the construction of sluices, etc., as may be found requisite for the safety of the works, or for increasing their usefulness." The report of the Commission resulted in a reorganization of the Public Works Department, but little or nothing was done towards a systematic maintenance of irrigation works.

Maintenance of all irrigation works by Public Works Department.

Commission of 1870.

3. *Systematic treatment of irrigation works recommended by the Famine Commission in 1878.*—The birth of the scheme which has now been in existence for upwards of 18 years may be traced, however, to the following remarks of the Famine Commissioners in their report of 1878:—

"There is a general consent that the measures now adopted for the maintenance of the tanks in efficiency, are wholly inadequate. The expenditure has been more liberal of late years; but still the Irrigation Department reckon that, in order to make the more important tanks safe in years of ample rainfall, an annual grant three times as great as that hitherto appropriated for this purpose, and a period of 20 years would be necessary. Such a delay in effecting the necessary improvement would be very bad economy. The security of the annual revenue of £700,000, which is dependent on these works, is a matter which the Government cannot be justified in overlooking; and any loss which Government sustains corresponds to far more serious damage inflicted on the agricultural class. The Government ought then, in our opinion,

to frame a scheme for putting the tanks in order with as little delay as financial considerations and the arrangements of the administration will permit, and carry it out in a systematic and continuous method till this serious cause of preventible loss has been removed."

"Imperial" and "Minor" works.

The Irrigation Committee appointed by the Famine Commissioners recommended the division of irrigation works into two general classes :—

(1) Those irrigating over 200 acres to be called "Imperial."
(2) Those irrigating less than 200 acres to be termed "Minor."

There were exceptions to each class, *e.g.*: small works irrigating less than 200 acres, which from their position affected important Government works, were to be included in the first class, while other works irrigating over 200 acres, being isolated and not requiring professional supervision in their upkeep, were to be classed as "Minor." The "Imperial" works were to be placed in charge of the Public Works Department and the "Minor" in charge of the Revenue Department. The Minor works were to be divided into three classes :—

Three classes of "Minor" works to be handed over to villagers.

A. Tanks irrigating more than 50 acres but not classed as "Imperial" works.
B. Tanks irrigating less than 50 acres.
C. Tanks irrigating less than 10 acres the maintenance of which might be of little importance to the State.

Tanks of A. class were to be repaired up to a certain standard and then handed over to the villagers to be maintained. Tanks of B. class were to be handed over forthwith to the villagers, and not maintained to any fixed standard, the Public Works Department having nothing further to do with them, except as regards masonry repairs. Tanks of C. class were to be left or repaired by the villagers. In G.O., No. 284 I., dated 5th May 1880, Government proposed to give grants-in-aid to villagers to enable them to bring the bunds of tanks of A. class to a safe standard and to allow conditional remission of assessment as a compensation for work done by village communities in excess of that they were, under the name of "kudimaramat", bound by ancient custom to do. And in order to enable Collectors to obtain complete information in such detail as they might find necessary regarding the state and requirements of the Minor Irrigation works in their districts, they were given Tank Inspectors on Rs. 150 per mensem. A Tank Inspector was to have charge of 1,000 "Minor" works, each of which he was to report on to the Collector once a year. In consequence of this report of the Famine Commissioners, the Kudimaramat Bill, 1883, and an Irrigation Law were drafted.

Grants-in-aid and conditional remissions.

4. *Colonel Hasted's Scheme.*—Thus it may be seen that steps were gradually taken towards a better management of the irrigation works of the Presidency. In his note to Government on the subject of Irrigation works, dated 27th November 1882, Colonel Hasted stated that, before the famine of 1876–77, steps were taken to group tanks and channels in all districts, that is, to ascertain the circumstances of each individual work with reference to those lying above and below it in each drainage basin and to note requirements, and the progress made in this direction was as follows :—

Grouping of Irrigation works.

	Area.	Revenue.
Works grouped	392,697	18,94,654
Works to be grouped	2,413,021	70,97,836
	2,805,718	89,87,490

He classed the work to be done under two heads—

"Restoration" and "Conservancy."

(1) Bringing each work up to a standard of efficiency and providing proper weirs and sluices.
(2) Maintenance of works already brought up to the standard.

The first of these he asserted would bear no relation to the revenue and in many cases would mean simply "restoration," but in the case of most works it would be a work of "improvement." In the majority of cases the smaller tanks had never been provided with efficient weirs, and in many instances water had been drawn from the tanks by cuts. Under the second head "maintenance" which should be taken to mean "ordinary repairs" that the ryots could not perform, "petty repairs" such as the filling of gullies, removing silt in a channel, replacing displaced stones in revetment, etc., being left to the ryots. He considered that the expenditure should be a certain percentage of the revenue, and in deciding what this percentage should be he took the following opinions of committees and individuals as a guide. Sir A. Cotton considered that works in which water is retained require an annual outlay of 3 to 4 per cent. on the cost of works. The committee of 1852 stated that 10 per cent. on the revenue should be expended on "maintenance" and "improvement." The Commission of 1870 considered that 8 per cent. on the revenue should be spent on "maintenance" and "minor improvements." Colonel Mullins was of opinion that considerably more than 8 per cent. on the revenue would be required for many years, but Sir W. Robinson proposed 6¼ per cent. (one anna in the rupee) only as a grant-in-aid. If Rs. 6 were taken as the total assessment, including second crop, 8 per cent. on the revenue would approximate to a "charge of 8 annas an acre." Colonel Hasted estimated the work to be done under the first heading of expenditure including "establishment," "tools and plant" to be 550 lakhs, allowing for three times the annual grant for a period of twenty years, as recommended by the Famine Commission, and deducting 8 annas per acre for "maintenance." This he said would be the sum required for "restoration" or "extensions and improvements." Referring to the statement printed with letter No. 2696 W., dated 16th October 1882, from the Madras Government to the Government of India, the return to be expected amounted to 7·2 per cent. This figure was calculated and based on the assumption that, although some of the ayacut would remain uncultivated, other waste lands not included in the ayacut might be irrigated. In considering the way the money should be spent Colonel Hasted was of opinion that to avoid loss by wasteful expenditure a considerable sum would have to be spent on preliminary expenses, grouping, etc. He considered the permanent establishment was not sufficiently strong to deal with it and carry out works on any extended scale and the subject of the future management of minor irrigation works must be connected with the work of grouping, for on the investigation of the circumstance of each work depended the determination of—

"Ordinary" and "petty" repairs.

Maintenance and Minor improvements "8 annas an acre."

Permanent establishment insufficient.

(1) What tanks should be abandoned.
(2) What tanks could be handed over to the ryots without risk to other interest.

The proposal was therefore made to constitute tank divisions to work at first under a Superintending Engineer on special duty, so that the work should be started on a proper footing. The first year one tank division was to start work spending about 1½ lakhs. In the next year a second division was to be started and so on until there was at least one division working in each circle and the expenditure would then be 9 lakhs. An annual expenditure of 10 lakhs, Colonel Hasted stated, would make the work last 55 years.

Six proposed tank divisions to spend 9 lakhs annually.

5. *Inauguration of the Tank Maintenance Scheme.*—Accordingly this scheme for dealing systematically with the irrigation tanks and channels of this Presidency with a view to bringing each work into an efficient state, sketched out by Colonel Hasted in his note, dated 27th November 1882, was brought forward when the Hon'ble Major Baring, the Finance Minister, visited Madras in 1882 and the financial bearings of the question were discussed. The Finance Minister expressed himself prepared to accept generally the proposals put forward as regards the provision of funds. Subsequently in G.O., No. 113 I., dated 12th February 1883, the Government of India

sanctioned the temporary appointment of a Superintendent of works and a "tank" division to commence operations and stated that grants under 33. Irrigation and Navigation (works for which neither capital nor revenue accounts are kept) would be provided to the following extent:—

Imperial Funds sanctioned.

	Rs.
1883-84	19,78,300
1884-85	21,28,300
1885-86	22,78,300
1886-87	25,28,300

These annual grants allowed for the funds for Tank Maintenance operations suggested by Colonel Hasted. The Government of India also pointed out that in order to ensure the fullest possible benefit being derived from the expenditure, it was essential that the Statute Labour question, the question of the extent to which the Public Works Department agency should be superseded by Collectors, also the question of the extent to which tanks should be repaired by the State, should receive careful and full consideration, and for this purpose the Inspector-General of Irrigation, Colonel Brownlow, was deputed to Madras in 1883. The decisions arrived at on these questions by the Government of Madras will be mentioned hereafter.

Questions to be considered by the Madras Government.

6. *Commencement of Operations.*—Operations were commenced in April 1883 in the Madura district, where irrigation works of this class were much in need of repair and there was a fair water-supply, so that the fluctuations of revenue owing to the uncertainty of the local rainfall would be reduced to the minimum.

7. *Establishment originally employed in investigation.*—The first tank division was constituted as follows:—

1 Executive Engineer,	1 Supervisor,
1 Assistant Engineer,	4 Overseers,
1 Sub-Engineer,	

with office establishment equal to that of a 2nd-class division. The survey establishment of the division was made up of the following members:—

3 Surveyors.	2 Draftsmen.	1 Financial clerk.

The division was arranged so that there should be three sub-divisions—one under the Assistant Engineer, the other two under the Sub-Engineer and Supervisor. In the Assistant Engineer's sub-division there were two survey parties at work, and one under each of the other Sub-divisional officers. Groups and sub-groups of the minor basin were assigned to each Sub-divisional officer for investigation.

Three sub-divisions.

8. *Nature of work done.*—First of all a map was prepared to show the main river basins of the Presidency. Then a group irrigation map of the upper Vaigai basin, being the one selected for operations, was prepared, showing the minor basins with groups and sub-groups, each work in the minor basin being numbered and the catchment areas of each being worked out. Next a detailed irrigation map for all groups in the minor basin, scale 4 inch = 1 mile, was prepared showing the position of each work in the group with longitudinal sections of all tank banks and detailed sketches of all masonry works showing the work to be done to put each tank and channel into repair. Statements of financial and hydraulic details were prepared with a descriptive memoir of each work, and the estimates for the repair of each were worked out in detail. Every advantage was taken of the experience gained in Mysore in the execution of work of a similar nature.

9. *Nature of Record maintained.*—The permanently useful record made under this scheme may be succinctly stated, thus:—

(1) Maping out the basin.
(2) Correct grouping of works in the basin.
(3) Positions of works ascertained.

(4) Existing circumstances and requirements laid down on paper and the latter estimated for.
(5) Financial and hydraulic particulars collected.
(6) Memoirs giving information as to standard levels, flood discharges, storages and irrigation details, compiled.

10. *Special investigation of the Periyakulam Minor basin (as typical of the work to be done for the whole Presidency).*—The upper Vaigai river basin was sub-divided into minor basins, and the Periyakulam minor basin was selected as a specimen of the whole basin and specially investigated with a view to indicate the lines on which the Tank Maintenance Scheme should be proceeded with for the whole Presidency. The results of this investigation were detailed by Colonel Montgomerie, the Superintending Engineer in charge of the Tank Maintenance Scheme, in his note to Government, dated 5th March 1884, embodied in G.O., No. 646 I., dated 12th July 1884. In determining the standard of efficiency for each work, the general principles enunciated in G.O., No. 284 I., dated 5th May 1880, were adhered to, viz., "as regards the smaller tanks to utilize the existing surplus arrangements, whether permanent or temporary, for the discharge of the flood water and to secure the safety of the works by fixing an efficient level for the top of the bunds above the M.W.L." Colonel Montgomerie stated that any scheme for the conservancy of the irrigation works must be considered in connection with the execution of the work required to bring them to a fair standard of efficiency, and he was of opinion that the two operations into which the subject of the management of minor irrigation works naturally divided itself, viz., (1) Professional treatment, (2) Conservancy, could not be intelligently conducted except under one head. Owing to the dual management of the minor irrigation works in force in Madras, he considered the systematic and comprehensive record of irrigation data, both revenue and technical, which was essential for intelligent administration, had been impossible. He accordingly proposed an entire separation in the Irrigation Branch of the Public Works Department of the duties of professional investigation and construction from that of conservancy, attaching one or more conservancy sub-divisions to each Collectorate to supervise the execution of general repairs and to assist the Collector in enforcing (1) the Kudimaramat Act, (2) the River Conservancy Act and (3) the Madras Irrigation Act.

Standard of efficiency.

Dual management of works unsatisfactory.

Proposed changes in the Public Works and Revenue Departments.

11. *The Order of Government on Colonel Montgomerie's Scheme.*—In G.O., No. 646 I., dated 12th July 1884, Colonel Montgomerie's scheme for the conservancy of minor irrigation works was not approved, as it appeared to Government that the objects to be arrived at, viz., to bring every work to the standard of efficiency and to maintain it in that state could be attained without having recourse to such measures, involving a radical change in the constitution of the Public Works Department, but the original intention that the works estimated for should be carried out by the Tank division was abandoned, as Government considered it would be waste of power and the work of investigation would be indefinitely delayed. The work of the Tank divisions was restricted to grouping and estimating for the restoration of irrigation works, and the Public Works Department ordinary divisions were to carry out the work to be done. Government in its order quoted above remarks—

Separation of duties of "investigation" and "execution."

"2. The investigation of the condition of a typical series of these irrigation works in the Madura district shows—

(1) That the works have deteriorated to an extent which will require an expenditure of one year's gross revenue to bring them up to the standard of efficiency.

(2) That, without taking into account the probability of the whole area commanded being brought under irrigation by the restoration of the works, the anticipated increase of revenue in consequence of this expenditure is

Anticipated increase of revenue.

sanctioned the temporary appointment of a Superintendent of works and a "tank" division to commence operations and stated that grants under 33. Irrigation and Navigation (works for which neither capital nor revenue accounts are kept) would be provided to the following extent:—

Imperial Funds sanctioned.

	Rs.
1883–84	19,78,300
1884–85	21,28,300
1885–86	22,78,300
1886–87	25,28,300

These annual grants allowed for the funds for Tank Maintenance operations suggested by Colonel Hasted. The Government of India also pointed out that in order to ensure the fullest possible benefit being derived from the expenditure, it was essential that the Statute Labour question, the question of the extent to which the Public Works Department agency should be superseded by Collectors, also the question of the extent to which tanks should be repaired by the State, should receive careful and full consideration, and for this purpose the Inspector-General of Irrigation, Colonel Brownlow, was deputed to Madras in 1883. The decisions arrived at on these questions by the Government of Madras will be mentioned hereafter.

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Separation of duties of "investigation" and "execution."

"2. The investigation of the condition of a typical series of these irrigation works in the Madura district shows—

(1) That the works have deteriorated to an extent which will require an expenditure of one year's gross revenue to bring them up to the standard of efficiency.

(2) That, without taking into account the probability of the whole area commanded being brought under irrigation by the restoration of the works, the anticipated increase of revenue in consequence of this expenditure is

Anticipated increase of revenue.

nearly 6 per cent. on the gross revenue or estimated outlay. And it has been clearly shown by Colonel Montgomerie, in the able report submitted by him, that what has been done in this typical instance can, and should, be done for the whole Presidency.

"3. These figures are encouraging and place beyond doubt the expediency of pushing forward as rapidly as financial considerations will allow, the task of restoring every tank and channel to a state of thorough efficiency.

"4. * * * The Government are decidedly of opinion that all the maps should be lithographed and the descriptive memoirs printed and bound up by main river basins as suggested by Colonel Montgomerie.

Publication of maps and memoirs.

" * * * * *

"9. The question of conservancy of establishments required for the maintenance of minor irrigation works will be referred to the Revenue Department for discussion with the Board of Revenue, and it will be considered in that Department what steps should be taken towards recording and utilising "customary labour" or cess in lieu thereof, which may be in force in the locality."

Special orders to be passed on subject of "conservancy."

12. *Operations known as Tank Restoration Scheme.*—Thus it will be seen that inasmuch as the professional treatment of these irrigation works was to be distinct from the conservancy of these works when once brought to the standard of efficiency, and that no real extensions and improvements were to be dealt with by the Tank divisions, the "Tank Maintenance Scheme" was a misnomer. It was not, however, till June 1887 that the operations now under consideration were known as the "Tank Restoration Scheme." (G.O., No. 1666 W., dated 21st June 1887.)

13. *Organization of "Tank" Divisions and Parties.*—In March 1884 a second tank division was started to commence operations in the Chingleput district, and in March 1885 another was formed to investigate works in the Kurnool district, and in March 1886 a fourth division started work in the Coimbatore district. The work proceeded on the lines sketched out by Colonel Montgomerie in his note on the investigation of the Periyakulam Minor Basin, but the Government of India having declined to allot special funds required for the Tank Maintenance Scheme for the year 1887–88, the Tank divisions were abolished at the end of February 1887. In March 1887, however, the Government of India sanctioned an additional allotment of 3 lakhs under "43. Minor Works and Navigation." So the tank maintenance operations were recommenced and the establishment reorganised under orders conveyed in G.O., No. 1103 W., dated 21st April 1887. Four parties to work in the Madura, Chingleput, Kurnool and Coimbatore districts were sanctioned, each party consisting of the following :—

Abolition of tank divisions from March to May 1887.

1 Executive or Assistant Engineer.	2 Draftsmen.
2 Upper subordinates.	4 Clerks.
4 Surveyors.	35 Lascars.

After the office of Superintendent of Tank Maintenance Scheme was abolished in 1886, the Tank divisions worked under a Superintending Engineer on special duty. This method was found unsatisfactory and the necessity arose for a controlling officer in Madras. It was proposed that the work should be under the supervision of the Chief Engineer for Irrigation, with an officer of about the standing of a 3rd-grade Executive Engineer in charge of the office, and that he should be the Assistant Chief Engineer for Irrigation, Tank Maintenance Scheme. In December 1887 (G.O., No. 2936 W., dated 5th November 1887) a fifth party was started under a selected temporary upper subordinate to work in the North Arcot district, and in 1888 a sixth party was started and temporary establishment placed under the Executive Engineers of the Gódávari Eastern and Gódávari Western divisions. Two sub-parties consisting of one overseer and two surveyors with office and petty establishment were started under the Executive Engineers, Gódávari Eastern and Western, and one small party of the same strength under the Executive Engineer, Vizagapatam, was started on 1st April 1889, making in all eight parties. As the six parties existing at that time turned out estimates exceeding in amount the

Necessity for a controlling officer in Madras.

annual grant for "works," the strength of each party was reduced by one overseer and one surveyor. The amount of sanctioned estimates in Chingleput being about 4 lakhs in advance of expenditure, No. 2 party was transferred to Tinnevelly and the Executive Engineer, No. 1 party, was also given charge of it. Similarly, Nos. 4 and 5 parties were combined under the Executive Engineer, No. 4 party. In G.O., No. 641 W., dated 28th February 1890, it was deemed necessary to reduce the work of investigation as it was found that the number of estimates sanctioned was far in excess of the requirements for execution, and also that there was a large accumulation of estimates in the Central office, and Nos. 3 and 6 parties were accordingly abolished. In May 1889, the post of Assistant Chief Engineer for Irrigation, Tank Restoration scheme, was abolished, and the work transferred to the Assistant Chief Engineer for Irrigation. No. 7 party working under Executive Engineers, Gódávari Eastern and Western, was abolished in the beginning of 1891. No. 8 party under the Executive Engineer, Vizagapatam, on the completion of Kondakirla and Upper Varaha Minor Basins, was abolished at the end of June 1895. The experiment of putting selected upper subordinates in charge of parties having proved successful, they were appointed to the charge of parties, and when the permanent establishment for the Tank Restoration Scheme was sanctioned in G.O., No. 2155 W., dated 29th August 1895, the parties were placed, in the interests of economy and efficiency, in charge of upper subordinates; the overseers were taken away and the surveyors replaced by permanent sub-overseers. The permanent upper subordinates now in charge of parties having taken the place of Executive Engineers and Overseers have to attend to grouping, determination of catchment areas, collection of hydraulic and financial details, preparation of designs and estimates, besides supervising and checking the work of the sub-overseers, and they have the status of Sub-divisional officers. The strength of the permanent establishment sanctioned in G.O., No. 2155 W., dated 29th August 1895, was fixed at five parties consisting of one upper subordinate and four sub-overseers in charge of the party. When His Excellency the Governor was touring in the Ráyachóti taluk of the Cuddapah district in August 1891, he suggested the desirability of reducing the number of very small tanks in that taluk, and of increasing their size. There were found to be 821 tanks with an average ayacut of less than 20 acres each, and as these tanks helped to maintain the level of water in wells upon which much of the cultivation depends, and as the substitution of direct tank-irrigation for the wells might interfere with the sub-soil drainage which the wells promote, and as it would involve a redistribution of existing water-supply and entail interference with existing rights, the matter was allowed to drop and a temporary Tank Restoration Scheme party was sanctioned to investigate the Ráyachóti taluk. After the country had been mapped and suitable sites for reservoirs inspected, it was thought that the further investigation of the project could be considered. Accordingly No. 6 party was entertained from April 1891, and has since been sanctioned annually as a temporary one for the investigation of works in the Ráyachóti taluk, Cuddapah district. In G.O., No. 2849 W., dated 11th August 1897, the post of Assistant to the Chief Engineer for Irrigation, Tank Restoration Scheme, was again sanctioned and an officer was accordingly appointed in February 1898.

"Investigation" a head of "execution."

Two parties abolished.

Post of Assistant Chief Engineer, Tank Restoration Scheme abolished.

Upper subordinates in charge of parties.

Upper subordinates do the duties of former Executive Engineers and overseers.

No. 6 party (temporary).

(Reducing the number and increasing the size of tanks in Ráyachóti taluk, Cuddapah district.

Project dropped until the taluk is investigated.

Post of Assistant Chief Engineer, Tank Restoration Scheme, sanctioned.

14. *Failure of attempt to hand over works to villagers for maintenance.*—An attempt was made to hand over the tanks after restoration to the villagers to maintain, but this proposal was abandoned in August 1889 (G.O., No. 359 I., dated 2nd August

1889), and the Government of India in remarking upon this fact said that it was a question of serious and immediate consideration whether the whole system on which the Tank Restoration Scheme was based would not have to be modified, and they called for full and early report as they considered it useless to continue to spend large sums on investigating and estimating for the requirements of works which the villagers refuse to, and the Public Works Department could not, maintain. The Chief Engineer submitted a report embodied in G.O., No. 294 I., dated 21st May 1890, in which he said "as regards the miscarriage of the experiment of handing over to the care of the ryots concerned the minor irrigation works to be put in order, it appears to the undersigned that it does not seriously affect the Tank Restoration Scheme, though it undoubtedly has an important bearing on the question of tank maintenance. Putting the irrigation works into an efficient state as soon as possible is a necessity, even though a way to secure continuous maintenance of them all has yet to be devised." The Government of India were not satisfied with this, and in their reply No. 143 I., dated 9th August 1890, stated that, when the special assignments were made for Tank Restoration, it was an understood corollary that some satisfactory scheme for maintenance was being matured. Now that it appeared inevitable that the duty of maintaining all the tanks restored should fall on Government, the Government of India were of opinion that the better course would be to restore and maintain all tanks irrigating over 50 acres and abandon the rest. In reply to this letter of the Government of India No. 143 I., dated 9th August 1890, the Chief Engineer in his note No. 97 I., embodied in G.O., No. 477 I., dated 6th June 1891, pointed out that the general intention of the Tank Restoration Scheme was not that of increase of storage of water except to the extent of increasing storage to what might be called "normal," in those cases in which the tanks have from disrepair ceased to hold as much as they did formerly. He showed that the works carried out under the Tank Restoration Scheme were in no way different from those executed from ordinary Provincial funds, and the only reason why the works could not be carried out from Provincial funds was a financial one. With regard to the suggestion of the Government of India to abandon all works irrigating less than 50 acres, he stated that there were about 20,820 such works irrigating 319,681 acres, and the loss of revenue would amount to over Rs. 4 lakhs a year, or more than the whole amount spent on all tanks irrigating up to 200 acres. He also explained that the beds of the tanks so abandoned could not be let out for cultivation, unless the tanks were purposely breached, and no longer allowed to hold water, which would be an unwise course. He considered the limit of importance of irrigation works below which Government should not meddle with them to be not above the irrigating duty of 10 acres. At that time nothing was done by the Tank Restoration Scheme to isolated works irrigating less than 5 acres. By abandoning the tanks, about 9,700 in number, each irrigating less than 10 acres and irrigating in the aggregate about 45,513 acres, about Rs. 54,600 annual revenue would be given up. With the reduction of the works by 10,000 and the much improved state that the Tank Restoration Scheme into, the Chief Engineer considered that operations would put the remaining works the Public Works and Revenue Departments could efficiently maintain the works if sufficient funds were annually available. From a consideration of the total area affected by the works already and to be investigated, the Chief Engineer calculated that Rs. 12 had been spent for every acre cultivated, giving approximately Rs. 297·35 lakhs for the whole scheme, or about three years' revenue derived from the irrigation works concerned.

Maintenance of works falls on Government.

Proposed abandonment of tanks irrigating less than 50 acres.

Tank Restoration Scheme works similar in nature to those carried out from ordinary Provincial funds.

Proposed abandonment of tanks irrigating less than 50 acres means loss of revenue of over 4 lakhs.

Limit of importance, 10 acres.

With reduction in number the works could be efficiently maintained.

Cost of restoration, Rs. 12 per acre.

15. *Results, Increase of Revenue, etc.*—In calculating the probable increase of revenue referred to in paragraph 2 of G.O., No. 646 I., dated 12th July 1884, Colonel Montgomerie did not take the difference between the revenue derived from the average extent of irrigation before the works were investigated, and that on the total ayacut under the works, but he consulted the villagers themselves as to the extent of land that would be brought under cultivation by them when the works had been restored. Colonel Hasted considered it unsafe to calculate on more, and if the result was disappointing he considered it satisfactory that the return on the proposed outlay was remunerative. Colonel Montgomerie was of opinion that in order to determine the actual capabilities for irrigation of each source of supply, revenue details extending over a series of years with explanations of the causes of remission were necessary. In reviewing the work done in the years 1883 to 1886 (inclusive), the Chief Engineer anticipated that the estimates sanctioned, viz., Rs. 5,76,775 would increase the revenue derived from the works proposed to be restored by Rs. 33,297 or about 6·9 per cent. on the proposed expenditure (G.O., No. 2134 W., dated 25th August 1886). In the years 1883–84 to 1886–87, inclusive, the Government of India made special grants to assist the Madras Government in the task of restoration (as shown in paragraph 5 *supra*) and from 1887 onwards an increase of 1½ lakhs was made to the Provincial assignment, together with a special grant not exceeding 5 lakhs annually upon a payment of 4½ per cent. interest. In G.O., No. 922, dated 20th August 1887, the Government of India agreed to concede to the Madras Government the whole increase of land revenue due to the 1½ lakhs included in the ordinary assignment and on the special assignment of Rs. 5 lakhs, provided satisfactory accounts were kept showing the increase of land revenue attributable to each of the works assigned to tank restoration, and in the order quoted the Government of Madras indicated the lines on which such accounts should be framed, adopting the method sketched in paragraph 274 of the Famine Committee's note, viz.: "For each tank it will be possible to lay down as the present standard of revenue, the average revenue demand for the last five years dependent on it, and similarly it will be possible on each future year to say what the revenue demand on the same land is. The excess of any future revenue as compared with the present standard we call the increase." The first statement based on the orders conveyed in the Government Order showed approximately the amount of increase of revenue for 1888–89, and was adopted in the Financial statement for the year printed in the Proceedings of the Madras Government No. 167 I., dated 13th March 1890. But it was subsequently found that out of a total increase of Rs. 29,000, Rs. 23,000 was the increase due to settlement in the Madura district leaving a balance of Rs. 6,937, which, added to the decrease in working expenses Rs. 8,548 for that year, gave an increase of revenue of Rs. 15,485 or 1·3 per cent. on the total expense incurred to 1888–89. The result for 1889–90 was an increase of revenue of Rs. 17,078 and a decrease of Rs. 21,921 in working expenses, or Rs. 38,999 in all equal to 2·3 per cent., on the total cost of work done including expenditure on works in progress but not completed—*vide* G.O., No. 420 I., dated 9th May 1891. The above results were obtained by considering the average revenue for five years prior to the execution of works and the actual revenue realized from the work in the year after restoration. In G.O., No. 975, Financial, dated 9th September 1891, it was laid down that the sum total of the increases in the gross revenue realized under each individual work should be credited to Public Works revenues without taking into account the decreases, assuming that the latter would have been greater if the works had not been restored. Accordingly in G.O., No. 847 I., dated 15th August 1891, the increase of revenue was calculated to be Rs. 55,284 and the saving in working expenses Rs. 27,642 making a total of Rs. 82,976, *i.e.*, 2·5 per cent., on the total outlay of Rs. 32,49,112, both in investigation and execution. That there is a net increase of revenue directly attributable to Tank Restoration Scheme operations is undoubted, whether it

Explanations of the causes of remissions necessary to determine actual capabilities of works.

Accounts prescribed by the Government of India.

Increase of revenue up to 1888–89, 1·3 per cent. on the total expenditure.

Increase of revenue up to 1889–90, 2·3 per cent.

Increase of revenue up to 1890–91, 2·5 per cent.

be shown as a direct increase of revenue, or a falling off in remissions or maintenance charges for many years, or indirectly by the prevention of breaches and damage in years of heavy rainfall on account of the provision of efficient banks and surplus works. There are so many indeterminate elements affecting the calculation, but whether a direct increase of revenue or not can be shown, it is most important that the works from which Government derives so large an income should be put in proper order as rapidly as possible, and kept in that order.

Rs. 72,76,492 on 2,234,288 acres (average for past ten years), or say 2,250,000 acres in round figures.

16. *Provincial Funds for Tank Restoration Scheme Works.*—In 1892 the terms of the Provincial contract were altered and no accounts of the increase of revenue due to the Tank Restoration Scheme operations appear to have been subsequently maintained, and it has become the practice in the Tank Restoration Scheme to ignore works irrigating less than 10 acres as being "insignificant." From the year 1891–92 to the present time no assignments were made towards Tank Restoration Scheme operations from Imperial funds and the assignments made from Provincial funds inclusive of "Establishment" and "Tools and Plant" gradually diminished from Rs. 6·67 lakhs in 1890–91 to Rs. 3·67 lakhs in 1899–1900 and Rs. 3·37 lakhs in the current year (exclusive of "Tools and Plant"). The assignment made in 1897–98 was only Rs. 2·98 lakhs. From 1895–96 the expenditure on Tank Restoration Scheme works was ordered to be classed under "Repairs" (G.O., No. 719 I., dated 7th September 1895), and the establishment required for investigation was made permanent. The amount of estimates available for execution on the 31st March 1901 was Rs. 11,42,919 or about 10·5 lakhs allowing for savings; and with such low grants as are now assigned for works, these estimates would take about 3½ years to work out. The average amount of estimates sanctioned annually with the present establishment and six parties at work (as sanctioned in G.O., No. 2155 W., dated 29th August 1895 and G.O., No. 634, dated 1st March 1899) is between 4 and 5 lakhs, say 4·25 lakhs, and at this rate the accumulation of fresh sanctioned estimates by the time the estimates now in hand are worked out will be over 15 lakhs, and by the time the estimates which are now under preparation are taken up for execution they will have become obsolete. The assignments made this year for South Arcot, Chingleput, Tinnevelly and Nellore districts are 20·06, 19·89, 14·95 and 32·76 per cent., respectively, of the balance of estimates available for execution on the 31st March 1901; and at the present rate of assignment of funds the estimates in hand on 31st March 1901 in the Nellore district would take over 6 years to work out, although No. I Party is at work in that district. The above figures plainly indicate that in the interests of all parties concerned a more liberal assignment of funds for Tank Restoration Scheme should be made. Each year the assignments should be increased to the utmost extent until the accumulation of estimates had been worked off. Assuming ample funds available, the limit will be determined by the amount that could be spent on the execution of Tank Restoration Scheme works in ordinary divisions. When once the accumulation of estimates had been worked off, under existing conditions an annual assignment of 4½—5 lakhs would suffice. Even calculating on an average assignment of 5 lakhs per annum, the work would have to be spread over another 24 years or so before it was completed. The amount spent from the beginning of operations till the 31st March 1901 is about Rs. 60 lakhs and the area of cultivation affected by the works investigated is about 750,000 acres or a rate of Rs. 8 per acre. The area affected by works still to be investigated is about 1,500,000 * acres and at the same rate the work would cost Rs. 120 lakhs. These 1,500,000 acres bring in an average revenue of Rs. 42·45 lakhs, which is about 35 per cent. of the expenditure to be incurred. Instead of extending the operations over a vast number of years it would be more profitable in every way if all the operations, both investigation and execution, were expanded by temporarily increasing the establishment, larger assignments made, and the work completed in a half to a third of the time or say from 8 to 12 years. The work has been in progress for the past 13 years and out of a total net area of 116,855 square

Assignments from Provincial funds.

Inadequacy of assignments.

Cost of "restoration," Rs. 8 per acre.

Work remaining to be done.

* This figure is obtained from an average area of cultivation of the past 10 years (1890–91 to 1899–1900).

miles to be investigated by the Tank Restoration Scheme, 45,459 square miles have been investigated up to 31st March 1901, leaving a balance of 71,396 square miles to be investigated, and the expenditure on works in the area investigated will be about 60 lakhs or Rs. 132 per square mile investigated.

Cost of restoration per square mile investigated is Rs. 132.

17. *The Problem of Maintenance to be solved.*—It may not be irrelevant to mention the fact here that unless the works are "maintained" at the standard of efficiency when once brought up to that standard under the Tank Restoration Scheme, a very large proportion of the benefit derived will be lost. It is obvious that after works are once investigated under the Tank Restoration Scheme and efficient standards are laid down, this conservancy becomes a much easier task. Colonel Montgomerie was of opinion that the two heads of the subject of "maintenance" viz., "restoration" and "conservancy" could not be considered separately. After considerable correspondence, however, Government came to the conclusion that the Minor works (class IV a) should be maintained by the Public Works Department and the Minor works (class IV b) maintained by the Revenue Department and in G.O., No. 696, Revenue, dated 7th December 1896, a permanent Minor Irrigation establishment under the Collectors was sanctioned, instead of allowing Collectors to entertain a temporary establishment within 15 per cent. of their respective grants for maintenance of irrigation works. Estimates for the repairs of all minor irrigation works costing over Rs. 500 are submitted by the Collectors to the Board of Revenue through the Chief Engineer for Irrigation, Tank Restoration Scheme, where the estimates are scrutinised and if they refer to works already investigated by the Tank Restoration Scheme are checked with reference to the standard laid down in the memoir of the work. Works requiring professional skill are carried out by the local Public Works Department officers. The Minor Irrigation establishment has not been in working order long enough to gauge the efficiency of the work done by it, but from the numerous estimates passing through the office of the Chief Engineer for Irrigation, Tank Restoration Scheme, it appears that many members of the establishment have much to learn to qualify themselves as professional advisers of Collectors, and it is doubtful whether they would be in a position to prepare estimates for, and supervise the execution of, works of maintenance required in their several charges, even if an adequate assignment of funds were made annually for the maintenance of minor tanks. The inadequacy of the funds assigned for Minor Irrigation works (class IV b) to be carried out by the Public Works Department is seen from the following facts. The funds placed at the disposal of the Public Works Department for such works for 1901–1902 is Rs. 35,000 and Rs. 36,539, including "Establishment" and "Tools and Plant", has been appropriated. A further demand has already been made to the extent of Rs. 47,846 and estimates have been forwarded up to date to Superintending Engineers through the Tank Restoration Scheme office to the extent of about Rs. 10,000, making a total requirement to the end of September of about Rs. 94,000 against the current grant of Rs. 35,000.

Minor Irrigation Establishment.

18. *Difficulties to be faced.*—In dealing with the subject of Tank Restoration Scheme works and Minor works generally the difficulties that have still to be faced are—

(1) To keep the "execution" of works in step with the "investigation," and yet to push on the investigation work as rapidly as possible so as to ensure that Government and cultivators derive as much benefit from the operations of the Tank Restoration Scheme as possible.

(2) To maintain all the minor works so restored to their standard of efficiency without neglecting those works which have still to be investigated under the Tank Restoration Scheme.

As a regular system of investigation has now been adopted and all operations have been curtailed to such extent as is consistent with accuracy and the maintenance of complete records, the first difficulty is only a financial one. The second difficulty is more complicated and has a financial as well as an administrative aspect, which latter involves a consideration of details of the establishments and duties of both the Revenue and Public Works Departments.

(Signed) M. R. KHAREGAT,
Asst. Chief Engineer for Irrigation, T.R.S.

13th October 1901.

STATEMENT of Progress of the Tank Restoration Scheme (Operations commenced in April 1883).

Year.	Area. Entered.	Area. Investigated.	Estimates sanctioned for Government and Private works.	Estimates sanctioned for Government works and sent for execution	Cost of investigation.	Cost of execution (including tools and plant).	Percentage of 6 on 5.	Balance of estimates in hand on 31st March. With Superintending Engineers.	In Central office.	Total accumulation.	Plates. Published.	In press.	Under preparation	Memoirs. Published.	In press.	Under preparation.	Remarks.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	RS.	RS.	RS.	RS.	RS.	RS.		RS.	RS.	RS.	RS.	RS.	RS.	RS.	RS.	RS.	
1883-84 ..			36,600		52,056	1,426											
1884-85 ..	8,082	5,485	2,01,623	8,19,871	1,23,352	63,717	69·1	Information for these years is not available.			5	..	4	4	1	1	Details for each year are not available.
1885-86 ..			3,35,552		1,73,047	1,61,314											
1886-87 ..			3,51,862	—	2,17,506	2,49,376											
1887-88 ..	602	1,748	2,15,662	2,04,595	86,519	2,72,667	42·3	4,16,813	2,00,669	6,17,482	3	..	1	1	1	2	
1888-89 ..	6,832	4,993	4,94,309	4,94,809	1,31,807	4,37,107	26·6	5,60,185	3,84,998	9,45,183	3	..	..	1	..	4	
1889-90 ..	8,325	8,525	6,07,407	6,07,407	1,03,541	5,03,724	17·0	7,62,674	4,62,001	12,24,675	1	..	2	2	..	3	
1890-91 ..	2,033	1,482	7,23,517	7,23,517	82,537	5,87,335	11·4	9,42,278	1,51,871	10,94,149	3	..	5	2	3	..	
1891-92 ..	2,323	2,695	5,53,572	5,53,572	68,704	6,05,019	12·4	10,03,543	96,873	11,00,416	5	..	1	4	5	1	
1892-93 ..	3,802	1,746	3,60,714	3,51,930	66,067	3,88,345	18·3	9,00,662	50,726	9,51,388	3	1	3	4	4	3	
1893-94 ..	1,201	2,794	4,04,025	4,04,025	62,581	3,78,443	15·4	9,65,539	94,596	10,60,135	2	..	3	3	1	5	
1894-95 ..	2,378	1,709	4,07,047	4,07,047	56,136	4,48,774	13·8	10,47,393	1,11,441	11,58,834	2	..	4	2	3	5	
1895-96 ..	1,865	1,799	2,79,156	2,77,861	51,038	5,33,615	12·4	8,49,002	1,22,658	9,71,660	2	..	4	3	2	4	
1896-97 ..	2,900	1,011	1,57,342	1,82,437	63,229	5,49,760	34·6	6,39,237	2,46,839	8,86,076	1	..	5	2	1	6	
1897-98 ..	650	1,827	2,29,107	2,23,712	54,157	3,06,276	23·6	5,98,763	2,72,295	8,71,058	3	1	5	8	2	7	
1898-99 ..	3,110	2,381	4,63,550	3,78,730	75,074	3,30,532	19·8	7,67,051	1,86,214	9,53,265	5	2	4	10	..	8	
1899-1900 ..	1,600	1,879	4,36,442	4,30,147	69,306	3,66,676	16·2	8,07,534	1,86,292	9,93,826	19	1	3	14	7	1	
1900-1901 ..	6,973	5,106	4,71,252	4,71,252	59,049	3,77,859	12·5	10,35,916	2,47,335	12,83,251	4	6	1	3	10	1	
Total ..	..	45,380	67,60,269	65,30,342	15,98,706	65,61,973	24·5	10,35,916	2,47,335	12,83,251	61	..	..	63	..	..	

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GENERAL RECOMMENDATIONS.

In addition to the special treatment above advocated for each district, I have a few general remarks to make.

2. Now that the condition that a work should pay 4 per cent. on the outlay expended on it has been removed, it will, if funds are forthcoming, be possible to carry out a number of useful works, many of which have been alluded to in the foregoing paragraphs, while many more have yet to be dug out from among the records where the estimates lie buried. It must, however, be remembered that we have to look forward to the time when all reasonable projects in this Province will have been carried out, and although that time is not yet close upon us, Madras Engineers will, in the not far distant future, have to admit that they have no fresh worlds to conquer. If, therefore, we hope to extend or even to maintain our irrigated area, we must look to two important points:

(*a*) The maintenance of our works in the most efficient state possible; and
(*b*) The most economical use of our available water-supply.

To these two points the attention of our Engineers and Revenue officers should be devoted, and the suggestions I am about to make do not in any way profess to solve a very difficult question.

3. The work of the Tank Restoration scheme has already been described. The scheme has been of great value not only in systematically repairing tanks and channels, but also in collecting permanent records regarding them, which if properly used are invaluable. But even in those districts where the work of the Tank Restoration party is complete, large sums must be spent if the works are to be kept in good order.

4. As regards the larger tanks under the Public Works Department, the principal requirement is increased maintenance grants to enable repairs to be promptly and thoroughly carried out; but with regard to the minor tanks under the Revenue Department, I do not think that the existing state of affairs is satisfactory and in this opinion I am supported by almost all the Collectors whom I have consulted. To make the position clear, it is necessary to recapitulate briefly a portion of the history of the Tank Restoration scheme. When this branch of the Public Works Department was started it was believed that when once the smaller tanks were put in order, they could be kept up to their proper standard of efficiency by petty repairs carried out by the ryots themselves under the system known as *kudimaramat*. The proper department to see that *kudimaramat* is carried out is undoubtedly the Revenue Department and it was accordingly directed that tanks irrigating less than 200 acres should, with certain exceptions, be placed under the control of the Revenue and not the Public Works Department. The decision thus arrived at was doubtless influenced by the fact that at that time a large reduction in the establishment of the Public Works Department had just taken place.

It was found, however, that the idea of having tanks maintained by kudimaramat was unworkable and that there is no means of defining exactly what it is in each district, or of enforcing it. It became necessary, therefore, to appoint an establishment under the control of the Revenue Department to carry out the necessary repairs to the tanks under its charge. That establishment from small beginnings has gradually increased until a cadre costing Rs. 71,376 per annum for the whole Presidency is now entertained. The pay of individual members is however small, the salary of the highest being only Rs. 140, and that of the great majority below Rs. 60 per mensem. The subordinates work under the orders of the Tahsildar and are subject to no professional control. It would be strange if the estimates drawn up and the work carried out by them were altogether satisfactory. The result of this is that when a work of any importance has to be done the Executive Engineer is asked to prepare an estimate for it and is not infrequently asked to carry it out as well. For this work he is given a specific allotment which he has to spend within the current official year. This official year terminates, as is well known, at a most unsuitable time as far as irrigation works are concerned. The Executive Engineer is thus often placed in a dilemma, he has either to refuse the grant and appear obstructive or he must put on a subordinate to push through a small work to the probable detriment of his own regular and *ipso facto* more important work.

5. I believe, and for many years have held the belief, that more regular and efficient maintenance of these works would be ensured were their control handed over entirely to the Public Works Department. The extra establishment necessary would in a great measure be paid for by the cost of that now employed under the Revenue Department. The work of the Executive Engineer would be increased, but not by so much as one would at first suppose, for knowing that he had the maintenance of these tanks to provide for he would make timely and systematic arrangements for their repair. He would probably in those districts where minor tanks are numerous take up their repair in groups, leaving the others alone, except in urgent cases, until their turn came. The system of lump sum grants and the Executive Engineer's powers of sanction would obviate many of the difficulties which now occur.

6. Against my proposal it may be said, "but the minor tanks are so numerous the Executive Engineer can never look after them all". The reply is obvious: If the Executive Engineer cannot do so, how can the Revenue Department with its much smaller Engineering establishment, supervised by an overworked Tahsildar; especially when it is remembered that, during the working season, which is also the end of the official year, the whole of the Revenue staff are engaged on jamabandi?

7. The subjoined statement shows the numbers of tanks now under the Public Works Department and the Revenue Department.

Name of district.	Number of tanks in charge of the Public Works Department.	Number of tanks in charge of the Revenue Department.
Ganjám	115	2,482
Vizagapatam	68	1,273
Godávari	102	1,213
Kistna	61	322
Nellore	187	894
Cuddapah	111	2,453
Kurnool	73	310
Anantapur	..	539
Bellary	* 164	197
Madras	..	6
Chingleput	654	1,653
North Arcot	256	2,392
South Arcot	349	2,419
Salem	98	1,826
Coimbatore	51	71
Malabar	..	..
South Canara	..	..
Tanjore	53	444
Trichinopoly	72	914
Madura	172	4,915
Tinnevelly	284	1,814
Total ..	2,870	25,669

* Includes tanks in charge of the Public Works Department in Anantapur.

Although the works in charge of the Revenue Department are very numerous, a large number of them, viz., about 18,000 tanks, irrigate less than 50 acres. For these the amount of repairs required will be trifling. In some districts a rearrangement of sub-divisions would undoubtedly be necessary and perhaps they would have to be increased in a few cases. The charges of subordinates would be more numerous and concentrated than they now are and this would be an undoubted advantage. At present in many districts an overseer spends twice as many days in travelling as he does in inspecting works, and he often passes on his way those minor tanks which would according to my proposals be under his charge.

8. The transfer of the minor tanks to the Public Works Department would, I firmly believe, lead to their being better looked after than they are at present. The cost of maintenance would probably be greater, but the money would be well expended in keeping the works in a higher state of efficiency. I would not here make the above suggestions had they not received the approval of the majority of officers both of the Revenue and Public Works Departments whom I have consulted. The former are unanimous in stating that they would be glad to get rid of them.

The above recommendations apply only to minor tanks and channels on which expenditure is regularly incurred by the Revenue Department. I would not alter the system of maintaining the large number of "spring" and river channels which are now kept up by the ryots themselves.

9. The question of the future maintenance of irrigation works cannot be dismissed without allusion to the silting of our tanks, which is going on year after year unchecked. The process is no doubt a slow one and many Engineers are inclined to say that the tanks will last our time, and there let the matter rest. That the evil is a real one is undoubted. The Cumbum tank has 14 feet of silt at the lowest sluice, while in the deepest part of the tank there is a deposit of about 8 feet above the sill. The Kaveripak tank is silted to a depth of 11 feet above the sill of the low level sluice. In these large reservoirs this diminution of capacity is not at present felt, but as regards many smaller ones, complaints are frequently made. Any one who could devise some method by means of which this steady deterioration of our storage works could be prevented would be a public benefactor. The most obvious remedy would seem to lie in a great extension of forest areas and a more strict conservation of those already reserved. This, however, is practically impossible, and I will only suggest two palliatives which may go some way to lessen the rate at which silting is now going on.

10. First, I would recommend that "dry" cultivation round the margin of tanks should be discouraged as far as possible, and that when circumstances will permit a fringe of waste land should be maintained round the waterspread of each tank. On this the growth of jungle should be encouraged; in fact it should be treated as reserved forest. In the case of many existing works this would be impossible without acquiring the land, but in the case of the numerous new reservoirs which, I hope, will be formed in the near future, it should be possible to reserve a belt of land 30 or 40 yards wide beyond the waterspread of the tank.

11. Another possible means of diminishing the rate of silting is suggested with some diffidence as it trenches on the duties of another department, whose officers may not consider my proposals feasible or likely to be effective. The Forest Department at present do a great deal in the matter of Forest conservancy principally by the indirect method of reserving tracts where a fresh growth undisturbed by the depredations of goats and cattle can spring up. That much more rapid progress would be shown were it not for the conflicting necessities of a pastoral population is undoubted; for one season's goat grazing undoes the patient conservancy of many years. In such matters the local Government has to preserve a nice balance between two opposing interests, and I do not wish to contend that the existing state of affairs, so unsatisfactory to the Forest Department, can be altered. It appears to me, however, that in the reserved areas, especially in sub-colline tracts where the gradients are not too steep, an attempt might be made to dam the smaller water courses, in order to arrest the silt and to encourage a deposit behind the obstructions. These dams would serve a double purpose. They would retain some of the silt which would otherwise be carried into the tanks, and on this deposit would spring up a thick growth of vegetation; for in the areas I allude to the principal cause of scanty vegetation is the shallowness and poverty of the soil. The dams should be numerous but very small ones, not more than 3 or 4 feet high. They may be built in the roughest possible way; a few boulders with a palmyra trunk or two would probably serve the purpose. The new vegetation would have every chance of growing as each shower would cause a pool of water to accumulate. Planting and watering would therefore be unnecessary. Nature might, however, be assisted by scattering a few suitable seeds; but details such as this can safely be left to the Forest Department who may perhaps act on this suggestion. Experiments on the lines I have indicated would cost money and would be at first unremunerative, but the cost would not be great and I believe that the results would in the end fully warrant the expenditure. I recommend that a trial should be made in a few selected areas.

12. In the matter of economical distribution of water much remains to be done. In the case of all the numerous minor irrigation works of this Presidency the distribution of water from tanks is left to the village officers, and there is practically no attempt at economy in any way. Tank sluices are generally provided with shutters for the purpose of regulation, but they are often removed or, if left in position, are kept fully open whatever the requirements of the land may be. The larger irrigation systems are provided with a conservancy establishment, who working under the orders of the Public Works Department officers regulate the supply according to

requirements. The efficiency with which this is done depends largely on the interest taken in the matter by the local superior officers, and by careful management the usual accepted "duty" can probably be considerably increased.

13. It is the opinion of most officers interested in the question that the quantity of water supplied can be largely reduced. Although there is no direct proof of this, there are many circumstances which tend to support it. One or two may be quoted: Firstly, in 1899–1900, a year of exceptionally scanty supply in the Gódávari, the irrigated area was the largest on record, the duty as worked out having increased by nearly 50 per cent. It is no doubt a fact that there are circumstances which tend to reduce this calculated duty, but even when they are allowed for, it is probable that a very much smaller supply per acre was used in that year than in previous ones. In the next place I have the following facts from M.R.Ry. S. Subbarayadu Garu, late Deputy Collector on special duty on the Kurnool canal. In 1896, owing to the large demand for water for dry crops there was a short supply in the Kurnool-Cuddapah canal. The standing paddy at the lower end of the canal was 2 or 3 months old and received no water for a period between 10 and 14 days; much loss was expected on this area, but when water was passed on to it the crops revived and on being harvested, to every one's surprise, yielded an outturn 25 per cent. greater than what was usual when unlimited water was supplied. Mr. Keeling, the Executive Engineer of Madura, who has been carrying on some experimental cultivation under the Periyar Project, informs me that he used, with good results, considerably less water than the surrounding ryots. He did not, however, keep any record.

14. There seems therefore to be a *primâ facie* case for instituting a series of exhaustive experiments. Some thirty years ago attempts were made to ascertain by actual measurement the most economical quantity of water for rice cultivation, but they were never carried out with sufficient accuracy or for a long enough period to enable any result to be arrived at. Those interested in the matter will find a précis of what was then done in Chief Engineer for Irrigation's Professional Circular No. 30, printed as appendix G. Since that Circular was issued no further experiments have been carried out and the question still remains in an unsettled state, the only rule Engineers have to go by being the old rough and ready one of two cubic yards per hour per acre. I strongly recommend, therefore, that a detailed investigation should be made in a manner which will preclude every possible chance of error. The mistakes made in former years are recorded to guide us, and General Mullins has drawn up a set of rules which will be found very useful. One cause of failure in the past seems to have been that the experiments were not under the direct supervision of persons accustomed to deal with agriculture, and it would be advisable that any future observations should be entrusted to the Agricultural Department. A scheme for the formation of experimental farms has recently been drawn up by the Deputy Director of Agriculture, and it is suggested that if any more such farms are opened in the future, a site or sites should be selected where an abundant supply of water for irrigation purposes is available. The Board of Revenue has in its Resolution No. 49, dated 9th February 1899, suggested the opening of eight such farms of which two have been sanctioned. The selection of sites for some of the future farms should be governed by the consideration of their suitability for irrigation. The necessary modules should of course be erected by the Public Works Department, but all the rest of the work should be left to the Agricultural Department. The experiments should be as exhaustive as possible. They should deal with as many soils and as many different kinds of rice as possible and they should extend over a series of years. This proposal will, if adopted, undoubtedly cost money, but it will be money well expended, for we shall then be in possession of information which will enable us to say more accurately than at present how much water should be issued for cultivation. It would be premature to discuss in any detail the methods by which the proposed economy of water could be enforced, assuming that the experiments establish its feasibility. A radical alteration in our present system of distribution would probably be required, and it is possible that recourse would have to be had to legislation. One obvious solution would be to sell the water; and in the case of new systems, especially in zamindari lands, there is no reason why a trial of such a method should not be made at once.

CONCLUSION.

To sum up the proposals above made, I would recommend as follows:—

I. Large works—(*a*) The best means of utilizing the large surplus of the Gódávari should be investigated.

(*b*) A reservoir on the Kistna should be investigated, unless the Commission considers that there are *primâ facie* reasons for abandoning the idea.

(*c*) The utilization of the surplus waters of the Tungabhadra on the lines to be decided on by the Commission should be taken up at once.

(*d*) The orders of the Government of India for the further investigation of the Cauvery river schemes have already issued and I have no recommendations to make on this point except that, should eventually the Cauvery reservoir be decided on, the utilization of the Bhaváni surplus in Coimbatore district should be considered.

(*e*) The extension of cultivation under the Periyár either by constructing a new reservoir or increasing the capacity of the old one, or by diverting a further supply into it; all the above being accompanied by the enlargement or duplication of the tunnel.

II. Smaller works which I have arranged in what I consider the order of their importance—(*a*) *Nellore district.*—Reservoirs on the Musi, Paleru, Manern and their tributaries, and after that on the Kandleru and Kollerú. An establishment will shortly commence work at this and it should go on until the possibilities of Nellore are exhausted.

(*b*) *Kistna district.*—The investigation of the Gundlakamma reservoir should be completed. Other projects in the district are being worked out by the Executive Engineer, Kistna Northern division, in ordinary course.

(*c*) *Cuddapah district.*—The Dorigallu project, the Itodu project and possible reservoirs with catchments of not less than 60 square miles should be investigated.

(*d*) *Anantapur district.*—All the alternative schemes for utilizing the floods of the Pennér in Anantapur should be examined and the most satisfactory worked out. Other possible reservoirs on the tributaries of the Pennér, especially in Tadpatri taluk, should be investigated.

(*e*) *Ganjám district.*—The various storage projects which have been proposed but about which but little at present is known, should be examined. If a strong enough party can be formed, the possibility of reservoirs on the Nagavalli river may also be examined.

(*f*) *Salem and South Arcot.*—The best means of utilizing the surplus waters of the Ponniar and Vellar should be considered. This will involve the reinvestigation of the Vaniar and Krishnagiri projects.

(*g*) *Kurnool district.*—The investigation of small projects which will principally be useful as famine works.

(*h*) In Madura district the Porundalar project should be investigated.

(*i*) In Coimbatore the Amrávati reservoir should be taken up, and after the question of supplying the Tanjore delta is settled, the utilization of the Bhaváni in Coimbatore should be considered.

(*j*) In Tinnevelly is the reservoir on the upper waters of the Tambraparni, the investigation of which is now going on under the Executive Engineer and should be pushed on to completion. The possibility of forming reservoirs on, or connected with, the Vypar should be examined.

2. To carry out these investigations systematically I recommend the formation of special parties, consisting, as a rule, of a junior Executive Engineer or even an experienced Upper Subordinate with the necessary number of overseers and surveyors. I would further recommend that these parties should work under a special officer who would be able to devote all his time and attention to their work. It will be seen that most of the more important projects (excluding the Cauvery-Bhavâni question) lie north of Madras; it would therefore be well for the convenience of inspection and supervision to first take up the more Northern districts and work south; as the northern portions are completed the projects further south may be taken up. There is, however, no reason why, when the Executive Engineers of divisions in which there are no investigation parties can find time, they should not, with their existing staff, or special establishments, prepare the estimates themselves. It will as a rule, however, be found, I think, that their time is too much taken up with their current work to enable them to devote enough attention to these projects.

There is no doubt that there are still great capabilities for extension of irrigation in almost every district in the Presidency. The accompanying statement shows the growth of irrigation under each class of works during the last ten years. This expansion has, however, taken place in the face of limited grants and half-hearted investigation. There is every reason to believe that a large number of the projects proposed would prove successful. What is mainly required is larger grant for irrigation in all branches—larger grants for repairs; much larger grants for execution of estimates prepared by the Tank Restoration Scheme; and special grants for investigation with a certainty of funds being available to carry out completed estimates as soon as they are approved. If this policy is adopted and continuously persevered with, I believe that a substantial increase in the prosperity of the country will be assured, while at the same time a fair proportion of the works will be found to yield sufficient pecuniary return to justify their construction from a financial point of view.

STATEMENT showing the Areas irrigated by, and the Revenue derived from, the different classes of irrigation works in the Madras Presidency during the past ten years.

Works.	1891-92.		1892-93.		1893-94.		1894-95.		1895-96.		1896-97.		1897-98.		1898-99.		1899-1900.		1900-1901.		Average.	
	Area charged as irrigated.	Irrigation revenue realized.	Area charged as irrigated.	Irrigation revenue realized.	Area charged as irrigated.	Irrigation revenue realized.	Area charged as irrigated.	Irrigation revenue realized.	Area charged as irrigated.	Irrigation revenue realized.	Area charged as irrigated.	Irrigation revenue realized.	Area charged as irrigated.	Irrigation revenue realized.	Area charged as irrigated.	Irrigation revenue realized.	Area charged as irrigated.	Irrigation revenue realized.	Area charged as irrigated.	Irrigation revenue realized.	Area charged as irrigated.	Irrigation revenue realized.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	ACS. IN LAKHS.	RS. IN LAKHS.	ACS. IN LAKHS.	RS. IN LAKHS.	ACS. IN LAKHS.	RS. IN LAKHS.	ACS. IN LAKHS.	RS. IN LAKHS.	ACS. IN LAKHS.	RS. IN LAKHS.	ACS. IN LAKHS.	RS. IN LAKHS.	ACS. IN LAKHS.	RS. IN LAKHS.	ACS. IN LAKHS.	RS. IN LAKHS.	ACS. IN LAKHS.	RS. IN LAKHS.	ACS. IN LAKHS.	RS. IN LAKHS.	ACS. IN LAKHS.	RS. IN LAKHS.
Class I Works.																						
Productive ..	24·13	75·04	23·92	73·18	24·52	87·49	24·93	91·01	23·70	95·71	25·43	101·16	26·39	106·90	26·93	111·93	26·87	103·72	28·32	114·91	25·52	96·81
Protective ..	..	..	·04	·06	·08	·17	·27	·47	·36	·64	·63	1·08	·67	1·14	·88	1·40	·82	1·47	·83	1·44	·45	·78
Total ..	24·13	75·04	23·96	73·24	24·60	87·66	25·20	91·48	24·06	96·35	26·06	102·24	27·06	110·04	27·76	113·33	27·69	105·19	29·15	116·38	25·97	97·59
Class II Works ..	3·79	13·18	4·51	16·06	4·72	16·12	5·23	17·22	5·34	17·68	5·28	17·98	5·36	17·70	5·63	18·58	5·18	15·95	5·12	15·78	5·01	16·37
Class III Works ..	2·17	7·42	2·27	7·77	2·36	8·09	1·71	6·86	1·77	7·00	1·64	6·62	1·77	7·02	1·76	7·07	1·75	6·88	2·16	7·66	1·93	7·22
Class IV Works.																						
In charge of the Public Works Department.	10·57	26·49	12·66	32·95	14·07	38·39	13·28	37·52	14·06	40·81	12·10	38·77	12·62	36·29	13·91	40·27	11·46	32·19	12·72	35·08	12·75	35·28
In charge of the Revenue Department.	14·50	29·20	17·28	37·57	19·31	44·21	16·76	38·84	18·09	43·83	15·79	36·83	16·92	39·63	17·84	42·58	15·07	38·00	16·87	37·22	16·84	38·19
Total ..	25·07	54·69	29·94	70·52	33·38	82·60	30·04	76·36	32·15	84·64	27·89	69·60	29·54	75·92	31·75	82·85	26·53	65·19	29·59	72·30	29·59	73·47
Grand Total ..	55·16	150·33	60·68	171·59	65·06	194·47	62·18	191·92	65·32	205·57	60·82	196·64	63·73	210·68	66·90	221·83	61·15	192·51	66·01	211·97	62·69	194·66

Notes.—(1) The areas entered in the statement include first and second crops.

(2) The years 1891-92, 1896-97, 1897-98 and 1899-1900 were more or less unfavourable years.

APPENDICES.

APPENDIX A.

From J. M. LACEY, Esq., Executive Engineer, Ganjám Division, to the Collector of Ganjám, dated 3rd March 1899, No. 5534.

With reference to your R.G.B. No. 553/J. of 1897, dated 23rd January 1899, I have the honour to state as regards the proposals for the investigation of irrigation projects to be undertaken as famine-relief works in this district.

I. The Basin of the Rushikulya.—(1) I have not sufficiently inspected the Kallikota and Atgadda taluks with a view of improving their irrigation sources. So far as the country lies, a reservoir at Babarada about 5 or 6 miles south-east of Buguda seems possible. Restoring and improving the existing tanks, strengthening their bunds and constructing others where suitable sites occur, can be undertaken with considerable advantage to the estate. I would be very glad to furnish the Agent with type-sections for the tank-bunds and any other information he may require.

Catchment basin 64 square miles; hilly and jungle.

(2) I have re-opened the Mallada tampara project scheme and will submit the same shortly for sanction to be undertaken as a famine relief work.

(3) The Heeradara channel taking off the north bank of the Rushikulya is at present under investigation and this will, when completed, enable water to be stored in the Purushottapur and Dobhli tanks.

(4) There seems a possibility of making a reservoir near Ballipadra with a supply channel from the Baguva river. This will enable flood water to be stored to supply river channels from the Rushikulya and possibly also the Heeradara channel.

Direct catchment about 20 square miles; catchment of feeder channel about 54 square miles.

(5) A reservoir across the Godahallo river near Patapore. This is one of Major Beckley's proposals. This reservoir would benefit the Chinnakimedi estate and store water for the Jayamangalam channel which takes off near Iriyelly and irrigates land up to the coast near Ganjám and Chatrapur.

This completes the basin of the Rushikulya river so far as investigation is at present necessary.

The present Rushikulya project provides for the irrigation of the Goomsur and Berhampore taluks.

The investigation of minor distributaries will be taken up in due course. A very useful famine-relief work would be the periodic restoring of the main Rushikulya canal to its original section, especially near Shergadda, where the cutting runs over 40 feet deep, and considerable slips have occurred.

II. The Ganjám and Gopalpore Canal runs in practically a narrow valley bounded by the sand hills on the east and the high sandy ground on the west. There can be possibly no irrigation from it; and all the land up to the present canal is commanded by the Rushikulya project. The only irrigation from it is at its north end or the Chatrapur tampara, where about 400 acres of low ground south of the Rushikulya river are irrigated. It might be converted into a high level navigable canal; the water for lockage being supplied from the Rushikulya canal.

III. Basin of the Babuda or Ichchhápur River.—A number of river channels take off from this river in the Ichchhápur khandam. A scheme is under preparation for improving them. From an inspection of the Revenue accounts, remissions on account of the scarcity of water are numerous. A reservoir would be most desirable as far as the land lies. One near Bempur about 7 miles north-west of Chikati, seems possible.

Catchment 64 square miles; hilly and jungle.

IV. A small reservoir may be constructed across the Godaka nalla in the limits of the village of Jogudi. This will prove a very useful work and not difficult of execution. It would protect the villages of Mantreddy and up to the coast, which are out of the sphere of the influence of the Rushikulya project.

Catchment 15 square miles. The slope of the Mohini hills rising about 2,000 feet high.

V The next basin is that of the Baruva River.—An ancient at Casipuram with a high level channel would, I imagine, have sufficient command to irrigate lands in the Sompet taluk. The river rises in the high hills forming the Mahandragery range and the run-off during rains must be considerable. A reservoir where the river emerges out of the gorge about 6 miles south-west of Jarada seems possible. The reservoir will be, comparatively speaking, a small one. A channel from Casipuram running south may also be excavated to irrigate Mandasa lands.

Catchment 32 square miles. The steep hill sides of the Mahandragery range rising about 4,500 feet.

Between the Baruva river and the Vamsadhara there are three small rivers. I do not think much can be done with them. The Garubulagedda system has been completed. The construction of tanks wherever suitable sites occur with feeder channels from these small streams, seems to be the only practical course we can follow.

As regards the two rivers of the Chicacole taluk –the Vamsadhara and the Langulya—I can do no better than refer you to Captain Rundall's report on them. An extract is given in the Ganjám District Manual, pages 255 to 257.

From my knowledge of the Palkonda taluk in the Vizagapatam district, the Langulya hardly ever fails and, I believe, I am right in saying that famines rarely happen in that taluk. A reservoir about 5 miles south of the Riegar seems possible. This would of course benefit chiefly the Parlákimedi estate, but it should be under our control to supplement the supply to the Chicacole channels. I have not included those schemes which are already in the famine programme. They are, however, very small ones.

Catchment about 150 square miles. The hill sides of Mahlias ranging 3,000 feet high in places.

I must bring to your notice that nature herself can provide no better reservoirs than the large forests which retain the rainfall and give it out slowly; and every effort should be made to prevent the denudation of forests which goes on especially in zemindari estates. Every available piece of land which is not required for cultivation should be reserved and efforts made to encourage the growth of forest bamboo or scrub jungle on it. Especially in a district like Ganjám where patches of low bamboo jungle retain sufficient moisture to give out small streamlets which the ryots turn into their fields, and are thus enabled to tide over the interval between the monsoons. This has become self-evident in the Berhampur taluk where nearly all the forest and scrub has been cleared; and any delay in the breaking of the north-east monsoon creates a demand for artificial irrigation.

Every hill should be reserved and efforts made as far as possible to encourage the growth of trees, bamboo, scrub or whatever will grow, as a prevention against drought and not as a source of revenue.

I would also commend to your attention page 266 of the District Manual, paragraph 4. Famines should be of rare occurrence in Ganjám, and the famine of 1897 was chiefly caused by the abnormally high prices that reigned.

APPENDIX B.

MEMORANDUM on the Irrigation of that part of the Rakapilly taluk lying to the east of the Sebbry.

The levels which have already been taken and which are laid down on Subramaniam's map, seem to indicate pretty plainly what shape this project should take. It appears from them that the Sillair, though incomparably the best supplied with water of the two streams, offers facilities very inferior in all other respects as a source of supply to the Sukelair. Its fall is only 7½ feet per mile while that of the Sukelair is 16 feet. In order, therefore, to lead water to the same level it would be necessary to draw from the former stream at a much greater distance from its mouth than in the case of the latter. The water level of the Sillair, 18 miles from its mouth, is 8 feet below that of the Sukelair at only 9 miles. If a dam only 12 feet in height were constructed on the Sukelair at Mithavada where it emerges from the hills (the highest point to which levels have been taken), a canal led off from above it with a fall of a foot a mile would commence to irrigate in less than a mile from the head, and would command almost all the cultivable land between the Sukelair, the Sebbry and the Gódávari. To lead water from the Sillair to the same level at Mithavada, it would be necessary to place the canal head at some point where the water level is at least 18 feet higher than at Mothugudem (the highest point to which levels have been taken) and would require a canal with heavy cuttings at the head of fully 20 miles in length. Hence it seems plain that the head of supply should be on the Sukelair if only that stream will furnish water sufficient for one crop to the irrigable area which a canal led off as above described would command. The probable direction which such a canal would take is sketched in pencil on the plan, and the irrigable area between it, the Sebbry, and the Gódávari, would appear to be about 56 square miles. It is doubtful what proportion of this is culturable land. The surveyors say about three-fourths, but probably not above one half could be reckoned on. Taking this proportion or 320 acres to the square mile, the extent of land available for irrigation would be $320 \times 56 = 17{,}920$ or 18,000 acres.

In the delta 1 cubic yard per acre per hour is considered sufficient when needless waste is prevented for one crop of the finest kind of rice. It is not improbable that for such rice as is grown in these taluks and which is only a four instead of a six months' crop as in the delta, a smaller supply than this might suffice. Perhaps 15,000 cubic yards per hour might be enough for 18,000 acres. But again it is certain that the whole irrigable area could not be taken up at once and that for several years probably not above one-half would be cultivated so that a supply of 8,000 or 10,000 cubic yards per hour might be as much as could be turned to account for sometime to come. The question then is whether an average supply of this amount could be reckoned upon from the Sukelair during the four months from July to October or perhaps for the five months from July to November.

All that is known for certain upon this point is that last year (1869) a year of extraordinary drought, the discharge on the 7th January, as measured by Mr. Rhind, was 3,241 cubic yards per hour, *i.e.*, that in a year of most scanty rainfall the discharge three months after the cessation of the rains was about one-third of what the project now proposed would require that it should be during the rains and up to say 15th October in an average year. I think there is at least a *primâ facie* probability that the ordinary monsoon discharge bears this proportion to that of January 1869 and that therefore the Sukelair would furnish a supply sufficient for one crop for as much land as the existing population could cultivate. This is the first essential. The object of such a canal is first, and before all things else, to prevent famine and to secure the food crop of the country. To this one consideration all others are secondary. This essential point attained, the extension of the irrigation and its application to cold weather crops and other crops of higher value and more remunerative than rice, may follow, and doubtless would follow with the gradual increase of wealth and improvement of agriculture. At present not only is there constant risk of famine but what is still more serious, it is certain that the greater part of the Koys habitually grow less food than they require for bare subsistence depending largely on jungle fruits, roots, etc., for their food during the 3 or 4 months of the year. The condition of this people at present is truly lamentable. They live a life of chronic starvation and the amount of disease among them arising from insufficient nourishment and the use of unwholesome food and filthy water, and indeed the almost total deprivation of water for any other than drinking or culinary purposes during the dry months is really frightful. I am certain that there is nothing that would have so powerful an effect for good upon their condition as the introduction of irrigation. It would lift them above the reach of want and remove many of the evils to which their present most degraded and miserable condition is attributable.

Even if the above estimate of 9,000 or 10,000 cubic yards per hour as the average discharge during the rainy months should prove too high, it is certain that there is at least water sufficient in the Sukelair for a considerable extent of irrigation and as the head works would not be expensive, a canal to deliver only half the above quantity or say 5,000 cubic yards per hour sufficient for perhaps 7,000 acres, would probably be found to be amply remunerative. If it should be found that the Sukelair cannot supply more than this quantity then additional water might eventually be either led from the Sillair or stored in a reservoir on the Sukelair, which ever might be found least expensive, but this is a secondary consideration, the first thing being to utilise the available supply from the Sukelair.

The irrigation of the tract between the two streams may also be treated as a separate project. Water might be led to it easily from the Sukelair, were it available, and with more difficulty and at much greater expense, but still for a larger extent of land from the Sillair. In the present state of the finances and the urgent need that exists for irrigation, it will be best to confine attention to the project for irrigation south of the Sillair—based upon the monsoon supply of that river. The principle points requiring notice in this project are the following :—

1. *The site of Dam and Head works.*—Mithavada would seem from the levels to offer a sufficiently favourable site, but as the fall in the part of the river is said to be great, it is very possible that a more suitable point might be found within the mile or mile and half of the river between Mithavada and the hills. If any sudden drop or falls should exist anywhere in this neighbourhood the dam might possibly be dispensed with. Assuming for the present that Mithavada is the best site then the water level there is 168, that of the bank is 208 and 206, but a mile lower down only 170. If a dam, 12 feet in height, were constructed so as to raise the water to 180, the cutting would be 28 feet immediately at the head diminishing to 3 or 4 feet in the first three-fourth mile. The canal head would be closed by a sluice with its parapet raised above highest flood level and with vents sufficient to discharge the full quantity of water that would eventually be required for the full extent of irrigable land under the canal.

2. *Slope of Canal Bed.*—The slope to be given to the canal depends so much upon that of the ground traversed by the canal in a direction transverse to its axes, *i.e.*, its slope from the hills towards the Sebbry, that without more information and details upon this point it is not possible to determine it. The slope must be fixed not with reference to saving of excavation but in a consideration of the advantage obtainable by this means as compared with the consequent loss of revenue on land left out of reach of the water. The greater the slope within the limits required for stability of the bed, the less the sectional area of canal prism and the amount of excavation, but the greater also the breadth of land deprived of irrigation. Where the slope of the country across the canal is great, it may be practicable to give such a fall as may considerably reduce the amount of excavation with very little sacrifice of canal revenue. Where the contrary is the case it will be advisable to carry the line on such a gentle incline as will take in the greatest breadth of land. It will probably in no case be advisable to give such a slope as 3 ft. per mile; but looking at the few levels now available, it appears not improbable that a slope of 2 ft. per mile for the first 10 or 12 miles, would leave out but a slight breadth of land as compared with a slope of 1 foot, and that there might be no objection to giving such an inclination. Many more levels are, however, required as well as a careful examination of the ground with reference to the quantity of soils before this point could be determined.

Two feet would probably be the maximum and 6 or 4 inches the minimum in the main canal.

3. *Drainage Works.*—The drainages should, as a rule, be taken under the canal, but with reference to the deficient water-supply of the Sukelair, it will be matter for consideration whether some should not rather be tanked in the same manner as the Buregala wagu. They are said to be well supplied during the rains. A great slope may be allowed in all aqueducts so as to diminish the transverse section of water way as much as possible. For instance, 3 inches might be given in spans of 30 feet, with but trifling loss of level and with an increase of velocity and consequent saving in cross section due to a fall of 44 feet per mile.

4. *Distributary Channels.*—These would follow the tops of the water sheds between the different drainages and would have much the same slopes as those of the natural ground, provided that the velocity in them do not exceed 3½ or 4 feet per second. Their sectional area should be such as to deliver four-fifths cubic yard per acre per hour. Each should be closed at the head by a regulating sluice of capacity sufficient to discharge one and half times the full quantity of water required in the distributary with a very slight head, say of 2 inches. Sub-distributaries or branches from the distributaries need not now be considered as the villagers may perhaps be induced to cut them themselves.

5. *Silt Basin in Main Canal.*—It will be desirable, if at all practicable, to select some spot near the head of the canal whereby carrying the line across a wide and deep hollow, a large basin way be formed in which the sediment brought in from the river may be deposited. If this can be managed, clearance will be considerably facilitated and the necessity of closing the canal for the purpose diminished.

DUMMAGUDEM,
11th May 1870.

(Signed) HAIG, Lieut.-Col., R.E.,
Suptg. Engineer, U.G.C.

APPENDIX C.

STATEMENT of projects proposed in Bellary division.

Serial No.	Name of work.	Locality.	Probable amount of estimate.	Probable ayacut.	Probable increase of revenue.	Brief history.
1	2	3	4	5	6	7
						BELLARY DISTRICT.
						I.—Irrigation schemes investigated and estimated for.
			RS.	ACS.	RS.	
1	Alabur tank ..	Harpanahalli taluk.	13,110	150	820	*Note.*—This is an old tank breached about 50 years ago for want of surplus arrangements. The ryots had petitioned for the restoration of the tank and have also agreed to pay an enhanced assessment of Rs. 3 to Rs. 4 per acre. The existing bund is strong and revetted in front. There is one sluice which is in good order. It has now been proposed to close the breach and restore the tank, providing the necessary length of surplus escape. The existing sluice could well command the area irrigable under the tank when it gets the usual supply from the catchment area. The tank is situated to the south-west of the famine road from Ittigi to Kottur and 5 miles distant from the former. Cross sections will be taken which will, it is feared, prove that the tank-bed has greatly silted up.
	Note.—Estimate under check in Division office.					
2	Upparagatta Siddapuram.	Kúdligi taluk ..	18,500	150	600	*Note.*—The tank was not completely formed by the anicuts and is now in a breached condition. The ryots now wish for its restoration. It is situated 17 miles south-east of Kúdligi. A new sluice has been proposed for the tank and two distributaries, one for the high and the other for the low, level lands, have also been proposed and marked out on ground. Necessary surplus arrangements have also been provided. The bed is thickly grown with date trees, and considering the abkári revenue derived therefrom, the Collector has decided that that revenue should not stand in the way of restoring the tank and thereby improving the condition of the people living in the surrounding villages. The ryots have agreed to pay an enhanced assessment of Rs. 4 per acre.
	Estimate under check in Division office.					
3	Tamburhally supply channel.	Hadagalli ..	6,900	125	750	*Note.*—The channel is an offtake from the left bank of the Chinna Hugari river, which is a perennial stream, and there is no anicut across the stream at the head of the channel. The channel runs close to the margin of the stream for about a mile and then turns inland. Throughout its course along the margin, the right bank of the channel has been very much damaged by the floods and necessary proposals for strengthening the bank have been made in the estimate submitted. The channel at present irrigates over 300 acres, and is in charge of the Revenue Department. The necessary repairs should be carried out scientifically by proper professional agency and the Revenue Department could not supply the necessary establishment for doing such works, and since the ryots also suffer for want of proper repairs being carried out to the channel, it has now been proposed to transfer the channel to the imperial list. The estimate was prepared at the request of the Revenue Department, since that department was not able to consider scientifically the whole question and prepare estimate accordingly.
	Estimate under check in Division office.					
4	Yeprual Kolical tank supply channel improvements.	Rayadrug	17,000	..	..	Levels being taken afresh.
5	Kolur tank ..	Bellary ..	73,300	550	2,200	Estimate sanctioned.
6	Katirithi tank ..	Alúr ..	9,190	110	275	The proposal is to raise the bund. Estimate sanctioned.
7	Kuruvalli tank ..	Alúr ..	9,400	60	..	The proposal is to raise the bund. Estimate sanctioned.
8	Kampli channel, extension of.	Hospet taluk ..	15,600	400	1,600	The proposal is to extend the channel to irrigate the dry lands of Sanapur village bordering on the right margin of the Tungabhadra river. Estimate under check in Division office.
9	Doddaghatta Chikasamudram tank improvements.	Rayadrug ..	8,960	216	886	The proposal is to raise the bund. Estimate under check. Sketch herewith.
10	Chinnatambalam tank improvements.	Adóni	23,600	714¾	4,267	Raising and improving the Chinnatambalam tank estimate under check.
11	Mandigiri tank restoring.	Do.	10,5000	80	400	The proposal is to restore the ruined tank. Estimate under revision in the Division office.
12	Rampuram tank restoring.	Kúdligi ..	6,920	65	390	The proposal is to restore the ruined tank. Estimate sanctioned.
13	Jattineutta tank restoring.	Harpanahalli ..	9,000	50	151	The proposal is to restore the ruined tank. Estimate under check in Division office. Sketch herewith.

Serial No.	Name of work.	Locality.	Probable amount of estimate.	Probable ayacut.	Probable increase of revenue.	Brief history.
1	2	3	4	5	6	7
						II.—Investigated but not estimated for.
			Rs.	Acs.	Rs.	
1	Gudicota big tank ..	Kúdligi taluk ..	6,000	80	320	This is a breached tank and has two sluices which are in good order. The bund is strong throughout and revetted in front. The old escape was not sufficient to discharge the surplus of the tank and hence the breach. The ryots have requested for the restoration of the tank through the Revenue Department. The tank is situated about 2½ miles north-west of Gudicota village in the midst of hills and receives supply from a catchment of 4 square miles of hilly country. There is another tank lower down called the Gudicota small tank, which receives at present not only the supply from the abovementioned catchment along the vanka flowing through the breach in the big tank, but has another supply from a separate catchment of 3½ square miles. Hence if the big tank be restored, the supply to the small will be curtailed, and therefore it is thought that there will be no use in restoring the big tank which is in a breached condition. Tracings showing the position of the tank and its catchment basin are submitted herewith. Keeping in view the loss of ayacut under the small tank if the big tank is restored and the supply to the small one cut short, the increase of revenue when both the big and small tanks are taken into consideration will be nothing. However, the F.T.L. of the small tank may be raised and bund further strengthened to hold the extra supply due to abnormal rains in any year. The small tank is a minor one.
						Levels of the big tank are taken and will be submitted with the estimate.
2	Halasagaram ..	Do. ..	10,000	200	800	This is an old tank 5 miles to the west of Gudicota village and is breached with its bund in good condition and revetted throughout, the present state of the tank being due to insufficient surplus arrangements. It has one sluice which requires only ordinary repairs to bring it to working order. The bed of the tank is cultivated dry and should be acquired, but a portion is overgrown with babul trees. The ryots have petitioned for the restoration of this tank. This is situated above another tank (Royapuram tank) which is also in a breached state. The tank, if restored, will form a good reservoir to hold a year's supply when in ordinary season to command 200 acres, and a tank is very much needed about the locality. Tracings of the tank and its catchment basin 11 square miles are submitted herewith.
3	Royapuram tank ..	Do. ..	8,000	200	800	The tank is situated two miles south-east of Halasagaram tank, and about a mile and three quarters from the Mysore frontier. The land available for irrigation is only 200 acres. The tank receives supply from the Halasagaram tank proposed to be restored from another vanka. The tank is now in a breached condition, due entirely for want of surplus arrangements; however, the remaining portion of the bund is strong and well revetted throughout. There are two sluices for the tank, which are in good condition and require only ordinary repairs. Tracings showing the tank, proposed ayacut and catchment basin are submitted herewith.
4	Gundahommanahalli.	Do. ..	1,00,000	500	3,000	The ryots had petitioned to the Collector for the formation of a tank across the Muddula vanka, which is a perennial stream to bring under cultivation a portion of the dry lands in Yekkayogundi, Huliganta and Madahalli villages. The vanka flows from beyond the Taramalai hills and has a very large combined catchment area of 40 square miles, and its free catchment is 37 square miles, these being a small upper tank in Ramadurgam village having a catchment of 3 square miles. The site of proposed tank is 5 miles south-west of Gudicota, which is 18 miles from Kúdligi. Although there is such a large catchment for the proposed reservoir, yet the nature of soil below the tank site proposed is such that no more than 500 acres could be brought under cultivation. However, there are no tanks in the vicinity, and the ryots in the surrounding villages feel very much the want of an irrigation work, and hence the proposals are recommended. The Superintending Engineer has called for the submission of plans and estimates for two proposals, one to hold a year's supply and the other to hold three years' supply. The [illegible] and surveys* that had now to be redone are herewith submitted, showing also the distributary channels proposed, which latter have also been marked out on ground.

* Not received.

5	Tummana Gudda tank.	Kúdligi taluk ..	(1) 3,000 (2) 8,000	24 120	60 600	The tank is situated near the village bearing the same name which is close to the Mysore frontier, about 12 miles south-west of Gudicota village and 21 miles from Kúdligi. There are two tanks—the upper one had breached many years ago and the lower tank was in working order and maintained by the Revenue Department until recently, but this tank also has now breached. The Revenue Department proposed and called for a complete estimate to restore the lower tank. The breach was due to want of proper length of surplus arrangements, so much so that the length of the south escape, being insufficient, water flowed over the bund and the breach occurred six years ago. The cost of repairing the damages and providing proper length of south escape will be considerable in comparison with the ayacut, which is only 24 acres. The tank-bed also is very much silted up. Hence it would be advisable to abandon the lower tank and restore the upper tank, whereby the bed of the former, together with its ayacut and also a fresh area under the upper tank could be brought under cultivation. Tracings showing the catchment and the two tanks are herewith submitted. Plan and other particulars for the restoration of the two tanks separately will be submitted for orders. The Kúdligi Tahsildar, who is an able Revenue officer, agrees to the restoration of the upper tank, whose bed is waste land.
	Kengeri Malyavantham Cheruvu in Hyarada Village.	Hadagalli taluk ..	5,000	50	300	This is an old breached tank situated about 21 miles to the south-west of Hadagalli and is now in a ruined condition for want of surplus arrangements. The Revenue Department have requested for the restoration of the tank on a petition from the ryots of the village. The vanka that flows through the breach empties itself in the Tungabhadra and does not supply any other tank. The soil in rear of the tank is rich, but the catchment being small, the tank, if restored, could irrigate only 50 acres. There are no irrigation works around, and hence the requisition from the ryots. There is a sluice which is in good condition and requires only slight repairs. The bund is in good condition and requires revetting. The tracing showing the position of the tank and its catchment is herewith submitted.
						III.—Under contemplation.
1	Harlahalli ..	Kúdligi taluk ..	25,000	400	1,600	It is under contemplation to form a new tank near the village to irrigate dry lands in Vakasi and Kumati villages. The vanka, which is proposed to be dammed for irrigation purposes, now flows to waste. The land proposed to be cultivated is very rich and 200 acres in extent. The drainage is sufficient to bring a year's supply to the extent proposed to be cultivated in ordinary season. The whole scheme will cost about Rs. 25,000, and the Tahsildar has been referred on the subject.
2	Kullahalli ..	Do. ..	20,000	300	1,200	The Revenue Department wished to build an anicut across the Jamballi vanka, which divides the Kúdligi taluk from the Mysore Province to irrigate lands in the southern most part of the taluk which is devoid at present of all irrigation works. Hence the country was inspected, and the anicut not being feasible, the site near Kullahalli has been selected for forming a tank, there being a vanka with large catchment going to waste. The area that could be cultivated is about 300 acres and is rich soil. The cost of the proposed project will be Rs. 20,000. The opinion* of the Tahsildar is enclosed.
3	Iyenhalli ..	Do. ..	50 000	600	2,400	Near the village, which is situated 4 miles from Kottur on the road to Harpanahalli, the Maroora vanka runs, and there is an old breached tank across the stream about a mile north of the village. The tank, if restored, could command 300 acres in Kúdligi and 300 acres in Harpanahalli taluks. The vanka rises in the Mysore Province and has no irrigation works across it anywhere and brings a large supply many times in a year. Besides, it is a perennial stream and is an affluent of the Chinna Hagari.
4	Nulla Kudair ..	Hadagalli taluk ..	..	230	..	The village is situated 4 miles north-east of Ittiji and near by there is a suitable site for constructing an anicut across the Chinna Hagari river. A channel could be taken from the right bank to supply Chintrapally tank (imperial No. 33) and thence in its course supply Kenchmabandi, Ankasamudram and Annadevanhalli minor tanks in Hadagalli taluk and finally close at the supply channel near Morebihal to Narayanadevarakeri tank (imperial No. 26) in Hospet taluk. On its way before falling into the supply channel referred to, a tank could be formed above Uppavayakanhalli to irrigate 230 acres of rich land. The proposal made will ensure good supply to all those tanks and enhanced assessment may be charged besides bringing 230 acres and more under cultivation.
5	Royarkerra tank ..	Hospet taluk ..	30,000	500	..	There is a large volume of water going to waste several times in the year along the Gowrepur vanka, and it is now proposed to divert this waste water into the Royarkerra tank. The big reservoir will then have its full supply from this source besides getting the supply from its own catchment basin, which is also very large. The bund is in good condition and all that is required is a channel from Danayankerra tank through a very small saddle and slight repairs to the existing sluice. About 500 acres could then be brought under cultivation. The whole proposal will cost about Rs. 30,000. Although the bund has a bad reputation of having been once leaky, about which no one knows exactly, still if it is really leaky the waste could be replenished by the Gowrepur vanka many times a year. A tracing of the site showing catchment areas is submitted herewith. The tank is situated on the road from Hospet to Balamusi, the 41st mile stone is on the bund.

* Not received.

Statement of projects proposed in Bellary division—*cont.*

Serial No.	Name of work.	Locality.	Probable amount of estimate.	Probable ayacut.	Probable increase of revenue.	Brief history.
1	2	3	4	5	6	7
						ANANTAPUR DISTRICT.
						I.—Irrigation schemes investigated and estimated for.
1	Restoring Kotha Kalva near Tadpatri.	Tadpatri taluk ..	Rs. 8,700	ACS. 280	Rs. 1,000	This is a ruined spring channel on the left bank of the Pennar, now proposed to be restored. The total length of channel to be excavated measures 2 miles 5 furlongs and odd. This is a productive work and has no cross drainages to be disposed of. The annual cost of maintenance will also be small.
		Estimate returned by Chief Engineer for further explanation.				
2	Excavating Virapur Vanganur channel.	Tadpatri taluk ..	20,000	200	800	This is a newly proposed spring channel on the right bank of the Pennar. The total length of channel to be excavated comes to 2 miles 7 furlongs and odd.
		Estimate sanctioned.				
3	Restoring Maruta tank.	Gooty taluk ..	21,000	256	1,280	This cannot be called a remunerative work, as the net increase of assessment after deducting the cost of annual maintenance will not yield so much so that this may be undertaken by ordinary labour. This should be classified only as a protective work.
4	Restoring Illur tank.	Gooty taluk ..	9,000	120	451	The proposal is to close the breach of the existing ruined tank and restore it. Estimate returned by Chief Engineer for further explanation.
5	Rolla Anantapur tank.	Kalyandrug ..	16,000	350	1,400	The proposal is to close the breach of the existing ruined tank and restore it. Estimate sanctioned.
6	Hindupur project ..	Hindupur ..	2,00,000	..	..	The proposal is to restore the ruined tank. Estimate received.
						Field work finished. Being estimated by Mr. C. Lawrence.
						II.—Irrigation schemes under investigation.
1	Restoring and improving the Yellanur tank with a proposed supply channel from the Chitravati.	Tadpatri taluk ..	1,75,000	1,150	4,600	The ruined tank having a catchment area of about 20 square miles. A supply channel is also to be excavated from the river Chitravati to supplement the supply from the basin. The net increase of assessment by restoring this tank will be nearly 3 per cent. The absence of any great reservoirs in these parts and the frequent failure of monsoons necessitate the restoration of this work, and it is most suitable for famine labour owing to the enormous quantity of earthwork to be done, and thus it can afford for a large concentration of people.
2	Restoring Pulicm tank.	Gooty taluk ..	25,000	..	..	The proposal is to close the breach of the existing ruined tank and restore it. Estimate not received yet.
3	Restoring Atlaдoddi tank.	Do. ..	4,300	..	..	The proposal is to close the breach of the existing ruined tank and restore it. Estimate returned to Sub-divisional officer for revision.
4	Jackalcheruvu tank improvements.	Do. ..	6,000	..	..	To restore the abandoned tank. Under investigation.
5	Reservoir between Togarkunta and Banookota.	Dharmavaram taluk, Togarkunta.	6,00,000	5,000	33,800	This project is for forming a reservoir in the hills between Togarkunta and Banookota village at 75th mile stone on Dharmavaram to Kalyandrug road and supplying it by means of a flood channel to be excavated from the Penner at Thimmapuram village, Dharmavaram taluk, and bringing it on a contour; and to lead the surplus from the reservoir into a vanka draining into one of the upper tanks in Anantapur minor basin. This project, when fully developed, will improve the supply of nine tanks in Anantapur taluk; the channel will be 60 feet wide at bottom with a depth of 6 feet water and with a fall of 1 foot per mile. A similar project was partly investigated in 1867, but for reasons unknown, not finally completed as per instructions of the then Chief Engineer, Colonel Mullins. The anicut at head of channel for the old project (Bookacherla project) was located in Mysore territory and that for the present one is located in British territory. *N.B.*—The floods in the river are, in designing the dimensions of the channel for the new project, supposed to last for ten days.

Remarks.

Expenditure.

	Rs.
Anicut	55,000
Head sluice	18,000
Channel to reservoir ..	3,00,000
Eight waste weirs	40,000
Seven bridges	28,000
Store-rooms	3,000
Improvements to Perur small tank .	5,000
Improvements to Kovetirayan Palem tank	2,000
Restoring Urucheru at Maddulacheru village	8,000
Reservoir	80,000
Sluices	20,000
Contingencies and supervision ..	21,000
Compensation	20,000
	6,00,000

	ACS.	CROPS.	
Reservoir ..	4,500	1	27,000
Perur smal tankll ..	100	2	230
Kovetirayani palem tank	50	2	100
Madulacheru tank ..	100	2	500
Totals ..			27,800

III.—Irrigation schemes under contemplation.

1	Kanauppalapand vanka to divert a supply channel to the Punnapalli tank.	Tadpatri taluk ..	15,000	..	..	The Pinnapalli tank has a catchment area of about 13 square miles. To increase the supply of the tank this work should be undertaken. An expenditure of about Rs. 40,000 is incurred to restore the Pinnapalli tank but the supply from the basin is found to be inadequate; hence the necessity to increase the supply. The tank has an ayacut of 200 acres and will yield an assessment of Rs. 1,000.
2	Royalcheruvu tank improvements.	Do. ..	..	..	..	
3	Restoring the ruined tank near Timmapuram.	Do. ..	..	..	..	
4	Restoring the ruined tank near Nittur.	Do. ..	..	..	..	
5	A tank in Peravali minor basin Upper Penner river basin.	Anantapur taluk, Nadimidoddi village, one mile to the south of Anantapur to Tadpatri road at 15th mile.	70,000	600	3,600	This project is for forming a tank at the locality mentioned in column 3. The remarks in the last column will show that a good supply in the vanka can always be expected. Combined catchment of tank at proposed site is 100 square miles. Excluding the cultivation under the breached tank marked in plan, an extent of 420 acres is now irrigated by means of channels from the vankas to be dammed.

(By order)

14th August 1901.

(Signed) S. SANKARA ROW,
Accountant, Executive Engineer's office, Bellary.

APPENDIX D.

Note on Irrigation Projects, Nellore District.

I. Pallikonda Reservoir.—A few levels have been taken and plotted to ascertain the water spread of the tank.

Rocky site for dam in bed of river; trial pits dug in two or three places in river bed; rock seems to be 5 to 6 feet below bed level.

Site is between two hillocks, the one on the left bank being Pallikonda.

Escape on right bank round the hillock about 40 feet above bed level in rock.

Irrigation on left bank not investigated.

Drainage area	350 sq. miles.
Duty	30
Acreage	10,500
Storage	2,100 mills. c. ft.

The Musi is the best river in the district except Pennér, and I expect eventual irrigation to be 15,000.

Heaviest fresh area about 20,000 square feet. Flood level marked with tar.

II. *Hajipuram* investigated, and estimate, I believe, has been submitted.

III. *Makerru project.*—Site between two hills, two miles above Garlapata. Escape over a masonry dam founded on granite rock.

Water spread zemin forest and ayacut mostly in zemin dry lands. There is a small anicut and a few acres of irrigation.

No levels taken.

Drainage area	40 sq. miles.
Duty	30
Ayacut	1,200 acres.

IV. *Kondapai tank Project.*—Diversion of Otleru waters into Kondapai tank greatly enlarged. Site of anicut which will also be the weir of the tank will be near Tatiakulapolam.

A weir could also be made in the bund on a rocky site.

No levels taken.

Drainage area	150 sq. miles.
Duty	30
Ayacut	4,500 acres.

There is irrigation at present and there was a petition asking for improvement to tank. A good deal of the land seems to grow excellent dry crops.

V. Levels were taken for Anangi project and from this it seemed possible to divert the water of the Mudigondayeru to Alur and neighbouring tanks.

But it would, I think, be better to make a tank in the stream itself; the lands near Alur are sandy waste and only fit for wet cultivation.

The lands drained by the Mudigonda are the best dry lands in the presidency and yield never failing crops.

Anangi project on the Gundlakamma was to irrigate these lands which were sufficient to condemn it.

Gundlakamma has been taken up in Kistna Northern Division.

VI. *Palettipalli Reservoir* investigated and plans submitted to Superintending Engineer.

Surplus over masonry dam. Majority of dam of earth. Site for masonry portion on solid trap rock.

Channel to ayacut has been marked out with stones in concrete.

Free drainage area	250 sq. miles.
Duty	30
Ayacut	7,500 acres.

Defects in having masonry and earth bund, but if rock is found throughout the whole length, it would be best to have masonry throughout.

The earth is not of good quality.

VII & VIII. *Minor tank sites. Rock sites.*—Not investigated.

Site marked by stone on either side being also site for aqueducts for Palettipalli tank channel.

IX. Where Makeru joins the Paleru, there is a rocky site which could be utilized by taking off the water by an anicut to fill a tank on the right side.

The ground above this point is very high above the bed of the river but below it is the reverse and the water will not have to be raised much or carried far.

No rocky site has been found below this.

X. Ponnalur tank project has, I believe, been sanctioned and begun.

XI. Cherlapatti tank. Water-spreads in zemin lands. Ayacut in Government lands near Peda Alavarpad. Site rock above the gorge.

The name of the village is not, I think, correct. It may be Timmareddipalli.

I don't think the gorge can be mistaken if the stream is followed up from close by Peda Alavarpad.

Above the gorge the stream takes a bend to the left (looking up stream) and 100 feet above seemed the best site.

I found no rocky site below, but a tank below is feasible with flank escapes.

Land below gorge waste. Drop of surplus into river near Peda Alavarpad will be protected from scouring back by rock.

XII. *Mopaud Reservoir* investigated by Mr. Ussher.

XIII. *Gandipalem old breached tank.*—The difficulty in restoring this tank lies in the escape.

It seems evident that soon after the tank was formed, the escaping water flowed down the rear of the bund washing away the rear portion of the sluice on the left and undermined the bank causing a breach.

Subsequently training banks were put up at the escape, the crest of which was also lowered in an irregular way, stones were collected in the bed for the revetment but the restoration was abandoned.

The recent investigation was completed by Mr. Ussher and the restoration was, I hear, again abandoned.

It might, I think, be feasible to go on the lines of the old attempt at restoration and put shutters to the old escape cutting a good escape channel.

It would also seem that if the F.T.L. was reduced by 4 feet, the M.F.L. remaining the same, the tank would be well worth restoring and probably irrigate the 3,000 acres being filled more than once. Shutters could be put to the escape afterwards.

The ayacut would then be further off on the right bank.

The F.T.L. should not be more than the old F.T.L. marked by a fish carved on the sluice and the carved figure on the escape.

The crops would be in all probability mostly semi wet crops, if the assessment allowed, but the present method of charging for crops prevents this. According to my investigation, at least 10 acres of semi wet could be irrigated for every acre of wet and with an assessment of 8 to 12 annas per acre, a very handsome profit could be made. Generally speaking, in Nellore district, this is the irrigation most likely to pay both on account of the soil and the habits of the people as there is practically no wet cultivation outside the delta except the semi wet under wells.

The food is also not rice but ragi, &c.

All ryots, I consulted on the matter, said they would pay Rs. 2 per acre willingly if there was no rice cultivation allowed near.

In zemindary, ryots do not grow much rice under tanks.

XIV. Anicut to supply Machavaram and Mopad tanks investigated by Mr. Ussher.

XV. Diversion of the Uppateru into the Sayapeta tank improved. Levels were, I think, taken to see if it was feasible and as far as I remember it proved to be so.

XVI. Investigated some time ago by Mr. Marjoribanks to form a subsidiary reservoir to Sangam project.

XVII. Improving anicut on Bogeru to supply Atmakur and Vasali tanks. The Atmakur tank escape will wash away the first time the water flows over. A sluice should be placed at the old breach site, so that water can be easily surplussed into Vasali tank.

XVIII. *Anantasagaram tank.*—The ayacut requires extending.

XIX. *Extension of Irrigation under Surrapalli Reservoir.*—The reservoir was to irrigate 20,000 acres but only irrigates 10,000; to irrigate the remainder, the main channel will have to be extended to Idampally tank and perhaps further.

Levels for channel have been taken and plotted.

The F.T.L. of the reservoir was reduced at one time owing to the escape being of insufficient size; the escape was also widened and might easily be increased more if necessary so that there would be no difficulty in increasing the storage.

The workshop regulator and the Kanaparttupad head sluice have, I believe, been widened to admit of more water going down the Survapalli canal. Then Renganayakulapet regulator may also require a greater waterway.

XX. *Vandaiore tank* on the Kondaleru proposed by Mr. Paul but not investigated.

There is an outcrop of rock here and there on the bed of the river.

Escape can be made in the saddle on the right bank.

Ayacut mostly forest scrub; soil, red.

Water spread forest scrub.

Drainage area	100 sq. miles.
Ayacut	3,000 acres.

XXI. This is another site on the same river not investigated.

Rock site in bed of river. Escape on the right side over rock.

Drainage area	150 sq. miles.
Ayacut	4,500 acres.

XXII. This project at first sight seemed impossible, it is of course a huge tank project and the volume of flood water is very great; but without going into Venkatagiri territory, a better site was not found.

The maximum flood level of the river rises above the F.T.L. of Chenur tank. Some other levels were taken of the flood of 1897. The co-efficient for discharge of the basin should be high.

A long earthen bund would be required with a long weir and heavy drop, the latter being most expensive—part of the project being about three-fourths of a mile long unless shutters were provided. The earth is very fair. In spite of the difficulties presented at first sight, it is well worth thorough investigation

Drainage area	400 sq. miles.
Ayacut	20,000 acres.

part of which would be old irrigation.

XXIII. *Kotapanika Tank Project.*—This tank has suffered from improvements. The head sluice being absolutely insufficient, the tank never fills.

The project is to divert the whole of the Salakalwa into the tank and raise its F.T.L.

The Salakalwa does a considerable amount of damage to the Buckingham canal as the Swarnamuki water passes down it and the Pulikalwa instead of down the main Swarnamuki.

There is plenty of laterite rock.

The ayacut would be mostly the tank-bed of Yerur tank and lands above, Yerur tank being practically useless. Levels have been taken. The Pulikalwa also requires similar treatment, the tanks at present being improved as well as other tanks supplied.

NEGAPATAM,
10th August 1901.

L. L. WICKHAM,
Executive Engineer, Negapatam Division.

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APPENDIX F.

List of works proposed as Famine Protective Works in South Arcot for 1901–1902.

No.	Taluk.	Name of works.	Remarks.
			Chidambaram Sub-Division.
1	Cuddalore.	Perumal tank, Shatiatope. Probable cost about Rs. 11,000.	The proposal is to divide the tank into two by putting in a cross bank (with a regulating work in it) at Ayathorai and to raise the F.T.L. of the northern portion of the tank by 3 feet. This scheme will make it possible to extend irrigation under all the sluices from Thanur old sluice to Umar sluice. Suitable as a relief work.
2	Chidambaram.	Extension of Ariaghosty channel.	This is a proposal to dig a new channel from the Ariaghosty channel for supplying the lands in the tract above Ariaghosty village and about 2 miles north of Periyappattu village. This will only be possible if the crest of Shatiatope anicut is raised, ~~for which an estimate has been submitted already~~. There is another proposal in this connection to prevent the wastage over the Laulpet weirs, by which a large quantity of water that could be thrown into the Vellar above Shatiatope anicut will be available for irrigation under the latter. Suitable as a relief work.
3	Do.	Extension of irrigation under the Goverapet channel.	This is to irrigate the new lands near Pichaveram village by a branch from the Goverapet channel into which surplus water available in the Rajah Vaikal may be diverted. Suitable as a relief work.
4	Do.	Raising the Veeranam and Vadavar banks.	As at present the storage in the Veeranam tank is not capable of supplying the lands under it for more than a week when the Vadavar gets no supply and as this supply would be entirely inadequate for the [illegible] crops, it is proposed to raise the ~~banks and the~~ tank F.S.L. The project has already been dealt with in Lobb's report on the Coleroon irrigation and the inspection reports of Colonel Smart during last year. Moreover the banks, especially of the Vadavar, do not at present allow a sufficient margin over M.W.L. for safety. Suitable as a relief work.
			Tindivanam Sub-Division.
1	Villupuram. [illegible]	[illegible] project. Tanks to be improved. The stream gets the surplus from [illegible] anicut system. Estimate, Rupees [illegible]. Increase of irrigation [illegible] acres.	This scheme is to construct an anicut across the Pombayar some distance below where Narayar odai joins and to excavate a supply channel by which the supply to the following tanks may be improved:—(1) Chinnapapasamudram tank, (2) Periyapapasamudram tank, (3) Kapperi large tank, (4) Kapperi small tank, (5) Palli tennel large tank and (6) Palli tennel small tank. Suitable as a relief work.
2	Tindivanam.	Sevur project. Cost, Rs. 26,000. Extension to be 1,200 acres.	This project is to improve the existing Modayur anicut across the Gingee river which is a big ~~jungle~~ stream. At present it supplies only the Modayur tank, but is capable of supplying more tanks if the anicut and supply channel and other connected works are improved. The following tanks now solely depend on the rainfall and the ryots are put to great difficulty owing to want of water in them:—(1) Kammandar tank and tangal, (2) Sevur tank, (3) Ichur tank, (4) Kalladikuppam tank, (5) Kilvylamur tank and (6) Nagander tank. Suitable as a relief work.
3	Villupuram.	Reddikuppam project. Cost estimated, Rupees 26,000. Extension about 1,000 acres.	The project is to construct a new anicut across the Gingee river and to make improvements to the tanks noted below. 151 acres of land in Reddikuppam village may also be directly irrigated. The proposal was originally made by Mr. R. E. Norfor in 1872. (1) Yaryhe tank, (2) Salay tank, (3) Avadayarpet tank, (4) Gananthaput tank and (5) Kayathur tank. Suitable as a relief work.
4	Do.	Vathanore project. Area to be irrigated 2,297 acres.	This project is to construct a masonry anicut in lieu of a earth dam in the Pombayar river and to construct head sluices of both banks and to improve the main channel on the left bank. The above improvements will tend to effect a better supply to the tanks noted below. This was originally proposed by Mr. J. S. Wilson in 1895 and by Mr. C. A. Smith in 1901. An estimate of Rs. ~~48,000~~ has been submitted for sanction. (1) Kappiambuliyur tank, (2) Chengam tangal, (3) Thoravi tank, (4) Vakkur tank, (5) Pagandai tank, (6) and (7) Mathur large and small tanks, (8) Vathanur tank. Suitable as a relief work.
			Vriddhachalam Sub-Division.
1	Vriddhachalam.	Opening out a main channel from the proposed Akkanur anicut across the Vellar river. In connection with this it is proposed to make a new reservoir to be fed from channel + 30 square miles catchment capacity to be 3½ millions cubic yards. The tank (Kilseruvai reservoir) could be constructed as a famine-relief work independently. The estimated revenue is Rs. 50,000. The dam to be an open one with bridge fitted with large shutters. The details how the Pelandorai and Shatiatope anicut systems should be saved from loss have to be settled, but under Pelandorai it will probably be got over by increased storage which is now deficient.	This is a proposal to construct an anicut combined with a bridge across the Vellaur river near Toludur, whereat the Trichinopoly-Madras trunk road crosses the river, and to take therefrom two main channels, north and south, of 20 miles length to the left with branches to supply about 40 minor tanks lying between the river and the Karmangudi odai. The ayacut proposed is about 18,000 acres (against 4,000 acres in existence). Some ten of these tanks are already supplied by means of open headed channels from the river at different points above and below Tittagudi with the help of temporary coramboos. The site of the anicut is 22 miles above the existing Pelandorai anicut with an ayacut of nearly 11,000 acres to the right side of the river. The work of excavating the supply channel does not appear to be suitable for famine work as the first 6 miles of the channel will run in rocky soil and the rest in shallow cutting to be carefully aligned with large number of masonry works. The preliminary investigation is not yet made.

APPENDIX F.

List of irrigation projects that have been investigated from time to time in the North Arcot division.

Name of project.	Object.	Remarks.
1. Pungani project, Palmanér taluk.	For supplying the Palmanér tank and maintaining a drinking water supply to the town of Palmanér. The project is estimated at Rs. 2,42,000.	The report of Mr. Larminie printed with G.O., No. 506-I., dated 8th June 1893, points to the fact that the returns to be derived from increased cultivation would be 1 per cent. on the outlay and while considered in the light of source of water-supply to the town the scheme would fail.
2. Moorthana project, Gudiyáttam taluk.	To form a reservoir to irrigate lands in the valley of Gudiyáttam river and to supplement the supply of water under Pálár system. Is estimated at Rs. 3,00,000.	This project has been abandoned for the reasons that the readings of the river taken at Gudiyáttam for the previous three years show that practically no water ever comes down the river and that the rainfall at Palmanér and elsewhere seemed to be steadily decreasing; it was therefore considered useless to go on with further investigation of the project—*vide* Executive Engineer's report to Superintending Engineer, No. 545, dated 21st October 1897.
3. Cheyathuvaram project, Wandiwash taluk.	To supply a chain of 13 tanks with cheyáru water. Estimate Rs. 19,400.	Plans and estimates prepared. It was found that owing to the restoration of Alathur anicut in South Arcot district, the quantity of surplus that would be available from the river would be out of all proportion. Hence the extension is not authorised—*vide* Superintending Engineer's No. 445, dated 12th August 1899.
4. Berah tank restoration in Chittoor taluk.	This tank breached some 70 or 80 years ago. The restoration was prayed for by the ryots. An estimate for Rs. 15,200 has been prepared for the restoration.	Sanctioned as a famine-relief work in G.O., No. 124-I., dated 7th February 1900.
5. Molmoyal tank, Gudiyáttam taluk.	This tank breached some 70 or 80 years ago. The restoration was prayed for by the ryots. Estimate, Rs. 10,450.	Sanctioned as a famine-relief work in G.O., No. 718-I., dated 18th August 1899.
6. Aliabad anicut project, Polur taluk.	To improve the supply of the tanks under the anicut by widening channels, &c. Estimate, Rs. 6,500.	Estimate under check.
7. Vadamadimangalam project, Polur taluk.	To extend the Aliabad anicut supply to 19 other tanks. Estimate prepared for Rs. 15,000.	Do.
8. Melkuppam tank restoration, Arcot taluk.	This tank was abandoned some years ago. It having been represented that its restoration would yield a revenue of about Rs. 2,000 per annum, the necessary plans and estimates for its restoration have been prepared.	Do.
9. Kávéripák tank silt clearance, Walajah taluk.	This work was ordered by the Chief Engineer to be estimated for as a famine-relief work. A rough estimate of Rs. 1,41,000 has been prepared.	The Chief Engineer for Irrigation considers the scheme inadvisable—*vide* his No. IV-15—N.A., dated 4th April 1900.
10. Poiney extension to— (1) Seruvamalle tank, Rs. 8,880. (2) Arkonam large tank, Rs. 1,410. (3) Anantapuram tank—No estimate prepared. (4) Kaisiur tank Rs. 3,200. (5) Seyyur tank—No estimate prepared.	These tanks are all under the charge of the Revenue Department. They have been reported to hardly fill themselves with water sufficient for crops raised under the tanks and their connection with Poiney anicut has been requested. Plans and estimates in the case of 1, 2 and 4 tanks have been prepared.	The estimates have been held over till it is ascertained by actual observation that water is available from the anicut—*vide* Chief Engineer for Irrigation No. IV-22—N.A., dated 2nd June 1899.
11. Cutting a channel from Cheyáru to Dusi.	This has not been investigated and there are no papers about it. The work has been entered in the famine programme at the request of the interested ryots. The work consists in the restoration of an old abandoned channel—*vide* Executive Engineer's No. 565, dated 15th September 1899, to the Superintending Engineer.	....
12. Digging wells in the bed of Sumamangalam tank, Polur taluk.	A proposal is made to dig wells in the bed of the tank to irrigate the 72 acres of land lying in the foreshore at a cost of Rs. 4,500. The matter is now before the Collector for verification of the expected returns.	....

APPENDIX G.

PUBLIC WORKS DEPARTMENT.

IRRIGATION BRANCH.

PROFESSIONAL CIRCULAR No. 30.

Experimental Rice Cultivation.

Experimental rice cultivation.

Object of the experiments.

The most economical expenditure of water.

A number of experiments have been made during the past eight or nine years, under the authority of the Government, in different parts of this Presidency in order to ascertain what was the effect of the supply of varying quantities of water on the produce of rice-sown land. This primary inquiry was pursued with a further view to the solution of the problem involved in the distribution of a limited supply of water to a practically unlimited extent of land, so as to raise the greatest amount of produce in the aggregate, and thus benefit most fully the country and the revenue.

The inquiry attended with difficulty.

No trustworthy results hitherto attained.

2. The carrying out of the experiments in a manner to gain trustworthy information is in practice attended with considerable difficulty, and none of the results which have as yet been communicated by various officers of the department can be relied on as giving more than an indication that the answer to the question to be solved lies within certain limits, and these are too widely apart to afford the means of approximation to the truth.

Cause of failure.

3. The cause of this failure has been, in a great measure, a want of system in the general arrangements, and the value of the results has been affected by omission to observe and record circumstances materially affecting them.

A resumé of the experiments and tabulation of the results desirable.

4. A short résumé of the reports of the officers who have conducted the experiments, and a tabulation of the results, will be useful by directing attention to the points where failure has most generally occurred.

Experiment of 1865–66, in the Madras district.

Rate of water-supply.

Period of irrigation not properly calculated.

Corrected rate of water-supply.

Defects in the mode of conducting the experiment.

Surplus not measured.

5. In the season of 1865–66, Mr. Ottman, Acting Sub-Engineer, conducted an experiment in rice cultivation on 2·2 acres of land in the Kunnumbille village of the Saidapet taluk, Madras district, under the orders of the Superintending Engineer of the 4th Division. Two crops were raised, and the rate of water-supply is stated to have been on the average for the first crop 2·75 cubic yards per acre per hour, and 2·3 cubic yards for the second; but the period of irrigation is taken at 190 days (including the cultivation of the seedlings). The proper number of days of irrigation of the land under crop was 152 days. Properly corrected the supplies were, as shown in the general table, including rain, for the first crop 2·2 cubic yards and for the second 2·3 cubic yards per acre per hour. The cost of irrigation (from a well) was in each case in excess of the value of the crops. No comparison was made with a plot differently supplied, *i.e.*, with less or more water, and probably there was excess of water. The whole of the rainfall is included in the quantity returned as used for irrigation, but if all falling in excess of the maximum rate necessary, say 3 cubic yards per acre per hour, were eliminated, it would diminish the supply entered considerably. There was no measurement of the surplus running off, though no doubt during rainfall it was very large. The experiment is of little or no value.

Experiment of 1866-67 in the South Arcot district.

6. In 1866–67 another trial was made on one acre of ground on the south bank of the Vellaur river in South Arcot, under the management of Mr. R. E. Norfor, Assistant Engineer. The quantity of water supplied is

given as being on an average at the rate of 2·06 cubic yards per hour per acre including the rainfall, but the period of irrigation is made to include that during which the seed bed only was cultivated, and is stated at 147 days. It was really 117 days, and the daily supply was 2·7 cubic yards per acre per hour. Obviously, also, there has been considerable error in estimating the surplus, as on certain occasions, on which the supply from rain was at the rate of from six to eighteen cubic yards per acre per hour, no surplus discharge has been recorded, while the total run to waste is estimated at only 625 cubic yards during the whole season. The amount of evaporation is not given. On the whole, however, the results are more to be relied on than those already noticed.

Rate of water-supply reported.

Corrected rate of supply.

Error in estimating the surplus water.

7. *Kistna District.*—During this season there was also a trial carried on of the same nature in the Kistna district, Bezwada range, by Captain C. J. Smith, R.E. An acre was divided into sixteen plots, and watered with the quantities and at the intervals shown below :—

Experiment of 1866-67.

Intervals.	Cubic yards per acre per hour.			
	4	3	2	1
Daily	(1, 2)	(3, 4)	(5, 6)	(7, 8)
Alternative days	(13)	(14)	(15)	(16)
Every 4th day	(9)	(10)	(11)	(12)

The numbers in brackets refer to the beds.

The relative outturn is tabulated as follows :—

Intervals of watering.	Cubic yards per acre per hour.								
	4 Outturn.		3 Outturn.		2 Outturn.		1 Outturn.		
	Paddy.	Straw.	Paddy.	Straw.	Paddy.	Straw.	Paddy.	Straw.	
	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.	
Daily	256	270	256	290	253	278	262	281	The outturn on the single plots 9 to 16 is doubled to compute with the beds (1, 2, 3, 4), etc.
Alternate days ..	396	458	387	442	317	406	225	376	
Every fourth day ..	Failure, soil.	saline	267	296	301	318	272	396	

1 Seer = 1·57 lb.

There were several circumstances militating against the value of the recorded results. A considerable portion of the crop was ravaged by rats, and 214 lb. of rice were actually recovered from their holes. The tanks from which the water-supply was measured out were merely constructed of rammed earth, and there must have been leakage, nor can they have been susceptible of very accurate gauging. Neither the surplus water running off the plots nor that required for the seed bed seem to have been taken into account. No close connection between the amount of produce and that of water-supply is established.

Circumstances militating against value of results.

8. *Kurnool District.*—An experiment by Lieutenant Taylor is recorded in the Proceedings of the Government of the 5th July 1870. This was carried out in the Cumbum range, Kurnool district, 1869-70, but was confessedly not elaborated, and the supplies of water whether artificial or from rainfall were not apparently noted day by day, and the whole information is too vague to be of use. It points, however, to a supply of between 1·7 and 2·8 cubic yards per acre per hour as sufficient for rice.

Experiment of 1869-70.

Roughly carried out.

9. *Ganjám District.*—In No. 2 Range, Ganjám district, three trials were made by the Range officer, Mr. Harris, in 1870-71. In two cases the artificial supply was small and the crop was mainly dependent on the rainfall,

Experiment of 1870-71.

while in the third there was no artificial supply whatever. In each case the area of land under culture was 1 acre. The information gained bears more on the question of the value of water from artificial sources when used merely as a reserve, and employed in minimum quantities to save crops suffering from drought, than to its economical use for purposes of irrigation in the ordinary sense. Even in the former view the deductions to be drawn are complicated by the fact that the quality of the soil varied in the first and two last experiments. It is impossible to ascertain how much of the increased crop shown in the first case as compared with the third experiment, is due to the greater artificial supply of water, and how much to the better quality of the land. The daily record of rainfall does not accompany the papers. No doubt there were occasions on which the quantity distributed over the area in twenty-four hours was in excess of the maximum useful supply in that time, but there is no note of any surplus being discharged off the land by natural drainage. The results are tabulated with the experiments already noticed.

Small artificial supply.

The information gained bears on question of minimum supply to save crops from total failure.

Varying quality of soil complicates results.

Rainfall daily record not available.
Probability of occasional surplus.

Results.

The supply per acre per hour is shown below :—

1st Experiment	2·2
2nd „	2·1
3rd „	1·9

but the whole of the rainfall is included, and it is probable that if the surplus had been observed and deducted, the quantities representing the useful supply would have been far smaller.

Cost of cultivation.

The cost of cultivation has been recorded in each case, and it is no doubt a fair approximation to the truth. It amounted to for the—

	Rs.	A.	P.
1st Experiment	13	15	2
2nd „	11	0	0
3rd „	10	12	0

10. *Kistna District, 1870-71.*—In the Kistna district, during the same season, a trial was made by the cultivation with a measured supply of water of 9 acres of land at Chebrole, and of a similar area at Peraly, both in the 2nd Range. In the latter case the experiment was a failure, owing to the arrangements not being completed in time and to the flooding of the fields with drainage water. Nor were the results at Chebrole entirely satisfactory since the surplus from the fields was not measured and the ground was not completely without the area influenced by the soakage from the tank whence the supply was derived. It will be seen from the tabulated results that the largest crop was produced by the plot which received 2·06 cubic yards per acre per hour on the average including the rainfall, but it is stated that an adjoining plot, receiving 3 cubic yards, but not cultivated under supervision, produced a still greater crop than the one referred to. Seeing that the method of measuring the water-supply and the nature of the cultivation in the latter case has not been recorded, it is better to disregard the result as being open to suspicion, and to accept as probably true the indication that, under the local circumstances at any rate, the smaller supply was the most advantageous. It is to be observed that a considerable quantity of manure was used, and this most probably largely influenced the return. The cost of cultivation per acre to the ryot is stated to be Rs. 17, not including the value of the seed.

Experiment of 1870-71.

One experiment, a failure.

Results at Chebrole not entirely satisfactory.
Surplus not measured.

Results.
Best supply of water.
Reported return of an adjoining plot.

Should be disregarded.

Use of manure.

Cost of cultivation.

11. *Kistna District.*—The above experiment was repeated during the season next but one ensuing on the same ground with more success. The surplus discharge was not observed, and this constitutes the defect of these observations. The plot which received 1·8 cubic yards per acre per hour gave the largest return, *i.e.*,

Experiment of 1872-73.

Surplus discharged not observed.

Best supply of water.

3,087 lb. of paddy and 2,072 lb. of straw per acre. It is reported that a plot cultivated, under ordinary conditions by ryots, returned 1,930 lb. of grain and 2,251 lb. of straw per acre. The water-supply to this land was estimated to be at the rate of 3 cubic yards per acre per hour.

Reported return of an adjoining plot.

It is quite possible that the previous year's manure may have assisted in the favourable yield of the land experimented on. Nevertheless, it is conclusively shown that with a supply of water of somewhat less than 2 cubic yards per acre per hour rice can be successfully grown. In the two last-mentioned experiments the discharge was calculated by the formula applicable to the case, which was that of discharge through an orifice in a thin plate under a head maintained as uniform as practicable. To produce the conditions, the supply was delivered into a masonry tank, at the bottom of which was an orifice fitted with a diaphragm with a hole 6 inches square. It is not shown what measures were taken to ensure uniformity of depth of water in the cistern, and careful adjustment and watching would be necessary. Apparently, it was measured thrice daily. The accuracy of the calculated discharge is open to some doubt.

Probable effect of previous year's manure.

Mode of calculating discharge of water on to the land.

Attended with difficulty in manipulation.

Accuracy open to doubt.

12. *Gódávari District.*—During the year 1871 a piece of ground, having an area of 21 acres, in the 3rd range of the Gódávari district, was under cultivation, with a gauged supply of water from an irrigation channel with a view to acquire information of the nature adverted to in this paper. The experiment was very loosely conducted, and the results are obviously quite fallacious. The water was passed on to the land over a stone weir 1 foot 6 inches broad; and as the depth flowing over was only from 1 inch to 4 inches, the co-efficient of discharge would not be constant enough even for practical purposes owing to the large and varying influence of friction. The quantity of water supplied to the seed bed is not separated from that allotted to the 21 acres; consequently it is impossible to ascertain accurately what was the quantity delivered per acre or per acre per hour, but it may be approximately calculated on the supposition that during May the supply was limited to the seed bed. The delivery per acre per hour amounted, therefore, to about 4·2 cubic yards including rainfall, which is certainly far too large. No real restriction was placed on the use of the water. No surplus is noticed as run off. The outturn was not weighed, but the statement of the ryot that it was 1,714 lb. was accepted, this being rather more than an average crop. Of course, under such circumstances, the experiment was useless.

Experiment of 1871-72.

Experiment loosely conducted.

Method of gauging the water.

Probably very inaccurate.

Supply to seed bed included in supply to land.

No surplus recorded.

Crop not measured or weighed.

13. *Coimbatore District.*—In 1871 also experimental rice cultivation was carried on in the Kollegal range of the Coimbatore district, but as there was only one plot and one rate of water-supply, the results are of little value. No attempt was made to watch and gauge surplus water, on the supposition that because only as much water was discharged on to the land as could be retained thereon, there would be no out-flow. But, as there was occasionally heavy rain, it is most probable that water ran to waste occasionally. The produce was not weighed. The grain is given in Madras measures, and these are [illegible] cart loads, obviously a very indefinite measure of quantity. As regards the former, the superintending Engineer remarks that, as the measure of paddy weighs 3·1 lb., the outturn comes to 2,876 lb.

Experiment of 1871.

Only one plot and one rate of water-supply.

Surplus not recorded.

Surplus probable.

Produce not weighed.

Water was not admitted on to the seed bed till the 16th June, but rainfall is recorded from the 1st May and included in the water-supply.

Error in the record of rainfall supply.

The land which was the subject of experiment was not supplied with water till the 1st August, but the supply to the seed bed in the interval, amounting to 212 cubic yards is included in the record. Both rainfall and seed-bed supply being deducted, we have the results shown in the general table appended.

The supply to the seed bed included in that for the land.

The total supply to the land averaging 1·8 cubic yards per acre per hour is not large, and the crop for an upland country is perhaps fair. It is, however, useless to attempt to theorise from the results, as they are not trustworthy.

Corrected results.

14. *Trichinopoly District.*—At Trichinopoly, in 1872, arrangements were made in order that there might be another attempt to arrive at more satisfactory results, and during the ensuing season, 1872–73, the cultivation of three plots of half an acre each of rice land was carried on under a system which seemed to include all that was necessary. The supply of water was apparently measured out with care. The estimation of the surplus discharge was provided for, and evaporation was daily recorded.

Experiment of 1872-73.

Carried out under better system.

It was decided to supply water to one plot to the full extent required by the cultivator, and to allot to one of the two other plots half a cubic yard per hour more and to the other half a cubic yard less than was discharged on the first-mentioned plot.

Nature of the variation in the supply to the plots.

The supplies were actually including rainfall for—

Actual supplies including rain.

No. I Plot	... ...	3·9
„ II „	... ...	3·6
„ III „	... ...	3·3

} cubic yards per acre per hour.

The largest outturn was derived from No. III, as will be seen on reference to the tabulated results appended of the whole of the experiments. The defect seems to have been that the supplies were not sufficiently varied and that the lowest was considerably too great. The difference should have been 1 cubic yard per acre per hour above and below the mean.

Largest outturn from No. III plot.

The variations in the supplies not sufficiently great.

For the preparation of the land the plots received—

Supplies for the preparation of the land.

	Cubic yards.	Per acre per hour.
No. I	... 704	2·9 cubic yards.
„ II	... 673	2·9 „
„ III	... 724	3·2 „

For irrigation including rain—

Supplies for irrigation.

	Cubic yards.	Cubic yards.
No. I	... 5,368 or per acre per hour	4·0.
„ II	... 4,858 or „ „	3·7.
„ III	... 4,276 or „ „	3·2.

So that the intended variation of half a cubic yard per half acre per hour above and below the supply for No. II does not seem to have been carried out in practice.

15. *Trichinopoly District.*—The experiment above detailed was repeated during the season 1873–74 in the same locality, and all necessary precautions seem on this occasion to have been taken to ensure reliable results. An acre and a half of black loam, placed by the Revenue Department in the third-class nunjah, was divided into four plots, two of half an acre each and two of a quarter of an acre each. Plot No. 3 was cultivated by an experienced native farmer, who used his discretion as to all matters of water-supply, etc. The results are included in the general table annexed to this paper. The quantity of water used was very large, and the land was heavily manured. The outturn seems to have been exceptionally good, and in this case the plot which received the largest supply of water, viz., 2·64 cubic yards per acre per hour including rainfall, produced the most, the crop being 3,908 lb. of paddy and 6,300 lb. of straw.

Experiment of 1873-74.

Extent of land experimented on.

Quantity of water very large.

16. On taking a general view of the results from all the various trials (with the exception of the last more or less imperfectly carried out) one is struck with the extreme variability of the returns, and the apparent absence of any rigid law connecting them with the water-supply when the latter has not ranged below a certain limit, after which apparently the vitality of the plant is affected and its powers of assimilation diminished. It is true that there are many circumstances connected with the experiments which render the results open to suspicion, and it would probably be rash to found any theory on them. It is evident, however, that there are causes, such as the quality of the soil, the supply of manure and the character of the seed, as

General view of experiments.

Variability of returns.

Apparent absence of intimate connection between amount of supply of water and crop within a certain limit.

The results often open to suspicion.

Powerful causes other than water-supply affecting return.

well as the retentiveness or porosity of the sub-soil, which exercise so powerful an influence in modifying the return as to overwhelm the effect of the variations in the water-supply even when these are considerable. There is thus much difficulty in effecting a useful comparison of results arrived at in different localities since the proportion of each result due to the innate fertility of the soil or to the other circumstances is an unknown quantity. These must be eliminated, and this can only be done by selecting, in the first place, in each locality land of uniform quality, and by repeating the experiments for several seasons in succession, and, while maintaining the same range of variation in the supply of water to the several plots, subjecting each in succession to the changes in the supply thus provided for. At the same time every effort must be made to assimilate all the circumstances of cultivation in the group of plots.

Difficulty in effecting a useful comparison of results.

Necessity for eliminating these effects.

Method of elimination.

If then the experiments are continued, we shall expect to find under such circumstances that while the returns vary each season, the differences between the crops from these several plots follow and accord with the changes made in the supply of water.

The differences between the crops in successive seasons should accord with the variations in the supply.

If for instance the crops in one season from three plots numbered I., II., III. were represented by the quantities, 25 : 19 : 13 while the water-supplies were to the plots respectively 3, 2, and 1 cubic yards per acre per hour, and the succeeding season the crops and water-supply varied as shown below, viz. :—

Example.

	I.	II.	III.
Crops as	20 :	18·2 :	10·4
Supply cubic yards	2 :	3 :	1

The deduction would be that while owing to various causes, such as for instance partial exhaustion of the soil or low average temperature, there was a general reduction of return in the second case, yet that the results in both showed that 3 cubic yards per acre per hour was the best supply, and this would follow because in the second experiment the falling off of No. II crop was less in degree than that of the other two plots, and it would be legitimate to argue that change to a larger supply of water had produced in No. II additional produce to the extent of nearly one-tenth of the first season's crop. It is only by reasoning on these principles that apparent discrepancies can be reconciled and true deductions drawn from the experiments.

Deduction to be chosen.

Argument deduced from a general reduction of crop.

But not a uniform reduction.

The best supply found.

17. In the appendix general rules are given for conducting these as well as forms for tabulating or recording the observations.

(Signed) A. DuC. SCOTT, Major, R.E.,
for Chief Engineer for Irrigation.

11th November 1875.

TABULATED Results of Experiments in Rice Cultivation from 1865–66 to 1873–74 in the Madras Presidency.

Season of Experiment.	Locality. District.	Locality. Range.	Area of land under experiment. Reference to No. of plot.	Area of land under experiment. Area of plot.	Area of land under experiment. Total area.	Water-supply. Rainfall. To seed bed.	Water-supply. Artificial. Supply per acre per hour. Maximum.	Water-supply. Artificial. Supply per acre per hour. Minimum.	Water-supply. Artificial. Supply per acre per hour. Average.	Water-supply. Artificial. Total supply per acre. Under 8 cubic yards per acre per hour.	Water-supply. Artificial. Total supply per acre. Above 8 cubic yards per acre per hour.	Water-supply. Total supply per acre per hour. General total per acre.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
				Acs.	Acs.	C. YDS.	C. YDS.	C. YDS.	C. YDS.	C. YDS.	C. YDS.	C. YDS.	C. YDS.	C. YDS.	C. YDS.	C. YDS.
1865–66	Chingleput	No. 3, Poonamallee.	1	2·22	2·22	168	8·0	0·37	1·5	..	..	..	..	..	2,412	2·2
1865–66	..	..	2	2·22	2·22	168	8·0	Not given.	2·8	..	..	..	..	..	119	2·3
1866–67	South Arcot	Beswada	(1·2)	0·126	1·00	113	2·7	1·3	1·0	0·7	8,714	8,714	4,900	4,900	2·7
1866–67	Kistna	..	(3·4)	0·126	..	..	Uniform.	..	4	0·4	336	336	1,407	1,407	4·5
1866–67	..	..	(5·6)	0·125	..	..	..	..	3	1,072	..	..	..	..	3·6
1866–67	..	..	(7·8)	0·125	..	..	..	..	2	1,072	..	..	..	..	2·5
1866–67	..	..	9	0·062	..	..	..	..	1	1,072	..	..	..	..	1·5
1866–67	..	..	10	0·062	1·0	191	6,880	0·75	1	1,072	..	..	..	..	1·5
1866–67	..	..	11	0·062	..	..	6,764	0·60	0·75	1,072	..	..	..	..	1·25
1866–67	..	..	12	0·062	..	..	4,808	0·25	0·60	1,072	..	..	..	..	1·0
1866–67	..	..	13	0·062	..	..	13,200	2·0	0·25	1,072	..	..	..	..	0·75
1866–67	..	..	14	0·062	..	..	10,822	1·5	2·0	1,072	..	..	..	..	2·5
1866–67	..	..	15	0·062	..	..	9,072	1·0	1·5	1,072	..	..	..	..	2·0
1866–67	..	..	16	0·062	..	..	6,048	0·5	1·0	1,072	..	..	..	..	1·5
1870–71	Ganjam	No. 2	No. 1	1	1	Not observed.	1,056	0·3	0·5	1,072	..	..	..	..	1·0
1870–71	Chingleput	No. 3, Poonamallee.	1	1	1	Not observed.	707	0·19	1·5	..	..	..	6,910	6,910	2·2
1870–71	..	..	2	1	1	..	0·0	0·00	..	..	..	..	..	6,910	2·1
1870–71	Kistna	Beswada	3	3	3	..	3,251	0·5	1·3	1,034	..	..	..	6,910	1·9
1870–71	..	..	1	1	3	..	4,362	0·6	1·8	1,034	0·4	900	1,934	1,934	2·06
1870–71	..	..	2	3	3	..	6,444	0·8	2·2	1,034	0·4	900	1,934	1,934	2·50
1872–73	..	..	3	3	3	..	2,926	0·9	1·2	948	0·4	486	1,434	1,434	1·8
1872–73	..	..	1	3·24	9·23	..	4,303	1·2	1·6	948	0·4	486	1,434	1,434	2·4
1872–73	..	..	2	2·88	..	..	2,561	0·7	1·1	948	0·4	486	1,434	1,434	1·7
1872–73	..	..	3	3·11	..	..	..	..	..	..	..	..	..	..	..	..

* These quantities copied from the original returns are apparently in error, as when divided by columns 8 they do not give the recorded rate of supply in column 12 also copied from the original.

Tabulated Results of Experiments in Rice Cultivation from 1865–66 to 1873–74 in the Madras Presidency—*cont.*

Season of experiment.	Locality.		Surplus.			Average net supply per acre.	Total evaporation per acre.	Crop per acre.					Total value.	Seed, nature of, and lb. or measure 100 cub. inches.	Class of soil.	Remarks.
	District.	Range.	Per acre per hour.					Grain.			Straw.					
			Maximum.	Minimum.	Average.			Weight.	Measure 100 cub. inches.	Value.	Weight.	Value.				
			18	19	20	21	22	23	24	25	26	27	28	29	30	31
1865–66 ..	Chinglepet ..	No. 3, Poonamalle.	C. YDS. Not observed.		C. YDS.	C. YDS. ..	C. YDS. Not observed.	LB. 2,700	873	Rs. A. Included with straw.	LB. Not observed	Rs. Included with grain.	Rs. A. 55 0	LBS. 44	Rich clay loam.	Rain on seed bed 2,646 cubic yards.
1865–66 ..	.. ..	.. ..	..	..	..	..	..	2,120	684	..	..	..	..	44		
1866–67 ..	South Arcot ..	.. ..	8 ..	..	0·18	2·52	..	1,841	594	35 9	Not observed	8 12	44 5	Not observed.		4 c. yds. per acre per hour.
1866–67 ..	Kistna ..	Bezwada ..	Not observed.			No return	..	2,045	661		2,160					3 do. do. do.
1866–67 ..	.. ..	.. ..	..	..	..	..	..	2,048	661		2,324					2 do. do. do.
1866–67 ..	.. ..	.. ..	..	..	..	..	..	2,024	653		2,224					1 do. do. do.
1866–67 ..	.. ..	.. ..	..	..	..	..	..	2,056	677		2,248					4 do. every 4th day do.
1866–67 ..	.. ..	.. ..	..	..	..	..	..	Failure	Failure		..					1 do. per acre every day.
1866–67 ..	.. ..	.. ..	..	..	..	..	..	2,136	689		2,348					3 do. do. do. ½ day.
1866–67 ..	.. ..	.. ..	..	..	..	..	..	2,408	776		2,544		56 0	Not measured.	Black cotton.	2 do. do. do. 0·5 do.
1866–67 ..	.. ..	.. ..	..	..	..	..	..	2,176	702		3,168					1 do. do. do. 0·25 do.
1866–67 ..	.. ..	.. ..	..	..	..	..	..	3,168	1,022		3,664					4 do. do. do. 2nd day. 2·0 do.
1866–67 ..	.. ..	.. ..	..	..	..	..	..	3,006	969		3,536					3 do. do. do. 1·5 do.
1866–67 ..	.. ..	.. ..	..	..	..	..	..	2,535	818		3,248					2 do. do. do. 1·0 do.
1866–67 ..	.. ..	.. ..	..	..	..	..	..	1,500	555		3,008					1 do. do. do. 0·5 do.
1870–71 ..	Ganjam ..	No. 2 ..	Not observed.			No data	Not observed	1,741	561	22 0	2,313	10 0	..	31	1st class.	
1870–71 ..	.. ..	.. 2 ..	..			..	..	1,288	413	15 0	1,472	6 0	31 0	31	3rd do.	
1870–71 ..	.. ..	.. 2 ..	..			..	..	1,000	322	12 0	1,280	6 0	18 0	31	3rd do.	
1870–71 ..	Kistna ..	.. 2 ..	..			..	..	3,680	Not observed.	26 0	3,750	7½ 0	34 0	56 Kasuma.	Black cotton.	The land was manured before sowing. The seed was of the first quality.
1870–71 ..	.. ..	.. 2 ..	..			..	..	3,134	..	22½ 0	3,588	7 0	29½ 0	56 „	..	
1870–71 ..	.. ..	.. 3 ..	..			..	..	3,377	..	24½ 0	3,516	7 0	31½ 0	56 „	..	
1872–73 ..	.. ..	.. 1 ..	..			..	..	3,087	..	42 0	2,072	4 0	46 0	48 „	..	
1872–73 ..	.. ..	.. 2 ..	..			..	..	2,820	..	38 0	2,329	5 0	43 0	48 „	..	
1872–73 ..	.. ..	.. 3 ..	..			..	..	2,930	..	40 0	2,489	5 0	45 0	48 „	..	

Tabulated Results of Experiments in Rice Cultivation from 1865–66 to 1873–74 in the Madras Presidency—*cont.*

Season of Experiment.	Locality.		Area of land under experiment.			Water-supply.										
						Artificial.						Rainfall.				
	District.	Range.	Reference to No. of Plot.	Area of Plot.	Total Area.	To seed bed.	Land under irrigation not including seed cultivation.	Total supply exclusive of supply to seed bed per acre.	Supply per acre per hour.			Under 3 cubic yards per acre per hour.		Above 3 cubic yards per acre per hour.	General total per acre.	Total supply per acre per hour.
									Maximum.	Minimum.	Average.	Total per acre.	Average per acre per hour.			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1872–73 ..	Gódávari ..	No. 3 ..	No. 3	ACS. 21	ACS. 21	C. YDS. ..	DAYS. 173	C. YDS. 13,920	C. YDS. 7·5	C. YDS. 0·8	C. YDS. 3·4	C. YDS. 2,707	C. YDS. 0·5	C. YDS. 1,313	C. YDS. 4,020	C. YDS. 4·2
1872–73 ..	Coimbatore ..	Kollegal ..	..	1·0	1·0	212	154	4,100	9·0	3·2	1·1	920	0·5	1,072	2,992	1·8
1872–73 ..	Trichinopoly ..	Trichinopoly ..	1	0·5			129	9,130	Not observed.		3·0	Not observed.	No return.	Not observed	2,965	3·9
			2	0·5	1·5	..	128	6,098			2·6				2,965	3·6
1873–74 ..	Do. ..	Do. ..	3	0·5				7,036			2·2				2,965	3·3
			1	0·5		152	127	7,420			1·74	No distinction.		No distinction.	2,634	2·36
			2	0·5	1·5	152	178	6,760			1·58				2,634	2·20
			3	0·25		152	178	8,256			1·93				2,634	2·55
			4	0·257		250	178	8,666			2·03				2,634	2·55

Notes—Column 8.—The time during which the seeds were irrigated is not included.
„ 12.—This is obtained by dividing the total supply, column 9, by the number of days, column 8.
„ 9.—Is the total supply to the crop bearing field per acre.
Columns 10 & 11.—Give the maximum and minimum supply on any day on which water was delivered; sometimes there was no supply.
Column 12.—Is the total artificial supply divided by the number of days of irrigation.
„ 13.—Gives the total rainfall at a rate under 3 cubic yards per acre per hour.
„ 15.—Gives the total rainfall at and over 3 cubic yards per acre per hour.
„ 17.—Is obtained by dividing the whole supply artificial and rain by the number of hours the crop was under irrigation.

Tabulated Results of Experiments in Rice Cultivation from 1865–66 to 1873–74 in the Madras Presidency—*cont.*

Season of experiment.	Locality.		Crop per acre.																Remarks.
			Surplus.					Grain.			Straw.		Total value.	Seed, nature of, and lb. or measure 100 cub. inches.	Class of soil.				
	District.	Range.	Per acre per hour.			Average net supply per acre.	Total evaporation per acre.	Weight	Measure 100 cub. inches.	Value.	Weight.	Value.							
			Maximum.	Minimum.	Average.														
			18	19	20	21	22	23	24	25	26	27	28	29	30	31			
1865-66 ..	Chinglepat ..	No. 3, Poonamalle.	C. YDS. Not observed.	C. YDS.	C. YDS.	C. YDS. ..	C. YDS. Not observed	LB. 2,700	813	Rs. A. Included with straw	LB. Not observed	Rs. Included with grain.	Rs. A. 55 0	LBS. 44	Rich clay loam.	Rain on seed bed 2,546 cubic yards.			
1865-66 ..	.. ..	.. ..	..	..	..	..	..	2,120	681					44					
1866-67 ..	South Arcot ..	..	8	..	0·18	2·52	..	1,841	594	5 9	Not observed.	8 12	44 5	Not observed.		4 c. yds. per acre per hour.			
1866-67 ..	Kistna ..	Bezwada ..	Not observed.			No return	..	2,048	664		2,160					3 do.	do.	do.	
1866-67 ..	.. ..	.. ..	..	..	..	..	..	2,048	661		2,324					2 do.	do.	do.	
1866-67 ..	.. ..	.. ..	..	..	..	..	..	2,024	653		2,224					1 do.	do.	do.	
1866-67 ..	.. ..	.. ..	..	..	..	..	..	2,056	377		2,248					4 do.	every 4th day	do.	
1866-67 ..	.. ..	.. ..	..	..	..	..	..	Failure	Failure		..					1 do.	per acre	every day.	
1866-67 ..	.. ..	.. ..	..	..	..	..	..	2,136	689		2,348					3 do.	do.	do. ½ day.	
1866-67 ..	.. ..	.. ..	..	..	..	..	..	2,408	776		2,544		56 0	Not measured.	Black cotton.	2 do.	do.	do. 0·5 do.	
1866-67 ..	.. ..	.. ..	..	..	..	..	..	2,176	702		3,168					1 do.	do.	do. 0·25 do.	
1866-67 ..	.. ..	.. ..	..	..	..	..	..	4,168	1,042		3,664					4 do.	do.	do. 2nd day. 2·0 do.	
1866-67 ..	.. ..	.. ..	..	..	..	..	..	3,036	969	Average Rupees 44.	3,536	Average Rupees 12.				3 do.	do.	do. 1·5 do.	
1866-67 ..	.. ..	.. ..	..	..	..	..	..	2,535	818		3,248					2 do.	do.	do. 1·0 do.	
1866-67 ..	.. ..	.. ..	..	..	..	..	..	1,506	554		3,008					1 do.	do.	do. 0·5 do.	
1870-71 ..	Ganjam ..	No. 2 ..	Not observed.			No data.	Not observed.	1,741	5[illegible]	22 0	2,313	10 0	..	31	1st class.				
1870-71 ..	.. ..	,, 2 ..	..	..	..	..	..	1,288	413	15 0	1,472	6 0	21 0	31	3rd do.				
1870-71 ..	.. ..	,, 2 ..	..	..	..	..	..	1,000	328	12 0	1,280	6 0	18 0	31	3rd do.				
1870-71 ..	Kistna ..	,, 2 ..	..	..	..	..	..	3,680	Not observed.	26 0	3,750	7½ 0	34 0	56 Kusums.	Black cotton.	The land was manured before sowing. The seed was of the first quality.			
1870-71 ..	.. ..	,, 2 ..	..	..	..	..	..	3,134	..	22½ 0	3,566	7 0	29½ 0	56 ,,	..				
1870-71 ..	.. ..	,, 3 ..	..	..	..	..	..	3,377	..	24½ 0	3,516	7 0	31½ 0	56 ,,	..				
1872-73 ..	.. ..	,, 1 ..	..	..	..	..	..	3,087	..	42 0	2,072	4 0	46 0	48 ,,	..				
1872-73 ..	.. ..	,, 2 ..	..	..	..	..	..	2,820	..	38 0	2,329	5 0	43 0	48 ,,	..				
1872-73 ..	.. ..	,, 3 ..	..	..	..	..	..	2,920	..	40 0	2,489	5 0	45 0	48 ,,	..				

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Tabulated Results of Experiments in Rice Cultivation from 1865–66 to 1873–74 in the Madras Presidency—*cont.*

Season of Experiment.	Locality.		Area of land under experiment.			Water-supply.											
						Artificial.						Rainfall.					
	District.	Range.	Reference to No. of Plot.	Area of Plot.	Total Area.	To seed bed.	Land under irrigation not including seed cultivation.	Total supply exclusive of supply to seed bed per acre.	Supply per acre per hour.			Under 3 cubic yards per acre per hour.		Above 3 cubic yards per acre per hour.	General total per acre.	Total supply per acre per hour.
									Maximum.	Minimum.	Average.	Total per acre.	Average per acre per hour.			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
				ACS.	ACS.	C. YDS.	DAYS.	C. YDS.	C. YDS.	C. YDS.	C. YDS.	C. YDS.	C. YDS.	C. YDS.	C. YDS.	C. YDS.
1872-73 ..	Gódávari ..	No. 3 ..	No. 3	21	21	..	173	13,920	7·5	0·8	3·4	2,707	0·5	1,313	4,020	4·2
1872-73 ..	Coimbatore ..	Kollegal ..	..	1·0	1·0	212	154	4,100	9·0	3·2	1·1	920	0·5	1,072	2,992	1·8
1872-73 ..	Trichinopoly ..	Trichinopoly ..	1	0·5	1·5		129	9,130	Not observed.		3·0	Not observed.	No return.	Not observed	2,965	3·9
			2	0·5		..	128	8,098			2·6	,,	,,	,,	2,965	3·6
			3	0·5				7,036		,,	2·2	,,	,,	,,	2,965	3·3
1873-74 ..	Do. ..	Do. ..	1	0·5		152	127	7,420		,,	1·74	No distinction.	,,	No distinction.	2,634	2·36
			2	0·5	1·5	152	178	6,760		,,	1·58	,,	,,	,,	2,634	2·30
			3	0·25		152	178	8,256		,,	1·93	,,	,,	,,	2,634	2·55
			4	0·257		250	178	8,666		,,	2·03	,,	,,	,,	2,634	2·55

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Notes—Column 8.—The time during which the seeds were irrigated is not included.
,, 12.—This is obtained by dividing the total supply, column 9, by the number of days, column 8.
,, 9.—Is the total supply to the crop bearing field per acre.
Columns 10 & 11.—Give the maximum and minimum supply on any day on which water was delivered; sometimes there was no supply.
Column 12.—Is the total artificial supply divided by the number of days of irrigation.
,, 13.—Gives the total rainfall at a rate under 3 cubic yards per acre per hour.
,, 15.—Gives the total rainfall at and over 3 cubic yards per acre per hour.
,, 17.—Is obtained by dividing the whole supply artificial and rain by the number of hours the crop was under irrigation.

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Tabulated Results of Experiments in Rice Cultivation from 1865–66 to 1873–74 in the Madras Presidency—*cont.*

Season of experiment.	Locality. District.	Locality. Range.	Surplus. Per acre per hour. Maximum.	Surplus. Per acre per hour. Minimum.	Surplus. Per acre per hour. Average.	Average supply per acre.	Total evaporation per acre.	Crop per acre. Grain. Weight.	Crop per acre. Grain. Measure 100 cub. inches.	Crop per acre. Grain. Value.	Crop per acre. Straw. Weight.	Crop per acre. Straw. Value.	Crop per acre. Total value.	Seed nature of and lb. or measure 100 cub. inches.	Class of soil.	Remarks.
			18	19	20	21	22	23	24	25	26	27	28	29	30	31
			C. YDS.	C. YDS.	C. YDS.	C. YDS.	C. YDS.	LB.		RS	LB.	RS.	RS.	LB.		
[illegible]	[illegible]	No. 3	Not observed.			..	..	1,714	..	Not given.			..	Not observed.	..	
1872-73	Coimbatore	Kollegal	,,			..	Not observed.	2,876	928	33	15 carts.	5	38	,,	..	Kamborathy seed.
1872-73	Trichinopoly	Trichinopoly	None.	None.	..	3·9	3,350	1,756	..	Not given.	2,236	Not given.	..	42 Samba.	Sandy.	Each plot received 60 maunds of manure.
			,,	,,	..	3·6	3,350	2,080	..	,,	2,752	,,	..	42 ,,	,,	
			,,	,,	..	3·3	3,350	2,592	..	,,	3,440	,,	..	42 ,,	,,	9,500 lbs. of manure used to the acre.
1873-74	Do.	Do.	..	,,	..	3·8	1,853	3,169	1,480	73½	5,550	4⅜	77[illegible]	Not observed.	,,	
			..	,,	..	3·5	1,853	2,886	1,248	61¾	4,500	3¾	65¼	..	,,	
			..	,,	..	4·1	1,853	3,325	1,400	69¼	6,000	5	74¼	..	,,	
			..	,,	..	4·3	1,853	3,908	1,624	80¼	6,300	5¼	85¼	..	,,	

12th August 1874.

(Signed) A. DEC. SCOTT, Major, R.E.,
Under Secretary to Government.

Memorandum of Instructions to Officers in charge of Experiments in Rice Cultivation.

Choice of locality. In choosing the locality for the experiment the following points must be kept in view.

Points influencing. 1. The plots must not be on swampy land, or land liable to be flooded, or water-logged by rain or surplus from other ground. They must be, however, within easy reach of a channel or source of water-supply not likely to fail in the driest season.

Quality of the soil. Should be largely represented in locality. Uniformity essential in the quality of soil experimented on. 2. The class of soil should be, if practicable, that which is most largely represented in the locality in which the experiment is conducted. At any rate the plots should not be of soil of exceptional character, and the greatest care should be taken that the quality is as uniform as possible over the area experimented on.

Preparation of the land. Sub-division by kundums or banks. Trenching and puddling necessary. 3. The land should be sub-divided by kundums or banks in the usual manner. The ground should be trenched, if the surface soil is of a sandy nature, till the more impervious sub-soil is reached or for such a depth as may secure against leakage, and the kundum consisting of the most suitable earth procurable should be built up in puddled layers from the bottom of the trench. Care should be taken to lay the trenches out in right lines to facilitate measurement of the area of the plots.

Arrangements to be made with owners of soil. To be left in a great measure to discretion of officers. Security to be given against loss to ryot. Ryot should have an interest in proper cultivation. Assistance of Revenue Authorities to be sought. A written agreement necessary. 4. The arrangements to be made with the owners of the ground which may be selected must be left in a great measure to the discretion of the District Engineer or Range Officer. Any fair or reasonable commission in the way of security against loss, compensation for trouble given or for surrender of control over the land should be granted, the object in view being to secure cordial assistance and co-operation. Care must be taken that the ryot may have a direct interest in the proper cultivation of the land. In short he should be secured against loss and have the prospect of possible gain by his consenting to the experiment. The assistance of the Revenue Authorities in carrying out the negotiations and arrangements with the cultivators should, if necessary, be obtained, and the terms of the agreement should be recorded in writing and signed by both parties to it.

Appliances for measuring and delivering water. To be simple. 5. The appliances for measuring and delivering the water to the land and for gauging the surplus should be of the simplest description, consistent with accuracy, and those used at Trichinopoly seem to be best suited to the comprehension of the people who have to work them.

One or more cisterns to be built. Size of cistern. Cisterns of brick in chunam plastered should be built in convenient situations, one for each plot. A convenient size for plots three-fourths of an acre in extent would be 12 feet in length by 6 feet in width by 4 feet in depth interior dimensions, which would contain 288 cubic feet, and would maintain the supply for that quantity of land during the season of preparation and ploughing with ease if filled by means of two or at most three picottahs. Proper apertures should be made in the lower part of the cisterns fitted with shutters free from leakage. A small cast-iron frame and shutter, planed and grooved, for an aperture 6″ × 4″ may be indented for from the Public Works Stores. A gauge should be placed in each cistern and the cubic contents at each inch should be tabulated.

6. Officers are not restricted from filling the cisterns by causing water to gravitate into them so long as it is properly under control and can be kept from leaking on to the land under experiment, but usually it will not be possible to obtain sufficient command of the cistern to do this as the latter must in its turn completely command the ground it is intended to irrigate.

7. Each plot should have attached to it a small weir with the crest 3 inches or 4 above the general level of the bed, and provided with wings into which should be fitted a plank. This will be used for the purpose of letting off surplus water. It will be gauged by observing the depth above the crest of the weir before removing the plank and recording it again when it is closed. The area of the plot being known, the cubical contents of the water so passed off can of course be readily ascertained. Care must be taken to prevent leakage at the weir by puddling round the plank.

8. The area of the land for experimental cultivation should not exceed 3 acres, nor should it be less than one and-a-half acres. A larger extent than the maximum indicated becomes unnecessarily expensive to cultivate. Accuracy in gauging the water-supply is more difficult, and the operations are altogether less manageable. Too small an acreage, on the other hand, could hardly be relied on.

The land selected should be divided into three, four, or even five plots. With the maximum area the latter number would be preferable.

9. Every effort should be made to ensure uniformity in the manner of cultivation of all the plots. And from season to season they should be ploughed to the same depth and an equal number of times; and if manure is used it should be of the same kind and in the same quantity to each.

Every effort required to ensure uniformity in manner of cultivation.

10. The question of the maximum and minimum to be adopted for the water-supply requires some consideration. It is very obvious that the degree of retentiveness of the soil exercises much influence in the matter, and this is not surprising when it is considered what great variation there is in this respect. Apparently no general rule which leaves out of account this element would work satisfactorily. If three classes of soil are adopted under the heads of "retentive," "medium," and "porous," they will probably suffice for practical purposes. Under the first would be placed the stiff clays and black cotton soils, under the last the light loams and soils containing a large proportion of sand, and between the two would come those of an intermediate character. The maximum and minimum water-supply for each class should be as follows:—

Maximum and minimum supply of water adopted.

Affected by retentiveness of soil.

This element must be taken into account.

Classification of soil.

Distribution of soils to classes.

	C. Yds. per Acre per Hour. Maximum.	Minimum.
Retentive soils	3	1½
Medium ,, ...	3½	2
Porous ,, ...	4	2½

Maximum and minimum for each class of soil.

This supply should include the rainfall, and arrangements should be made for a reduction of the artificial supply from the cistern when it is or has been supplemented by rain, so as to make the average correspond with the scale given above. The variation from maximum should be evenly distributed over the number of plots.

This supply includes rainfall.

Artificial supply to be regulated accordingly.

11. The amount of daily evaporation should be recorded by means of the apparatus used in the Trichinopoly experiments, and first adopted by Captain C. J. Smith, R.E.

Daily evaporation to be recorded.

It is described as follows:—

An iron tub or pan, well tarred within and without, is placed in the paddy-field in which the experiment is being conducted. Earth should be piled up round the tub to its top or rim, which should be about 10 inches above the level of the paddy-field. The tub may be 10 inches deep. Five inches of earth from the paddy-field should be placed in the tub and 4 inches of water. To indicate the amount of evaporation a float should be used; this should be attached to the shorter arm of a lever by means of a hook; the fulcrum on which the lever moves should be on the side of the pan, and the longer arm, which would terminate in a point, would move over an index marked to 10ths of inches on a post fixed in the ground. The shorter arm of the lever may be one-fifth or one-tenth of the longer arm. The index should be so marked that on the shorter arm of the lever being attached to the float, when the water in the pan is about an inch below the rim, the longer arm will point to zero on the index.

When rain is expected, the evaporation should be registered before it sets in. After light showers, in which the depth of rain is less than the evaporation during the day, it may be registered correctly by adding to the evaporation indicated the depth of rainfall recorded by the adjacent rain gauge. If the rainfall is greater than the daily evaporation, the arm will travel in a reverse direction and will give a minus reading. In this case the difference between the rainfall by gauge and the reading on the index will be the evaporation.

12. The rainfall should be measured daily by a rain gauge in the ordinary manner. The gauge should be placed where the experiment is being carried out or as near to the spot as may be practicable.

Rainfall to be gauged.

13. The temperature in the shade should be recorded twice daily at any office within a reasonable distance, viz., at 6 A.M. and 3 P.M. and the mean given in the register.

Temperature to be recorded twice daily.

14. The seed grain should be of the best quality and of the kind used for the main crop. It should be well mixed if it consists of more than one sample and sown in a seed bed distinct from the selected plots, but equally under the control of the officer in charge and under command of the cistern. The gauging of the supply and the surplus water should be carried out as in the case of the plots and the plants should be transplanted out in the usual

Seed grain to be of the best quality.

To be mixed to ensure uniformity.

Seed to be sown in a seed bed.

Supply to be gauged and also surplus.

Seedling to be transplanted.

manner and as far as practicable in equal proportions. The quantity and weight of the seed should be stated.

15. The crop should be harvested under close supervision, and every portion should be thrashed out, weighed and measured on the day on which it is cut. A thrashing floor should be constructed on the ground.

Harvesting of crop to be under close supervision.

The weight of the grain and straw are to be given in lbs. avoirdupois, and the contents of the grain in Madras measures of 100 cubic inches. The accuracy of the weights and measures should be ascertained before use. That of the measure can be checked by weighing it empty and then full of rain-water. The weight of 100 cubic inches of rain-water being known gives the data whence to determine the cubical contents of the measure.

The standard to be lbs. avoirdupois and Madras measures of 100 cubic inches.

Weights and measures to be checked before use.

A hut should be built abutting on the fields under cultivation, and it should be provided with a door and lock. It should be used as an office and place of shelter for the goomastah in charge of the ground, and as a store in which to place all articles used or likely to be used in the course of the experiments.

Hut required for Overseer.

Use as a store.

16. The forms appended provide for the insertion of all the particulars required to be known. Forms A and B for field use are for the daily entry, without reduction or calculation, of the observations made on the ground. Form C is a register of the same particulars after calculation and reduction to cubic yards of rainfall and evaporation and of all quantities to the unit of an acre. Form D is a summary of the water-supply at three different periods, and Form E is a general summary of the water-supply to and produce from each plot with statements of manure and seed used.

Forms to be used.

Description of Field Registers A and B.

Office Register Form C.

Summaries Forms D and E.

It will be observed that the summation of quantities is provided for at three periods, and it is essential that it should be carried out. The periods are—

Summation of results at three periods required.

Period of seed bed cultivation.

Period of preparation of land.

Period of irrigation of crop.

Definition of periods.

1st.—During the cultivation of the seed bed.

2nd.—The preparation of the land for planting.

3rd.—The irrigation of the growing crop.

The first terminates when the seedlings are transplanted, the second commences when the land for the crop is first ploughed and terminates when transplanting commences and the third commences when the second terminates, and ends when the water is run off and the ground allowed to dry prior to harvesting.

Form A is applicable to the seed bed cultivation only, and comprises the first period. In Field Form B and in the Office Register C the entries in each column should be totalled at the end of the second period, and the entries recommenced anew.

Form A for seed cultivation only.

Results in Forms B and C to be totalled twice.

It is desirable to exclude from the total of the "days under irrigation" the period during which water was supplied to the seed bed only, and in like manner to cut off from the "total water-supply" the water given to the seed bed, as they tend to falsify the general result to be ascertained of the average daily supply per acre per hour to the general crop. Therefore in the summary D provision is made for the separate exhibition of these quantities. A table for the reduction of inches and decimals of rain and evaporation to the equivalent in cubic yards per acre is attached to the forms.

Seed bed period and water-supply to be excluded from general summary.

Result required to be ascertained.

With the above explanations it is believed that no difficulty will be found in using the forms.

In conclusion, it cannot be too forcibly impressed on the officers in charge of these experiments that want of care and exactitude in carrying out the details renders the results worse than useless, inasmuch as they are then calculated to mislead, and the attainment of the knowledge sought is then almost impossible.

Concluding remark.

Necessity for rigid accuracy in observation.

(Signed) A. DEC. SCOTT, Major, R.E.,
for Chief Engineer for Irrigation.

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FORM A.

FIELD REGISTER.

Experimental Rice Cultivation in the *Range,* *District.*

Irrigation to seed bed. Area ..... Acres.

Name of Officer in charge.

Date of commencing irrigation.

„ of concluding „

Month.	Day of month.	Water-supply. From Cistern.	Water-supply. Rainfall.	Surplus run off.	Evaporation.	Thermometer.	Remarks and Diary of Cultivation.
		Cubic yds.	Cubic yds.	Inches.	Inches.		
Totals ...							

Signature of observer. Date.

Signature of Officer in charge. Date.

NOTE.—The column of remarks should contain a diary of the cultivation carried on and any accidents or occurrences affecting the crop.

FORM B.

FIELD REGISTER. *Range* *District, A.D.*

Experimental Rice Cultivation in the

Name of Officer in charge of experiment.

Month.	Day of Month.	Plot No. 1. Area. Acres. Water-supply. From Cistern, Cubic yards.	Plot No. 1. Area. Acres. Water-supply. Rainfall, Inches.	Plot No. 1. Area. Acres. Surplus run off, Inches.	Plot No. 2. Area. Acres. Water-supply. Cubic yards.	Plot No. 2. Area. Acres. Water-supply. Rainfall, Inches.	Plot No. 2. Area. Acres. Surplus run off, Inches.	Plot No. 3. Area. Acres. Water-supply. Cubic yards.	Plot No. 3. Area. Acres. Water-supply. Rainfall, Inches.	Plot No. 3. Area. Acres. Surplus run off, Inches.	Plot No. 4. Area. Acres. Water-supply. Cubic yards.	Plot No. 4. Area. Acres. Water-supply. Rainfall, Inches.	Plot No. 4. Area. Acres. Surplus run off, Inches.	Evaporation, Inches.	Thermometer.	Remarks and Diary of Cultivation.
		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

Preparation of land for planting.

Form C.

(Office Reduced Register.)

Experimental Rice Cultivation in the _____ *Range* _____ *District, A.D.* 187 .

Month.	Day of Month.	Plot No. 1. Area, Acre. Water-supply per Acre. Artificial.	Rainfall.	Total.	Surplus run off.	Net supply.	Average supply per Acre per Hour.	Plot No. 2. Area, Acre. Water-supply per Acre. Artificial.	Rainfall.	Total.	Surplus run off.	Net supply.	Average supply per Acre per Hour.	Plot No. 3. Area, Acre. Water-supply per Acre. Artificial.	Rainfall.	Total.	Surplus run off.	Net supply.	Average supply per Acre per Hour.	Plot No. 4. Area, Acre. Water-supply per Acre. Artificial.	Rainfall.	Total.	Surplus run off.	Net supply.	Average supply per Acre per Hour.	Evaporation per Acre.	Thermometer.	Remarks.
		C. Y.	C. Y.	C. Y.	C. Y.	C. Y.	C. Y.	C. Y.	C. Y.	C. Y.	C. Y.	C. Y.	C. Y.	C. Y.	C. Y.	C. Y.	C. Y.	C. Y.	C. Y.	C. Y.	C. Y.	C. Y.	C. Y.	C. Y.	C. Y.	C. Y.	C. Y.	
		Irrigation of seedlings, Days.																										The quantities are reduced (from the field register to the proportion required for seedlings for one acre of ground.

District Engineer.

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Form D.

Summary.

Experimental Rice Cultivation in the _____ *Range,* _____ *District, A.D.*

Phase of Cultivation.	Plot No. 1. Period of Irrigation.	Water-supply per Acre. Artificial.	Rainfall.	Total.	Surplus.	Net supply.	Average supply per Acre per Hour.	Plot No. 2. Period of Irrigation.	Water-supply per Acre. Artificial.	Rainfall.	Total.	Surplus.	Net supply.	Average supply per Acre per Hour.	Plot No. 3. Period of Irrigation.	Water-supply per Acre. Artificial.	Rainfall.	Total.	Surplus.	Net supply.	Average supply per Acre per Hour.	Plot No. 4. Period of Irrigation.	Water-supply per Acre. Artificial.	Rainfall.	Total.	Surplus.	Net supply.	Average supply per Acre per Hour.	Evaporation.	Mean Temperature.	Remarks.
	DAYS.	C. Y.	C. Y.	C. Y.	C. Y.	C. Y.	C. Y.	DAYS.	C. Y.	C. Y.	C. Y.	C. Y.	C. Y.	C. Y.	DAYS.	C. Y.	C. Y.	C. Y.	C. Y.	C. Y.	C. Y.	DAYS.	C. Y.	C. Y.	C. Y.	C. Y.	C. Y.	C. Y.	C. Y.	C. Y.	
Preparation of land for crop																														
Irrigation of crop ..																														
Total ..																														General average supply per acre per hour = cub. yds.
Irrigation of seedlings ..																														The quantities are reduced to the proportion per one acre planted out.
General Total ..																														

Signature of District Engineer.

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FORM E.

GENERAL SUMMARY.

Experimental Rice Cultivation in the _____ *Range.* _____ *District, A. D.*

Number of Plot.	* Net Water-supply.		Manure per Acre.	Seed per Acre.	Straw.		Total value of crops.
	Cubic Yards.	Average per Acre per Hour.	lbs.	lbs.	Weight in lbs.	Value	Rs. A. P.
No. 1.							
No. 2.							
No. 3.							
No. 4.							

* The quantities are exclusive of those applied to the seedlings.

Signature of District Engineer.

Date

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Table for the Reduction of Rainfall and Evaporation measured in Inches to the equivalents in Cubic Yards per Acre.

A.		B.		C.	
Depth, Inches.	Per acre, Cubic yards.	Depth, Inches.	Per acre, Cubic yards.	Depth, Inches.	Per acre, Cubic yards.
1	134·44	0·1	13·41	0·01	1·34
2	268·88	0·2	26·89	0·02	2·69
3	403·32	0·3	40·33	0·03	4·03
4	537·76	0·4	53·78	0·04	5·38
5	672·20	0·5	67·22	0·05	6·72
6	806·64	0·6	80·67	0·06	8·07
7	941·08	0·7	94·11	0·07	9·41
8	1,075·52	0·8	107·5	0·08	10·75
9	1,209·96	0·9	121·00	0·09	12·10
10	1,344·40	..	..	..	..

The equivalent for the inches to be taken out under A.
Do. for tenths do. B.
Do. for hundredths do. C.

The total content will be the sum.

Example.—Required the number of cubic yards per acre equivalent to 3·36 inches of rain—

Under A for 3 inches, cubic yards	...	403·32
Do. B for ·2 inch "	...	26·89
Do. C for ·06 inch "	...	8·07
		438·28

APPENDIX H.

I.—Statement showing the surplus discharges over and through Dowlaishwaram anicut for the ten years ending with 1899–1900.

Months.	1890–91.	1891–92.	1892–93.	1893–94.	1894–95.	1895–96.	1896–97.	1897–98.	1898–99.	1899–1900.	Average.
1	2	3	4	5	6	7	8	9	10	11	12
	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.
April ..	..	..	..	25,227	..	..	..	..	..	191	191
May ..	..	..	..	3,810	..	..	..	..	..	..	381
June ..	1,79,585	..	76,297	3,27,824	73,721	2,05,711	1,33,365	15,202	1,20,023	19,573	1,15,130
July ..	12,06,208	4,27,499	5,64,197	4,88,072	9,16,180	5,80,599	5,89,031	2,08,229	8,79,102	15,543	5,88,536
August ..	16,23,640	10,22,308	11,33,426	14,04,497	9,68,493	16,07,980	20,01,884	11,96,002	8,63,361	1,23,856	11,94,735
September	10,46,678	15,27,640	17,70,133	19,49,705	14,52,542	8,71,557	4,90,295	12,02,418	6,65,304	1,79,458	11,15,573
October ..	4,36,263	9,08,986	3,87,800	7,73,784	4,82,618	2,77,303	25,600	5,66,059	1,38,696	2,034	3,96,916
November	69,408	..	1,85,168	2,69,000	2,25,592	40,394	..	91,835	30,883	..	90,828
December	2,763	..	5,368	26,912	..	..	..	3,154	5,959	..	4,414
January ..	..	..	..	..	..	..	..	..	167	..	17
February ..	..	..	..	..	..	..	..	..	..	..	..
March ..	..	..	3,47,086	..	..	..	..	..	..	..	34,709
Total ..	45,58,135	38,96,433	44,69,475	52,68,831	41,19,146	35,83,544	32,40,175	32,82,899	27,03,495	3,40,464	35,12,262

II.—Statement showing the surplus discharges in the Kistna over the Bezwada anicut for the ten years ending with 1899–1900.

Months.	1890–91.	1891–92.	1892–93.	1893–94.	1894–95.	1895–96.	1896–97.	1897–98.	1898–99.	1899–1900.	Average.
1	2	3	4	5	6	7	8	9	10	11	12
	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.
April ..	3,353	8,028	7,265	14,312	8,885	7,313	2,617	..	13	9,607	6,129
May ..	1,63,772	5,451	4,117	11,161	11,027	9,893	430	2,317	8,289	12,085	8,216
June ..	1,08,991	23,458	2,60,659	6,77,048	1,60,310	10,153	2,03,202	1,61,235	1,75,909	89,370	1,86,025
July ..	13,17,085	4,97,454	11,53,057	7,17,104	13,88,849	5,07,568	6,44,676	4,62,838	5,41,269	2,45,679	7,47,557
August ..	14,91,193	12,51,962	9,97,150	10,87,095	6,97,068	8,27,071	12,91,895	8,90,833	5,67,697	1,02,553	9,70,460
September	3,94,390	4,04,946	16,60,181	8,83,690	5,04,800	7,75,439	1,20,641	4,88,659	4,38,213	2,92,722	5,91,369
October ..	2,17,773	2,95,087	7,17,185	7,37,318	2,62,518	4,16,014	42,181	4,39,643	3,33,480	16,622	3,50,882
November	1,18,034	15,166	6,43,955	1 24,146	1,67,254	1,09,188	16,903	28,051	69,465	117	1,29,141
December	29,896	..	42,401	21,748	22,760	18,080	21,422	..	11,772	..	15,909
January ..	..	..	1,85,310	..	1,049	2,282	..	..	1,205	..	15,985
February ..	..	..	1,23,425	..	567	1,215	..	..	..	..	12,524
March ..	7,907	6,356	70,929	..	2,011	6,163	512	512	595	..	9,498
Total ..	36,85,704	25,07,908	58,96,007	42,23,631	32,27,038	26,90,419	25,44,652	24,74,086	21,47,997	7,69,475	29,96,686

III.—Statement showing the surplus discharge for each month over the Nellore anicut for the ten years ending with 1899–1900.

Months.	1890–91.	1891–92.	1892–93.	1893–94.	1894–95.	1895–96.	1896–97.	1897–98.	1898–99.	1899–1900.	Average.
1	2	3	4	5	6	7	8	9	10	11	12
	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.
April ..	..	..	..	..	..	..	..	..	..	191	19·1
May ..	..	..	..	..	..	..	..	..	..	..	..
June ..	..	..	7,594	..	..	..	..	608	572	..	877·4
July ..	..	..	30,790	11,455	6,104	..	..	2,123	..	..	5,047·2
August ..	6,419	1,229	36,856	1,823	25,487	..	3,782	9,706	191	..	8,549·2
September	14,402	..	76,912	4,363	83,293	27,730	953	41,362	30,552	21,065	25,111·2
October ..	21,458	3,002	77,165	39,293	29,842	57,441	..	22,179	12,061	2,968	26,541·0
November	29,417	..	31,106	79,048	61,776	17,006	8,598	..	37,853	7,478	26,328·2
December	381	..	667	4,192	..	..	1,216	..	16,471	..	2,292·7
January ..	..	..	..	Figures	..	11,337	..	..	286	..	1,162·3
February ..	..	..	..	not avail-	..	..	..	..	..	..	..
March ..	..	..	1,153	able.	..	..	..	..	..	..	115·3
Total ..	63,077	4,231	2,62,222	1,40,674	1,56,503	1,13,514	14,549	75,968	97,986	31,692	96,041·6

IV.—Statement showing the total surplus in each month in the Ponniar at Tirukkóyilúr anicut from 1890–91 to 1899–1900.

Months.	1890–91.	1891–92.	1892–93.	1893–94.	1894–95.	1895–96.	1896–97.	1897–98.	1898–99.	1899–1900.	Average.
1	2	3	4	5	6	7	8	9	10	11	12
	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.
April ..	..	..	..	..	..	..	..	..	..	114	11·4
May ..	303	..	..	635	..	189	..	29	..	915	210·1
June ..	958	..	194	931	..	156	19	138	..	..	169·6
July ..	196	..	2,006	1,382	766	..	..	..	..	..	435·0
August ..	1,694	..	3,862	414	3,526	407	..	3,026	..	..	1,291·9
September	2,990	..	511	..	2,855	8,216	3,311	16,539	214	5,701	4,048·6
October ..	2,212	3,584	999	2,473	4,484	14,621	1,217	16,957	4,585	1,110	5,224·7
November	6,701	1,754	..	10,421	4,568	8,453	1,872	109	38,779	..	7,265·7
December	..	246	..	400	55	1,807	4,762	13	13,282	..	2,016·5
January ..	..	..	..	..	..	2,357	Figures	..	839	..	319·6
February ..	224	..	..	..	..	..	not	..	..	..	22·4
March ..	..	..	..	..	..	..	available.	..	..	..	..
Total ..	14,587	5,584	7,562	16,661	16,264	35,706	11,181	36,811	57,799	7,960	21,010·5

V.—STATEMENT showing the total surplus in each month in the Vellar at Shaiatope anicut from 1890-91 to 1899-1900.

Months.	1890-91.	1891-92.	1892-93.	1893-94.	1894-95.	1895-96.	1896-97.	1897-98.	1898-99.	1899-1900.	Average.
1	2	3	4	5	6	7	8	9	10	11	12
	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.
April ..	..	47	..	119	399	23	..	..	..	..	58·8
May ..	346	208	..	1,035	..	106	..	120	91	..	190·6
June ..	799	109	..	786	..	243	128	20	..	..	208·6
July ..	42	..	710	195	..	..	5	..	42	58	105·2
August ..	1,553	..	2,329	961	1,243	3,108	94	1,634	278	..	1,120·8
September	929	579	12	817	851	14,826	5,718	8,054	510	786	3,311·2
October	2,856	6,889	1,906	7,263	842	20,619	3,035	9,337	4,113	1,903	6,456·3
November	8,969	2,464	..	29,263	2,376	14,344	6,708	1,206	33,958	186	10,010·1
December	..	1,089	..	8,733	619	14,759	16,598	3	976	596	4,340·8
January	..	5	..	..	..	5,809	8,058	..	1,265	..	1,613·7
February *	449	..	634	133	..	67	67	..	..	..	125·0
March ..	..	..	1,243	..	..	1,663	1,668	..	..	..	456·9
Total ..	16,043	11,390	6,731	49,308	6,436	84,797	42,072	20,404	41,263	3,528	27,897·4

VI.—STATEMENT showing the surplus discharge for each month over the Srívaikuntam anicut for the ten years ending with 1899-1900.

Months.	1890-91.	1891-92.	1892-93.	1893-94.	1894-95.	1895-96.	1896-97.	1897-98.	1898-99.	1899-1900.	Average.
1	2	3	4	5	6	7	8	9	10	11	12
	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.
April ..	810	186	1,210	..	156	..	..	477	..	1,344	420·3
May ..	1,272	825	708	1,070	144	59	62	288	247	403	458·8
June ..	..	315	92	71	2	350	1,157	5,592	79	194	791·2
July ..	..	1,758	55	..	..	..	6,380	1,625	258	2,113	1,110·9
August ..	..	..	..	98	..	..	2,864	2,462	..	..	541·4
September	..	..	..	..	..	..	..	181	..	..	18·1
October ..	3,405	15,690	152	258	..	4,432	921	74	4,543	1,027	3,019·3
November	2,471	21,977	..	10,558	3,946	2,930	23,916	1,344	10,460	1,247	7,884·9
December	1,918	12,734	202	1,466	4,357	4,773	28,949	655	35,440	3,780	15,425·7
January	..	2,280	..	Figures not available	..	16,159	1,696	5,224	6,853	..	3,223·3
February	8,692	..	..		..	..	2,177	689	2,841	..	1,439·9
March ..	..	..	138		..	..	..	..	..	..	13·8
Total ..	18,598	55,275	2,558	13,521	8,675	38,750	67,166	18,621	60,721	10,111	34,383·6

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NOTE ON THE TUNGABHADRA SCHEME.

The waters of the Tungabhadra are tapped by eight minor anicuts in Bellary district, but they only command a very small area of land. This is owing to the fact that the slope of the country towards the river is very rapid, while the fall of the river itself is small except in a few places. It is, therefore, impossible to get far away from the river. Below this are the head works of the Kurnool-Cuddapah canal at Sunkesala. The accompanying statement shows that during five months of the year a considerable quantity of water passes over the anicut and as at that time water is also passing over the Bezwada anicut there is no objection to its being used if possible.

2. Proposals for extending cultivation under the Tungabhadra have for a long time been discussed.

When the Madras Irrigation and Canal Company was inaugurated the projects in view consisted of (1) a Bellary section, (2) the Kurnool-Cuddapah canal, and extension to Somaiswaram, (3) a Nellore section, (4) of supplementary reservoirs, chiefly in Mysore. Of these the Kurnool-Cuddapah canal alone was completed, and the results of that portion gave no encouragement for the prosecution of the rest. But the ravages of famine in the Bellary district could not but constantly revive the hope that a large irrigation scheme depending on the water of the Tungabhadra might yet, if not directly a pecuniary success, nevertheless bring in sufficient financial returns to prevent its being absolutely ruinous and to warrant its construction as a protection against famine, with the resultant mortality, suffering and expense. Consequently schemes for an upper and lower Bellary project, in forms extensively modified from time to time, have been under the consideration of Government for many years.

Vincent's monograph, paragraph 85, *et seq.*

The upper Bellary project (*a*) high level line, consisted in taking off a canal from the Tungabhadra at Valvapur to irrigate 150,000 acres and at a sufficiently high level to supply Bellary town and cantonment with water. The length of this line was 66¾ miles to Bellary and thence 56 miles to the river Hagari. The supply through the head sluice was to be 2,250 cubic feet a second and the estimated cost Rs. 1,43,88,000, with a net return of Rs. 3,74,500, or 3·26 per cent. on *direct* charges, or 2·6 per cent. including maintenance and collection.

G.O., No. 1756 of 22nd March 1869.

The line taken by this canal would have involved very heavy cuttings as well as a considerable amount of tunnelling through rock, and the Government of Madras expressed an opinion unfavourable to its execution.

There was also the difficulty that very little water is, in years of deficient rainfall, available for the Bellary district except during the flood season. The demands of the Kistna delta render impossible the supply for any further irrigation on a large scale from the Tungabhadra, unless by storage of flood water.

The above facts led to the consideration of another scheme, viz., the upper Bellary project (*b*) low level line. This consisted in taking a canal from the Tungabhadra at Hosúr, which is 9 miles in distance and 60 feet in level below Valvapur, to carry 3,187 cubic feet per second and irrigate 212,500 acres. This canal would have passed about two miles from Bellary and considerably below it, affording therefore no supply to the station. The length to the first proposed terminus 2 miles from Bellary would have been 75 miles, the extension to the river Hagari involving an increase in length of 20 miles. The estimated cost was Rs. 1,65,24,640, with a return of Rs. 5,66,700, or 4·07 per cent. on direct charges, or 3·4 per cent. including maintenance and collection.

Vincent's monograph.

The same objection as regards water-supply applies to this as to the high level project, and though there was not so much heavy cutting some very long retaining walls would have had to be built.

P.M.G., No. 210 of 28th December 1876.

Altogether it was considered that both the high and low level schemes for a canal from the Tungabhadra in the Bellary district were very unpromising whether cost, result of outlay, or probability of successful irrigation were considered.

Projects for lower Bellary were merely extensions of either the abovementioned high or low level lines and shared their disabilities.

The subject was revived from time to time, and in 1885 Mr. C. Norfor, who had been deputed to examine a project for the supply of drinking-water to Bellary station, submitted a "Preliminary Report" in which he advocated the investigation of the "Upper Bellary project" on a greatly reduced scale, which with certain remarks he was instructed to do. In 1886 the result was submitted. The then Chief Engineer for Irrigation considered that further investigation of short duration was necessary.

In 1889 Mr. A. S. Russell was deputed for further investigation and in that year submitted a "Preliminary Report" from which it was evident that it would take a long time to carry out all the investigations that he understood Government intended.

G.O., No. 521 I. of 29th October 1889.

The then Chief Engineer for Irrigation, Mr. G. T. Walch, thereupon made a personal inspection and reported to Government that, irrespective even of the sufficiency of supply from the river in bad years, the scheme was one on which it was inadvisable to spend more money in any way. His reasons were that for 18 miles out of 35, the canal would have to be taken along the slopes of rugged rocky hills such as form the distinctive feature of the Bellary district, over and through fields of boulders lying on shattered gneiss where no soil is available for banks and where the water must be retained by miles of continuous walling; and across ridges by cuttings of great depth and through hills by tunnels some three miles in length. The cost of overcoming these difficulties he considered it impossible to forecast, because not only would much of the work be of an unusual character but because it seemed likely that along the hill slopes, in the cuttings, and in the tunnels, the water would escape through the fissures and faults of the shattered gneiss, and thus necessitate lining the whole canal with water-tight masonry or cement. As the result of such expenditure, not less than Rs. 50,00,000, the most that would be possible would be the irrigation of 50,000 acres during 6 or 7 months of the year, but it was extremely doubtful whether the land would be taken up for wet cultivation, the soil, the climatic conditions, the nature of the crops which find favour with the people, and the people themselves, being similar to those in the Kundar valley through which the Kurnool canal carries its volume of water almost unused.

These views Government accepted.

G.O., No. 521 I. of 29th October 1889.

Mr. O'Connell reported in December 1897 and February 1898, but his investigation so far as it extended, disclosed no new facts of importance material to the question, on which Government observed that the subject must not be dropped, since there was a vast quantity of water in the Tungabhadra running to waste which it was the duty of Government to utilise, if possible, in the interests of a district specially liable to famine. The investigation was therefore to be resumed without being confined to any particular site or channel.

G.O., No. 222 I. of 8th March 1899.

Colonel Baddeley submitted a report with a note by Mr. H. E. Clerk on 5th November 1898.

These officers reported on three possible reservoir schemes on the Tungabhadra, (1) a reservoir within 12 miles of Hospet to irrigate Bellary and Alúr taluks, (2) a reservoir somewhere west or south-west of Hadagaly to irrigate Hadagaly and Hospet

taluks, (3) a reservoir at the best site on the river, from which water might be passed down and taken off by anicuts where most required. In regard to (1) and (2) they examined sites at Mallapur and Vallabhapur. The Mallapur site they described as good but with doubtful foundations and 34 villages (of which 16 in the Nizam's territory) and a not inconsiderable quantity of irrigated land would be submerged, while at Vallabhapur also 31 villages (of which 19 in the Nizam's territory) would be submerged, so that irrespective of the serious objections to the destruction of so many village-sites and the opposition of the Nizam, the compensation in both cases would be enormous.

After again urging the cost and difficulty of the passage through the Daróji hills, Colonel Baddeley insisted on the unlikelihood of utilising the water, in which his personal experience coincided with the views of all the Revenue and Public Works officers who were familiar with the subject.

He further reported that between Bellahunsi and Hampaságaram there were sites nearly as good as Vallabhapur, but the fall of the river above Vallabhapur being slight no gain in command would be obtained and the Daróji hills would still have to be traversed and by a longer channel; while from Hampaságaram to Honnur the country was flat and there were no sites for a reservoir. At Honnur he considered that the schist and indurated clays forming the river-bed were unsuitable for the foundation of a dam. Above Honnur there were no reservoir sites.

With reference to the third alternative—of forming a reservoir and using the water where required from place to place along the river—he pointed out that the main utilisation would be near Cuddapah and in the Kistna delta, which were not in question.

He recommended in preference small reservoirs on tributaries, as numerous and widely scattered as possible, so as to have the largest possible catchments, the least possible submergence of villages and cultivated land, with greater facilities for the spread of irrigation in small areas; and he instanced sites at Hagaribommanhalli on the Chinna Hagari and near Honnur across a tributary of the Tungabhadra.

G.O., No. 222 I. of 8th March 1899.

The above report, the Government of Madras still considered, did not settle the matter, and directed the further examination of sites at Honnur, where the river passes through the Sandúr hills, and at Valvapur, and the preparation, if either were found suitable, of a detailed estimate for a reservoir. If both were found unsuitable a site was to be sought for on one of the tributaries of the Tungabhadra in Mysore. If a suitable site was found, an estimate was to be prepared in detail for a channel to irrigate 50,000 acres in Bellary east of the Daróji hills and as much land as it could command west of the Daróji hills.

In accordance with this Government Order, Colonel Baddeley once again reported that the only proper site for a reservoir was at Valvapur; since at Mallapur 39′ of command would be lost, and at Honnur the foundations were bad and the channel would be much longer, that the channel would, as previously described, be enormously difficult and would cost from 44 to 50 lakhs of rupees; that no appreciable area was irrigable west of the Daróji hills; that a dam at Valvapur to store 18,000 millions cubic feet would be $4\frac{5}{8}$ miles long and would cost from 84 to $100\frac{1}{2}$ lakhs of rupees; that a sum of quite 19 lakhs would be needed for compensation; that the minimum cost would therefore be 147 lakhs with a maximum gross return of $2\frac{1}{2}$ lakhs; and that even such small return was, he believed, quite illusory.

It only remains to summarise the information available regarding reservoirs on the tributaries of the Tungabhadra. While the Kurnool-Cuddapah canal was being constructed and the happy anticipation, that the Ceded districts could be converted into a large scale repetition of the great deltas, still existed, enquiries and surveys were made on a considerable scale concerning five sites for reservoirs on tributaries of the Tungabhadra out of 21 suggested. These five sites were—

Vincent's monograph.

(1) Maddak-Massur on the Choardy.
(2) Mudaba on the Tunga.
(3) Lakvalli on the Bhadra.
(4) Mari on the Hagari.
(5) Bajoli on the Tunga.

The fifth was soon rejected, as it was close to the second, which was superior. The fourth was also abandoned after long correspondence, as the other three were more favourable.

No. (1) site, with a drainage area of 500 square miles, was estimated to be capable of storing 37,800 millions of cubic feet with a waterspread of 40 square miles at a cost of 12 lakhs, or of storing 17,388 millions cubic feet with a waterspread of 24 square miles at a cost of 6¾ lakhs. The compensation in the latter case as assessed by the Mysore authorities was taken at 4·7 lakhs, but this was considered far too low, since the site included the bed of an abandoned native reservoir which had all been occupied.

No. (2) site, with a drainage area of 760 square miles, was estimated to be capable of storing 128,250 millions of cubic feet, with a waterspread of 13 square miles submerging many villages, depth of water 162 feet, length of surplus 1,523 feet with 6 feet overflow, this length not being obtainable; total cost 65 lakhs. This project was not considered feasible, as further the compensation demanded was 70·35 lakhs.

No. (3) site was considered best, the area of occupied land being small and the engineering difficulties much less. The drainage area was 760 square miles, and it was estimated that a reservoir of 31,075 millions cubic feet capacity could be constructed for 31¼ lakhs, or including establishment about 50 lakhs, *plus* a compensation estimate of 40·84 lakhs.*

* This history of the project is taken from a note compiled by the Assistant Chief Engineer for Irrigation.

3. It will be seen from the above that any extension of Tungabhadra irrigation must depend on storage and it has first to be decided on how the water is to be utilised. The original idea was to irrigate the Bellary taluk and this has first to be considered. A reservoir and channel for this purpose has been estimated by Colonel Baddeley to cost about Rs, 1,50,00,000 † while the prospects of the water being utilised in ordinary years are almost *nil*. The following are the reasons why irrigation would fail here:—

† I believe this to be a low estimate and that Rs. 2,50,00,000 would be required.

(1) The soil is stated to be unsuited to wet cultivation.

(2) The people of the country do not care for it and immigration is unlikely.

(3) Wet cultivation would not pay as long as there is no pressure of population on the soil.

(4) It would not improbably render the country unhealthy. The Commission will doubtless obtain further evidence on this point which I regard as a revenue and an agricultural rather than an engineering one and I will pass on to other means of utilising the water.

4. It is exceedingly difficult to make a forecast of what would happen if this project were carried out. I believe, however, that the result would be something of this sort—

	Lakhs of rupees.
Expenditure.	
Capital cost	200
Annual maintenance	2
Returns.	
10,000 acres permanent wet at Rs. 6	0·6
Once in five years $\frac{3,00,000 \times 2}{5}$	1·2
Total	1·8

The project would not, therefore, pay its working expenses. It would enable crops to be grown in times of scarcity and would in a large measure (but not entirely) protect the Bellary taluk and a portion of Rayadrug.

5. There are two places where the surplus water of the Tungabhadra could be conveniently utilised—

(1) In extending irrigation in the Kistna.

(2) In irrigating fresh tract of Nellore and possibly also a small area in Cuddapah.

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6. As regards the supply to the Kistna, the best way to extend cultivation there would be the construction of the Kistna reservoir, regarding which Mr. Reid has submitted a note. In the event of its being considered that that reservoir is impracticable, I consider the best place to utilise any waters stored on the Tungabhadra would be in the Kistna district. Assuming the Kistna reservoir scheme to be accepted, we have to look to Nellore as the destination of any storage. It will be seen that the Kali, a tributary of the Pennér, rises close to the water-shed of the Tungabhadra in the Nandikotkur taluk and that the problem is how most economically to turn the waters of the Tungabhadra into that basin. The Kurnool canal already passes through the water-shed by a shallow cutting at the 75th mile, and is an obvious means of attaining the desired end. There are, however, difficulties in the way. In the first place, the canal is carried on a contour through difficult country and is 75 miles long when the cutting is reached. The banks and the soil on which the banks are founded are very porous so that there is an immense loss in percolation. From the 54th to 60th miles the canal passes through the Pagadiala and Tangedantza tanks, where the banks, although not very high, are continually giving trouble. There is a great deal of percolation here which leaves the ground in rear in a most dangerous condition. Much has been done by draining, but the soil is of so treacherous a nature that I do not think that the local officers would recommend any considerable raising of water level in the tanks.

The bed-fall of the canal in the first 75 miles is very slight, especially in the latter end of it; *e.g.*, in the 65th and 66th miles it is only ·17 feet per mile. It would therefore be necessary to enlarge the canal very greatly if it were proposed to send down any large quantity of water.

7. There are two different ways in which storage can be effected—

(1) by the construction of a reservoir above the canal and passing down only so much of water as would be required for direct irrigation, and

(2) by largely increasing the capacity of the canal and passing down large quantities when available to be stored in Nellore. The latter method would, if practicable, be the best way of disposing of the question. There are numerous tanks in Nellore which can be commanded by a channel taken from an anicut at Somesila. This is the point chosen by the Irrigation Canal Company for their anicut and partially-sunk square wells of brick work are still in evidence at the site. A channel on the right bank taken about 20 feet above the deep bed of the river would run for about 30 miles in the basin of the Pennér, and from it all the tanks between it and the river as far as the Nellore tank could be commanded. The ridge into the Kandleru basin could be crossed close to Yetur tank and from thence the channel could be taken to command a large area of fertile land now cultivated with paddy.

Unfortunately there are not many large tanks. The united capacity of the existing tanks commanded as far as the Upputeru river is only a little over 2,000 millions cubic feet. This, however, could probably be doubled and an additional 4,000 millions cubic feet given by forming new tanks, making a storage of 8,000 millions cubic feet * or enough for 40,000 acres.

* Since writing the above I have received a report saying that good sites for reservoirs can be found on the Kandleru and Pinneru. The amount of storage capacity abovementioned is, therefore, probably understated.

8. In view of the fact that the opportunities for storing water in Nellore district are not so good as one could wish, it is worth considering whether the construction of a reservoir at Somesila would not be feasible. Some preliminary investigation of this scheme has already been made. The site, except so far as foundations are concerned, is a very suitable one. The river passes through a gorge, 1,200 feet in width, and a dam 60 feet above the deep bed of the river would hold up 10,000 millions cubic feet. This reservoir would fill several times in the course of the year and with the existing tanks it would be possible to irrigate at least 100,000 acres.

The principal difficulty would be with the foundations for the dam. Borings have been taken and show that hard rock is met at from 25′ to 30′ below the river-bed. The rock which forms the chain of hills here is quartzite and it is probable that the surface layers are much fissured. It is likely, however, that at a depth of 40 feet

sound foundations could be formed. The surplus and the water required for irrigation lower down would be passed through vents in the dam. Such a work would be expensive, but if feasible would solve the question of storage in Nellore.

9. A reservoir at this site would have at its disposal practically all the surplus water of the Pennér, but as will be seen from the table of surplus discharges at page 173 of my report there is no certainty of water from the Pennér itself being available for storage until September and in some years such as 1891-92 the supply would fail. An earlier supply could be given from the Kurnool canal. This could be done on a small scale in the following manner :—

The upper reaches of the canal should be improved and strengthened. A contour channel should be made round the Pagadiala and Tangadentza tanks and the reach from the 61st to 75th mile should be widened and deepened sufficiently to enable it to carry 2,500 cusecs. * By this means the discharge of the canal at the 75th mile could be trebled as it can only discharge 800 cusecs at present without heading up the water enough to endanger the tank above it. Of the 2,500 cusecs thus discharged through the Mittakandala cutting I estimate that about 900 would be required for the lands under the canal itself with extensions in Cuddapah. Of the remaining 1,600 cusecs, probably about 1,000 would reach the dam or anicut at Somesila. This supply would be continuous from July to November and would be ample for all requirements in the early part of the year. Later on the reservoir would be replenished by the surplus discharges of its own catchment.

10. Should it be considered that this scheme does not utilise a sufficiently large proportion of the waters of the Tungabhadra, it might be possible to take off a much larger quantity by forming a dam across the river and making a tunnel through the high ridge which separates the Tungabhadra basin from that of the Kunderu. This would virtually amount to making a new head to the Kurnool canal and would do away with the 75 miles of dangerous channel which now exists. Two possible sites have been suggested—

(1) Near the village of Nagatur near the 42nd mile of the canal. From this point a tunnel would be taken in a south-easterly direction and the water would be discharged into the Kunderu, somewhere near the village of Parumanchala.

(2) A dam near Sangamesvaram a little below the confluence of the Kistna and Tungabhadra with a cutting and tunnel somewhere near the present cutting near Mittakandala. No surveys have been taken, but the first of these proposals would probably be cheapest as a much smaller body of water would have to be dealt with, the length of the tunnel being about the same in each case. The work would be very expensive involving a tunnel at least 5 or 6 miles long, and on further investigation may prove impracticable.

11. Three schemes of varying magnitude may therefore be proposed—

I. The improvement of the Kurnool canal to carry 2,500 cusecs. The construction of an anicut at Somesila and the formation of storage tanks in Nellore.

The cost of this may be roughly estimated as follows :—

	Lakhs.
Improvements to Kurnool canal above 54th mile	0·75
Contour channel from 54th to 61st mile	1·25
Deepening and widening from 61st to 75th mile	4·00
Anicut and storage works in Nellore	40·00
Total ...	46·00

The returns to be expected would be—

Increase of cultivation in Cuddapah, 20,000 acres at Rs. 5	1·00
Increase in Nellore, 40,000 acres at Rs. 5	2·00
Total ...	3·00

This would give a return of $6\frac{1}{2}$ per cent.

II. The same improvements to the Kurnool canal, but the construction of a reservoir at Somesila substituted for improvements to the tanks.

The cost of this would be—

	Lakhs.
Improvements to Kurnool canal as above	6·00
Reservoir at Somesila	60·00
Distributaries, etc.	20·00
Total ...	86·00

The returns would be—

20,000 acres in Cuddapah	1·00
100,000 acres in Nellore	5·00
Total ...	6·00

or a little higher yield on the capital outlay than the first scheme. It is, however, quite doubtful whether it would be found possible to construct a reservoir at Somesila.

III. The third form would be the same as the second, with the substitution of a new dam and cutting for the improvements to the Kurnool canal. The cost of such a work is very difficult to guess even roughly. It may be put down approximately as follows :—

	Lakhs.
Dam and tunnel to Kunderu	120
Reservoir in Nellore	60
Distributaries	20
Total ...	200

With this combination, the area irrigated would, practically, only be limited by the demand for water. I do not think it likely to exceed 20,000 acres in Cuddapah and 150,000 acres in Nellore. This would give a return of $8\frac{1}{2}$ lakhs or a little over 4 per cent. on the capital outlay.

12. The above approximations are admittedly very unsatisfactory, but they are enough to show that something may be done to improve cultivation south of the Pennér in Nellore district. It is undoubtedly certain that, if water were provided, it would be readily utilised on all classes of soil. The existing tanks, especially those removed from the coast, received a very precarious supply and for some years past ragi has been the principal crop grown under them. On a recent inspection I found that with the influx of a fair supply of water into the tank, the ragi, which had already been planted, was in many cases being uprooted to make room for rice. I have not the slightest doubt, therefore, of the water being readily utilised if provided.

13. I have not alluded to the possibility of the combination of the Bellary project with the utilisation of the water further down as this point is, I believe, being taken up by the Chief Engineer for Irrigation.

What is first required is a full investigation of the best means of utilising the water which now goes to waste.

H. E. CLERK,
Supg. Engr. on Special Duty.

7th January 1902.

ENCLOSURE.

SURPLUS discharges of the Tungabhadra over Sunkesala anicut for the last ten years.

Months.	1891-92.	1892-93.	1893-94.	1894-95.	1895-96.	1896-97.
1	2	3	4	5	6	7
	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.
April	..	..	267	1,082	1,070	..
May	3,267	4,092	8,801	6,936	5,157	..
June	12,084	31,741	39,857	17,139	31,644	..
July	90,853	175,864	72,589	63,455	77,325	3
August	97,217	139,119	82,661	99,263	105,914	3,243
September	35,082	123,879	56,078	29,352	39,413	46,376
October	40,042	52,671	74,851	36,726	50,271	195,726
November	11,205	15,099	15,552	14,725	17,994	326,676
December	810	7,269	4,515	1,181	3,515	49,147
January	..	3,174	..	..	..	39,243
February	..	..	..	..	..	30,354
March	..	3,179	..	..	..	12,015
Total ..	291,560	554,690	354,879	249,859	333,301	702,788

Months.	1897-98.	1898-99.	1899-1900.	1900-1901.	Average.
	8	9	10	11	12
	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.	MILLS. C. FT.
April	507	112	6,610	200	1,078
May	213	6,312	7,590	6,497	5,047
June	88,339	16,440	14,122	27,661	33,901
July	98,993	114,480	98,121	285,394	107,533
August	217,980	148,745	18,776	272,896	120,581
September	169,237	120,930	110,007	99,084	82,944
October	104,738	136,652	84,266	58,451	77,417
November	22,560	66,707	8,061	19,896	51,997
December	10,198	24,186	..	12,093	11,281
January	416	13,304	..	520	5,666
February	..	910	..	11,016	4,228
March	..	..	..	2,028	1,722
Total ..	713,181	678,778	358,482	795,736	503,395

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NOTE ON UTILIZATION OF TUNGABHADRA SURPLUS (TO BE ATTACHED TO MR. CLERK'S NOTE).

Hitherto the Tungabhadra project has been regarded as a project for irrigation in the Bellary district and has been generally condemned because—

(*a*) The people do not want rice cultivation and will not utilise water for the purpose (instances Dharoji tank and Kurnool-Cuddapah canal). The dry crops which they prefer are cholam, ragi, cumbu and cotton and, under ordinary conditions of rainfall, excellent crops are raised.

(*b*) The engineering difficulties are very great and the cost for overcoming them will be enormous. If the reservoir is located on the Tungabhadra itself, there would be many villages and much land submerged belonging in great part to the Nizam. The bill for compensation would be very great. These are serious objections and they may be accepted as those generally held by all officers whether of the Revenue or Public Works Department.

2. In bad years, however, with a deficient rainfall, the ryots would take the water for saving crops, as instanced by the case of the Kurnool canal, where, in 1876, over 90,000 acres dry were irrigated. The channel taken from Valavapur would command from 500,000 to 600,000 acres of land under dry crop and a reservoir of 30,000 millions cubic feet would be sufficient to irrigate 600,000 acres of such land. The total area cultivated in Bellary in 1900 was 2,150,917 acres. To save one-fourth of this area in a year like 1876 would be an incalculable benefit to the district.

3. The right way, however, is to deal with the surplus of the Tungabhadra as a whole and not piecemeal. If this is done a feasible protective and productive project is possible. The engineering difficulties are great, but they are not insuperable.

Looking at the statements of surplus discharges of the Tungabhadra at the Sunkesala anicut and of the Kistna at Bezwada, we may say that 100,000 millions cubic feet are available for storage from June to October and may be utilized in the districts of Bellary, Anantapur, Cuddapah, Nellore, Kistna and the Nizam's territory. Of this surplus 30,000 millions cubic feet may be reserved for use in the Nizam's Dominions. In the absence of many essential levels and of detailed investigation, it is impossible to more than indicate generally and superficially the possibilities of the case. Of these districts, the only one in which there is any doubt with regard to irrigation is Bellary; in ordinary years it may be assumed that the water will not be used save to a small extent. On the analogy of the Kurnool canal we may take 30,000 acres as likely to be the maximum of rice cultivation in Bellary; in years of deficient rainfall 500,000 acres dry crop may be irrigated.

4. There are three ways in which the general project may be worked out:—

(*a*) A large storage work on the Tungabhadra at Valavapur, which is the best site yet found on that river. If this is condemned for adequate reasons, then storage must be on one or more of the branches. It will be seen from the surplus statement that a reservoir of 30,000 millions cubic feet on the main river will give at least 50,000 to 60,000 millions cubic feet and will be a much more powerful work than any combination of storage works on the branches. The channel would be taken preferably on Gordon's high level above Bellary to the Haggri; it would cross that river (on which there should also be a reservoir, if possible) and then branch into two—one branch passing down the right bank of the Haggri towards Adóni and the other across the

water-shed into the Pennair. The discharge of the main channel at the head may be taken provisionally at 6,000 cusecs, or may have to be increased because of the large inevitable loss by absorption.

(*b*) The upper part or Bellary part may be dealt with separately and the Kurnool canal improved so as to take at least 2,500 cusecs. This is a very poor substitute and is only mentioned as a possible combination. The discharge of the canal should be increased quite independently of these proposals.

(*c*) A reservoir at Vallabapur as in the first case and a high dam at Nagatur below Sunkesala or below at junction of Kistna and Tungabhadra, with cut and possibly tunnel into the Kondair, an affluent of the Pennair. In this case the upper channel for Bellary may be designed to take 3,000 cusecs and the Nagatur channel also 3,000 cusecs.

5. In Nellore irrigation will be taken up eagerly and will only be limited by the area commanded. In the absence again of levels and of detailed investigation it is impossible to say what area is likely to be irrigated. Storage will be required whether on the main Pennair or in the district itself. A 20,000 millions cubic feet reservoir on the Pennair will be filled with Tungabhadra water and with the ordinary supply of the Pennair would be sufficient filling 1½ times for 150,000 acres of rice cultivation; with good distribution the duty should rise to 200,000 acres of rice. (In the case of the Periyár, a storage of 7,000 millions cubic feet is expected to irrigate 100,000 acres.)

6. The importance of passing an adequate supply of water from the Tungabhadra into the Pennair cannot be exaggerated. It will not only bring a large tract in South Nellore under irrigation, but will steady the supply to the Sangam and Nellore channels and perhaps, most important of all, it will release the upper waters of the Pennair and branches for utilisation in Anantapur and Cuddapah. There need be no fear then that reservoirs or anicuts on the branches of the Pennair will infringe lower irrigation rights.

7. With regard to the Bellary part of the project, it may be for the present assumed that in five out of six years the water, save for 30,000 acres of rice, will not be utilised. Can it be utilised elsewhere? Undoubtedly it could either on the Kistna or Nellore for second crop. At the end of the irrigation season, when it would be certainly known that Bellary did not require the water, the reservoir could be emptied at the rate of 4,000 cusecs, of which 2,000 cusecs may be assumed will arrive at Bezwada. A portion could no doubt be utilised advantageously by the channels taking off the Tungabhadra above including the Kurnool canal. The 2,000 cusecs arriving at Bezwada would in the three months at the end of the season be sufficient for 200,000 acres of second crop and would yield a revenue of Rs. 6,00,000. (As suggested by Mr. Lacey, in his answers to the Public Works Department questions, it would be well to give water in the Kistna for dry crop only and not for rice.) On the 500,000 acres dry which may be irrigated in Bellary in a bad year, a charge of Rs. 2 an acre may be imposed. (In the case of the Kurnool canal the charge for irrigating dry crop is Rupee 1 per acre, but is certainly too low a rate for saving crop already on the ground.) A tax of 4 annas an acre as insurance would be certainly justified for years when water is refused. It is suggested that this tax should give the right to one watering at seed time. It is often the case that deficiency of rain at the beginning of the season delays sowing most prejudicially to agricultural operations. To give water for sowing should act as a great encouragement to the regular use of water throughout the season and the gradual extension of the practice of irrigation. On this point Mr. Wedderburn in 1863 (see his report printed with G.O., No. 2773, dated 24th September 1863) said "with a prospect of water agricul-"tural operations might commence at an earlier date than they now do, because the "first ploughing depends at present on rain falling in June and July and it often "fails."

8. Judging from the figures given by Mr. Clerk and from previous partial investigations, the capital cost of all the works required for storing and utilising the Tungabhadra surplus, including minor reservoirs on the branches of the Pennair for use in the districts of Anantapur and Cuddapah, may be taken at 3 millions sterling.

On the revenue side we have

	Rs.
200,000 acres Kistna second crop at Rs. 3 (or say 150,000 in Kistna and 50,000 in Nellore)	6,00,000
30,000 acres (rice) in Bellary at Rs. 4	1,20,000
500,000 acres Bellary insurance at As. 4	1,25,000
In Cuddapah—30,000 acres at Rs. 4	1,20,000
In Anantapur—30,000 acres at Rs. 4	1,20,000
In Nellore *—150,000 acres at Rs. 4	6,00,000
	16,85,000

Loss in Kistna in bad year, say, 400,000.

(It will be noticed from the surplus discharges that water may be stored in October so that after supplying Bellary in a bad year up to October there should be some water left for Kistna, so that loss of second-crop water in Kistna would only be partial.)

Gain in bad year in Bellary 500,000 acres at Rs. 1½, Rs. 8,75,000.

This would give yearly (say)	75,000
Total revenue ...	17,60,000
Deduct for maintenance ...	3,00,000
Net revenue ...	14,60,000

or a little over 3 per cent. on capital cost.

The revenue in Nellore will be greater than shown. There will be some second crop cultivation and as said before a much larger area may be irrigated if commanded. It may be said then under the best conditions that the project will pay from 3 to 3½ per cent. But should it fail to do so and if the percentage were reduced to 2 or even less, would not the project even then be justified? Colonel Hasted in 1883 speaking of the Kurnool canal (see G.O., No. 184 I., dated 28th February 1883) says "in one respect it (the canal) is of greater value than can readily be estimated, that is, as a famine protective work. In the late famine (of 1876–77) the canal irrigated 90,373 acres, which without water would have been barren waste, and this when its use was not known and appreciated. In future times of scarcity it is certain that the people will avail themselves largely of the canal. It runs through districts which are some of those most liable to famine in this part of India and commands a very large tract of country, and when in the unprotected parts of these districts people are dying of starvation by hundreds and thousands who can put a money value on the produce of 500 square miles well watered". This is an aspect of the case which it behoves Indian statesmen to consider and it remains for them to say whether the general ideas of Sir Arthur Cotton, modified by our experience, should not, as regards this part of the Presidency, be carried to completion. What is now, however, required is a full detailed investigation.

(Signed) A. W. SMART, Col., R.E.,
Ag. Chief Engineer for Irrigation.

(* If more can be commanded more will be irrigated.)

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PRELIMINARY REPORT

ON

IRRIGATION UNDER WELLS

IN THE

MADRAS PRESIDENCY.

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CONTENTS.

Districts.	Ayacut wells: Government, Dasabandam and Private.				Supplemental wells: Government, Dasabandam and Private.		Average area irrigated during the last five years ending with 1899–1900.	Maximum area, 1898–99.	Number of wells constructed by loans during the past decade.	Number of wells repaired or improved by loans during the past decade.
	Fasli 1301.		Fasli 1307.		Fasli 1301.	Fasli 1307.				
	Number.	Area irrigated.	Number.	Area irrigated.						
1	2	3	4	5	6	7	8	9	10	11
		ACS.		ACS.			ACS.	ACS.		
Ganjám	681	1,198	176	1,661	56	646	1,505	1,271	84	..
Vizagapatam	..	..	..	..	3,971	2,125	..	..	18	2
Gódávari	1,633	1,782	1,149	2,009	5	61	1,912	1,665	..	..
Kistna	3,226	8,297	3,231	9,753	272	407	9,721	8,837	51	52
Nellore	9,090	59,221	13,853	54,406	938	1,184	55,855	56,135	230	384
Cuddapah	37,222	128,273	37,926	131,413	10,190	10,287	134,834	136,204	1,772	3,534
Anantapur	12,032	58,999	13,790	45,895	1,945	3,940	48,313	50,880	628	1,030
Bellary	8,072	[illegible]	7,955	20,306	646	631	19,188	19,141	452	817
Kurnool	5,399	27,171	7,294	24,215	683	681	23,392	25,251	566	906
Chingleput	10,624	19,022	12,738	28,033	10,902	12,781	24,760	28,451	4,613	850
North Arcot	32,490	[illegible]	58,364	116,601	47,865	51,928	118,372	[illegible]	4,686	3,252
South Arcot	34,075	[illegible]	48,903	79,966	25,135	22,290	73,982	77,194	1,061	712
Tanjore	..	[illegible]	24,891	17,458	..	29	18,547	21,522	..	..
Trichinopoly	23,048	[illegible]	25,352	45,048	[illegible]	[illegible]	44,987	45,928	174	172
Madura	12	[illegible]	27,847	77,411	3,511	8,470	79,063	81,217	688	446
Tinnevelly	31,770	68,577	43,078	73,29	3,795	5,889	78,161	82,009	1,029	584
Coimbatore	64,084	330,854	74,173	189,739	2,369	3,215	293,683	300,325	1,693	4,887
Salem	45,868	42,558	[illegible]	65,125	18,393	20,580	70,246	72,730	618	2,095
Total ..	321,700	1,081,216	[illegible]	[illegible]	[illegible]	149,792	1,096,521	1,136,996	18,363	19,223

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WELLS.

General Remarks.

The limited time which I have had at my disposal and the fact that I had not, prior to the date of my deputation to special duty, made any special study of the subject of well irrigation have prevented my going in any great detail into this subject; and for the remarks and suggestions I am about to make I am entirely indebted to the officers of the Revenue Department of whom I have consulted as many as possible.

2. The principal fact with which I am confronted is the great variety of conditions which exists in different districts and, in consequence of this, no doubt, the equally great diversity of the opinions of the officers consulted. It may therefore be taken as an axiom that in attempting any improvement of well cultivation no panacea can be adopted, but each tract or district must be treated as the physical nature of the country and the manners and customs of its inhabitants may require. In these circumstances, it will conduce to clearness if we first discuss the various possible methods of promoting further well irrigation and afterwards deal with each district separately noting what has already been done and suggesting the most likely means for improving matters.

3. In this Presidency the only means hitherto adopted by the State to assist landholders in constructing or improving wells is the grant of loans under section 10 of Land Improvements Loans Act XIX of 1883 and section 4 of the Agricultural Loans Act XII of 1884. I have unfortunately no figures showing to what extent loans have been taken for well-sinking of recent years; but it is a fact that, although a large number of wells have been dug during the past decade, the number of those dug from loans bears but a small proportion to the total, and it cannot be considered that the present system is altogether successful.

4. The terms on which loans may be effected appear at first sight to be so favourable that it is strange that the ryots do not hasten to avail themselves of the opportunity thus given them. There are, however, numerous reasons for the unpopularity of the system which may be enumerated as follows:—

(1) As thoroughly good security is required, it is impossible for the poorer ryot who is already in the hands of the money-lender to obtain loans. The only persons who can avail themselves of the favourable terms offered by Government are the well-to-do classes who could afford to construct the wells without this aid.

(2) Government insists on the work being carried out within a certain time and the ryot has therefore to pay much more for doing the work than if he were allowed to do it at his convenience.

(3) Great rigidity is exercised in recovering the advances; whereas the money-lender, if he is satisfied with his security and the personal character of the borrower, is always ready to give extension of time.

(4) A loan from Government involves much delay and many troublesome formalities before the money can be obtained.

(5) Government gives undue publicity and is unduly inquisitive before granting the loan.

(6) The whole of the loan must be devoted to the purpose of digging the well, it being contrary to the rules to utilize part of it for other purposes.

(7) Government requires that a patta should be made out in the name of the borrower and will not accept joint pattas.

(8) The ryot believes that the local money-lender will be more sympathetic and accommodating than Government.

(9) A certain portion of the loan fails to reach the ryot's hands.

Of these reasons, I believe that (1), (2), (3) and (9) are most important.

5. Various modifications in existing procedure have been proposed to render the system more popular. The more important may be mentioned—

(a) *To relax the rigidity with which the loans are recovered.*—This might meet objections (2) and (3). It would however probably lead to some loss with doubtful compensating advantages.

(2) During non-famine times Government to sink wells on the application of pattadars in tracts where the extension of well irrigation is required for protective purposes.

(3) Wells to be sunk for the irrigation of dry lands only and not to be taken in hand unless there appears a probability of reaching a spring without disproportionate outlay.

(4) If no water is reached, the pattadar to pay half the cost incurred by Government.

(5) If water is reached, the ryot to be charged *tirvajasti* on the area irrigated *minus* the usual lift deduction.

(6) The ryot to have the option (exercisable at any time) to buy up the well at *cost price only*.

The advantages claimed for the alternative scheme are—

(1) It is more favourable to the ryot.

(2) The charge in the form of *tirvajasti*, though perpetual, would be lighter and less burdensome.

(3) The scheme involves no intricate calculations and no selling up of ryots' effects.

Chingleput District.

The Collector approves generally of the scheme proposed and states that it could be worked in his district.

South Arcot District.

The Collector's remarks on the scheme are—

(1) *Rule* 1.—If a well is constructed, the cost of the trial borings may be added to the cost of the well.

(2) *Rule* 2.—Bought-in or relinquished lands being generally valueless, the employment of non-famine labour in constructing wells on such lands is not desirable; and the utilization of famine labour on such works is full of difficulties owing chiefly to the scattered nature of the works and to the fact that loose soil is not always available. In the case of rain-fed tanks, the existence of wells to supplement the tank irrigation would be a boon, and the employment of famine labour on such works will be less difficult.

(3) The necessity for the distinction between estimated and actual cost (rule 3) is not apparent. The actual cost alone should be taken into account.

(4) Repairs to wells should not be undertaken by Government as it will increase the amount due from the ryot.

(5) Rule 6 will give room for fraud in many cases.

Mr. Grimley's alternatives, viz., the fixing of the ayakat or payment of 1 anna per cent. irrigated, are vague and leave too much to the karnam. It is therefore proposed that, in the case the pattadar proves that the well ceases to be of any benefit, the Collector may forego the interest on the cost of the well and recover only the actual cost in annual instalments not exceeding 1 anna in the rupee.

(6) The maximum limit of cost, viz., Rs. 500, it is presumed, represents only the initial cost.

(7) *Rule* 8.—In the case of wells sunk in patta lands, the value of the lands to be irrigated should be greater than the cost of the wells after the wells are in operation.

(8) *Rule* 9.—In bad seasons Collectors should be empowered to suspend the collection of annual instalments.

Coimbatore District.

The following are the Collector's remarks on the scheme proposed :—

Rule 1.—Lands bought in by Government being, as a rule, the poorest of all lands, wells sunk in them are not likely to be successful. Further well-sinking in such lands would be difficult and expensive to supervise. If rule 3 is favourable to the ryot, it would probably be easy to give the lands out on pattas before wells are sunk in bought-in lands.

Rules 3 *and* 4.—The ryots may fairly be made to bear the cost of repairs, and the scheme seems to be in no way advantageous to the State, especially as Government will be incurring a heavy liability in what may be called speculative mining. A number of wells sunk in a limited area diminishes the average depth of the water below the surface and it will thus be necessary to spend money in deepening existing wells.

Rule 5.—This is a utopian idea, which, if carried out, would be inconsistent with the duties and obligations of Government to the general tax-payer. A geological survey of the localities, trial borings, etc., may minimise the number of failures; but even this is doubtful.

Rule 6.—This does not provide for the case of a partially successful well.

Rule 7.—No hard-and-fast rule can be laid down in the matter of cost of wells, and some discretion should be left to the officers entrusted with the working of the scheme.

Rule 8.—It would be wiser to make the estimate of value of the land when in yield, equal to the whole cost of the well.

Rule 9.—In times of famine well owners being the persons who would have harvests and high prices, it is not understood why they should have their annual charges reduced.

Rule 10.—It is a speculation inadvisable, for Government to make a profit by digging a well and selling it and the land it irrigates by auction.

The Collector concludes by saying that he believes it possible that his objections can be overcome by modifications of the scheme.

Madura District.

The Collector observes that proposed rules 4, 5 and 6 would, if adopted, give a decided advantage to the new scheme, viz., (1) a lower rate of interest and (2) no liability for wells which prove unsuccessful. Against this the disadvantages in his opinion are—

(*a*) The loan to be repaid in sixteen years instead of in thirty years.

(*b*) Annual instalment to be reduced only during famine, whereas under the present rules it can be altogether suspended.

(*c*) Land bought in by Government being usually of little, if any, value, expenditure thereon would be less likely to be useful.

(*d*) Construction by Government would add to the outlay necessary to produce any given well.

In view of these considerations, the Collector is of opinion that, in so far as the scheme is proposed to substitute direct intervention by Government for private action, it is radically unsound and that, however, if rule 5 of the scheme were introduced into the rules under the Land Improvement Loans Act, it could not but have an important effect towards extension of well cultivation.

Tinnevelly District.

The Collector states that the ryots of his district are fully alive to the advantages of well-sinking and considers that they require no special encouragement. He observes, however, that wells sunk with the aid of State loans are only few and that this is due to the existing rule that the property offered as security must be unencumbered. To remove this restriction, he suggests that by means of legislation the loan should be made the first charge on the land. Until this is done, it is impossible to introduce the proposed scheme on a large scale, unless Government is prepared to give wells free.

In the case of wells sunk in patta lands in order to afford employment for famine labour or as a protection against future famine, the Collector suggests that the pattadar be tenderly dealt with and $\frac{1}{2}$ to $\frac{2}{3}$ of the estimated cost of the well at normal rates charged (this charge to form the first charge on the land); or that a special well-rate be imposed.

Bought-in lands being usually the least valuable, the Collector doubts if wells sunk in them would ever be useful and remunerative.

8. The main feature of Mr. Grimley's scheme is that the chance of loss, if the well proves unsuccessful, is transferred from the ryot to Government. If this principle is accepted, there seems no reason why the scheme if properly applied should not work,

Note.—The criticisms of Collectors with the exception of those of the Collector of South Arcot apply to the original

It could, with the previous consent of the owner, be applied to patta lands, as well as to relinquished or bought-in lands. The latter would for reasons given by critics of the scheme be, as a rule, unsuitable for well irrigation, and it would be a rash experiment on the part of Government to sink wells on such lands without first assuring itself that the land would be cultivated as soon as the well is completed. Agreements before commencing work would in all cases be required and it would be desirable to arrange that this agreement should be binding on subsequent purchaser of the land. I do not know how far this can be done at present.

9. The objection that the work if carried out by the State would be far more costly than if done by the ryot himself, is a real one and can only be met by charging the ryot, what the well would have cost him if excavated by himself. These ryots' rates should be fixed for each taluk in which state well-sinking is commenced.

10. It will be seen that the Collector of Nellore prefers his scheme of charging well-rates; the well remaining the property of the Government. The objection to this, and it is a grave one, is that Government would always be liable for the maintenance of the well. The maintenance and repair of wells is a troublesome task which can only be done economically by the ryots using them, and any scheme which is adopted should transfer as soon as possible the duty of repairs to the cultivator. In the case of payments for wells by easy instalments, the duty of repairing them can be transferred to the cultivator at once; and as the well will be eventually his, he will be pretty certain to keep it in order without much supervision. If, however, the well is never to become his property, he has not the same interest in repairing it, and is not likely to do the work so well, even if it is found possible to get him to do it at all. I am therefore in favour of the scheme which transfers in the shortest time the ownership of the well from the hands of Government to these of the ryot.

11. Then there is the proposal to conduct trial borings at the expense of Government. This subject is not now raised for the first time. Mr. F. A. Nicholson, when Collector of Anantapur, wrote at length on the subject and strongly opposed the entertainment of establishments for making trial borings. It is probably not generally understood that making borings either in very sandy or very rocky ground is a difficult and expensive operation which requires a skilled expert to superintend it. I believe that the ryots themselves aided by professional well sinkers are the best judges of sites where water is to be found. Government might possibly do some good by instituting enquiries as to how far the professional water finder or "dowser" exists as he does in England. I believe that there are a good many, and whether they discover water by means of keen observation or instinct it would be well to register their names and foster such abilities as they possess.

12. It has further been suggested that geological surveys should be made to ascertain the areas most likely to be successful. I consider that this would serve no useful purpose. Broadly speaking, the areas where water is likely to be found are fairly well known. What is required is a means of ascertaining the exact spot on which to dig with success. This, I believe, the geological expert would be unable to say better than any one else, and possibly not so well as a person who had made water finding his business in life.

13. I am much impressed with the utility of supplemental wells, that is, wells situated within the ayakat of tanks to enable ryots to harvest their crops after the supply in the tank has gone out, or to assist them in tiding over periods of intermittent supply. From my experience when Executive Engineer, North Arcot district, I was much impressed with the value of these works and I formed the idea that they might be much more universally used in districts where they are not so common. Those who have not seen can hardly believe of what immense service these little wells are in bringing to maturity large areas of crops which would otherwise certainly perish. This view has obtained a striking confirmation in the opinions expressed by the Collector of North Arcot district, whose note will be found below. It will be seen that he strongly urges the necessity for the construction of more supplemental wells in the very district where they are much more numerous than anywhere else in the Presidency. I can only argue from this that in other districts their value is not fully appreciated or there would be more demand for them.

The figures supplied by the Board of Revenue, which are printed at the beginning of this note and which are the latest I have to refer to, show how North Arcot compares with the neighbouring districts in the matter of these wells:—

14. I am firmly convinced that an attempt should be made to extend the use of supplemental wells in all districts when there is a fair amount of wet cultivation with, at the same time, a precarious supply. It is of course probable that supplemental wells of a temporary nature are used in such districts as Vizagapatam and Bellary and that these are not shown in the returns. I believe, however, that there is hardly a district in which the use of supplemental wells could not with advantage be extended.

15. As far as I know, no attempt has been made in this Presidency to construct wells for irrigation by famine labour, the nearest approach to it being the repair of, and clearance of silt from, village wells. If, however, in future famines a programme of small works, as recently suggested by the Government of India, should be adopted, it would be well, if possible, to introduce a system of digging irrigation wells by famine labour as they would form a valuable addition to our otherwise scanty programme of village works.

16. The objections to such works as relief works are obvious and may first be noticed—

(1) Owing to the small number of workers who could be employed on each work, they would be difficult to supervise and in very few tracts would it be possible to sink wells close enough together to enable them to be grouped in charges.

(2) There would be great difficulties in the way of selecting sites for wells before famine began, and if started in a hurry there would be a large percentage of failures owing to want of care and skill in selecting suitable sites.

(3) It is hard to decide the class of land in which they should be sunk. Government waste lands are all almost invariably either very poor or remote from village sites; in neither case would ryots be found to take up land for well cultivation in such localities. Similar objections apply to Government bought-in lands. A well not in use deteriorates very rapidly; and supposing that a number of wells were sunk in such lands Government would be saddled with the burden of maintaining them with the possibility of no eventual return. If, on the other hand, it is determined to sink wells in patta lands, various agreements would have to be made binding the holder of the land to utilize the water and difining the terms on which he should do so. These formalities would inevitably consume much of the time which should be given to actual commencement of a work.

(4) A great portion of the work of well-sinking is unsuited for the employment of famine labour. Relief workers cannot be expected to excavate rocky soil, to dig deeper than about 25 feet, to construct revetments which are almost invariably necessary. If therefore wells are undertaken as relief works, it will be necessary to provide funds for completing them by professional labour.

For these reasons I do not think that the sinking of permanent wells by famine labour would ever be successful.

17. It might in certain areas be possible to sink temporary wells for irrigation during periods of scarcity. This could, however, only be done in a few specially suitable spots and the arrangements would need the supervision of superior officers of the Revenue Department who could ill-spare the time at such a crisis.

Irrigation from Wells by Pumping.

18. Other work has prevented my going into this question at all thoroughly, but I believe that in selected areas it might be possible to obtain a sufficient flow of water to render the erection of a small oil-engine economical. In the inland districts suitable sites for such installations could only be found near river beds, but along the coast and for a few miles inland there is often a large amount of water near the surface which might, if collected in a central swamp, be pumped with economy.

As an example, I may mention a tract close to the South Indian Railway a little north of Porto Novo in South Arcot district. Here I found irrigation of crops (mostly ragi) carried out from shallow pits, from which the water was baled by hand in chatties. It appears to me to be probable that, if collecting channels were dug, a sufficient supply could be obtained to warrant the erection of pumps. I think it improbable that for many years to come the ryots would undertake such work themselves and it would have to be done by Government charging a wet rate on the land irrigated. There is also an abundant supply of sub-soil water in all the minor rivers near the coast, the beds of which are dry for many months in the year. A great deal of this is utilized by means of river channels with long leading channels in the bed of the river and this is probably the best and most economical way of using the water. There are, however, places where these channels cannot be made and in such cases pumping may be very useful. Systematic enquiries into this subject should be instituted.

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GANJAM DISTRICT.

The opinion of the Collector of this district with the statistics afforded by him is appended :—

With regard to wells in Government taluks with an ayacut, there are 1,133 in Chicacole irrigating about 495 acres. About half of these have been dug in the past ten years, and from this I conclude that the ryots are beginning to see the advantage of having a source of irrigation in years of scarcity or famine. Only 32 have been built with State loans—an almost unaccountably small proportion—but the reason of this is probably that the ryots are unaccustomed to the condition imposed with regard to the completion of wells under State supervision within a fixed time, and have also been dissuaded by the money lenders who would prefer to lend the money to ryots in the usual way. A ryot who is in debt has little or no option in the matter. He must continue to borrow from one man who holds him at his mercy and generally holds a mortgage on his land. If the ryot is poor he is unable to borrow from the State as he cannot give sufficient security. It would seem to me of great advantage in times of scarcity if small sums from Rs. 25 to Rs. 100 were lent by the State to poor ryots for the construction of wells without demanding the security of land valued at least at 1½ times the amount of the loan which is now required under the rules. In the Berhampore taluk there are no wells for irrigation of dry land and I can hardly venture to explain this peculiarity. Berhampore generally suffers more than any other part of the district from famine; the ryots are apparently averse to borrowing any money from the State. They rely almost entirely on rainfed or wet crop. Yet the complete absence of wells is not accounted for by these facts.

In Goomsur, a taluk which suffers very seldom from famine, there are 560 wells with an area of 623 acres dependent on them. There does not seem to be room for much extension in this direction in Goomsur, and the ryots hardly require wells for raising garden or dry crops.

The supplemental wells are only numerous in one taluk—Berhampore—and they are little more than pits in wet land, which are filled up after each year. These wells which are of course very cheap cannot be of much service in seasons of scarcity. They are so shallow that they cannot reach any permanent watersource and their construction cannot be advocated.

With regard to the reasons for not digging more wells, one may be that in many villages the water is brackish; and if the villagers find that the water in their drinking well is brackish they would require a great deal of persuasion to sink wells in their fields.

I believe that wells near village-sites are more likely to be brackish than those at some distance, but I cannot speak from personal experience.

Class.	Number of wells and area irrigated.				The approximate depth below the surface at which water is available.	The effect of well irrigation in any special year when there was a failure or partial failure of rain.	The number of wells that have been constructed or improved by State loans during the past ten faslis 1299—1309.
	In fasli 1299.	Area irrigated.	In fasli 1309.	Area irrigated.			
Ayacut Wells.	NO	ACS.	NO.	ACS.			
Berhampore	..	..	..	..	..	..	..
Chicacole	583	Not known	1,133	495	24 cubits on the average.	Beneficial in years of failure of rains.	32
Goomsur	..	..	560	623·58	12 cubits on the average.	1896-97 *Nil*	..
Total ..	583	..	1,693	1,118·58	..	..	32
Supplemental Wells.							
Berhampore	90	47·01	909	722·89	12 cubits on the average.	Not very useful.	..
Chicacole	54	Not known	..	..	24 cubits.	..	..
Goomsur	..	..	..	..	..	..	..
Total ..	144	47·01	909	722·89	..	..	..

2. I have no personal knowledge of this district, but I cannot help thinking that the value of supplemental wells in such tracts as the Berhampur taluk is under-rated. I should certainly have thought that they would be of great use in tiding over times of scanty supply. There may no doubt be great difficulty in inducing the local cultivators to maintain and use them; but if they could be induced to do so, I believe that they would be very useful.

VIZAGAPATAM DISTRICT.

The greater part of the district is zemindari and no statistics regarding wells in these areas is available.

2. In the Golgonda and Sarvasiddhi taluks there are no ayacut wells, but the supplemental wells are fairly numerous. The following are the statistics supplied by the Collector :—

	Number.	Area irrigated.
		ACS.
Golgonda taluk	2,498	1,102
Sarvasiddhi taluk	3,026	1,917

3. The peculiarity of these wells is the small area that they are said to irrigate. Opinions as to their utility v ry. The Tahsildar of Sarvasiddhi considers that they were of great use in a bad y r, while the Head Assistant Collector does not appear to agree with him. Some extension of well cultivation in Palkonda taluk might be possible. The Collector, however, considers that no great extension of permanent wells is likely in the district.

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KURNOOL.

The only statistics available regarding wells in this district will be found in the table prepared by the Board of Revenue. The opinion of the Collector is given below :—

* * * * *

Wells are a failure in the black soils. The depth of water is great ; well-sinking costly ; water generally brackish ; and most of all, as one or two good rains mature dry crops no ryot will think it worth while to gird himself up for the laborious cultivation incident on well irrigation.

In red soils, wells may be a success. But when the district encounters several years of drought in succession—as it has now done—the wells get dry. Deepening does not tap fresh springs. The cattle deteriorate for want of pasture. Further, the Kurnool ryot is lazy ; he has been so much the sport of adverse seasons that he makes no effort to bestir himself. Again the existence of well cultivation pre-supposes necessity for intensive cultivation. Whereas in Kurnool there are acres and acres of good unoccupied land ; well cultivation in Kurnool will not become popular until the pressure of population renders such cultivation absolutely imperative.

No doubt in a few villages in the Markapur taluk there exist good wells with unfailing supply of water ; here the ryot is fully alive to the importance of well cultivation. This emphasises one of my arguments, viz., that the ryots will themselves take to well cultivation if one year at least in every three be a season of good rainfall, which unfortunately is not the case.

At the same time, I think, loans will continue to be disbursed as usual for the sinking of wells. Loans are dependent on several causes—the energy of the Tahsildar, the peculiar circumstances of individual ryots, and perhaps the greed of village sowcars to obtain additional interest. But this can be no index to the general requisites of the district.

2. It will be seen that the Collector holds out no prospects of any large extension of well irrigation in the district. I was however informed by an officer of the Revenue Department who had much experience of the Markapur taluk that there was a considerable tract of country in that taluk where water was to be found comparatively near the surface even in very dry years and that there was there great scope for the extension of well cultivation. This possibility should not be lost sight of.

3. The very small number of supplemental wells and the fact that they show no signs of increasing is noticeable. It would show either that the local conditions render them unsuitable or that their advantages are not appreciated. An enquiry into this mater would seem advisable.

BELLARY.

The following are extracts from the reports of the Head Assistant Collector and the Deputy Collector, Adóni :—

From the Head Assistant Collector.

* * * * *

As regards the possibility of the extension of well irrigation under Class I by private individuals, I have the honour to add that the ryots are fully aware of the rules for the grant of State loans, and experience shows that the ryots will have recourse to State loans only in times of drought.

The reports of the Tahsildars show that there are no tracts in this division which stand in need of a more liberal disbursement of State loans

* * * * *

From the Adóni Deputy Collector

In continuation of my letter, Ref. No. 328, dated 18th August 1901, I have the honour to submit the following report regarding the extension of well irrigation in the Adóni and Alúr taluks. This can be done in three ways :—

(1) By encouraging private individuals to dig wells either at their own cost or with the aid of State loans for irrigating dry or wet crops raised on dry lands or for supplementing irrigation from tanks or other small irrigation sources.

(2) By getting wells dug by famine labour at Government cost for irrigation during seasons of short water-supply.

(3) By the deeper sinking of already existing wells.

Speaking generally of the whole division, the extension of well irrigation seems to be attended with considerable difficulty and doubt. In Alúr taluk where soil is mostly black cotton and also in similar tracts of Adóni taluk the cost of sinking wells is so great that the average ryot cannot afford to do it; and moreover the wells have to be dug to very great depth, often not less than 20 feet below the surface, and even then the water available will be brackish and considerably low in seasons of drought. Again the cost of baling water is enormous, so much so that the working expenses will in all probability outweigh the expected outturn. This is why we find several wells, especially in Kosigi firka, left in disrepair and therefore much silted up. This is why also the sinking of new wells is generally always viewed with disfavour by the ryots. The Tahsildar of Alúr reports that in tracts adjoining the Hagari and in those bordering on the large streams and vankas good wells dug sufficiently deep can not only supply sufficient water for agricultural purposes, but also afford much help during years of deficient rainfall; but even in these cases the cost is said to be prohibitive while deeper sinking of existing wells will be prejudicial to existing revetments.

Now to turn to the first of the ways by which well irrigation could be extended. I beg to state that the State is already doing its best by encouraging well-sinking by the grant of State loans, but these are unfortunately not freely availed of. Some among other reasons for this unwillingness on the part of the ryots to take loans for sinking wells are :-

(1) That not seldom the cost of a well is double or treble of the loan taken.

(2) That the rules regarding repayment of instalments are stringent and require the repayment of the whole loan in the event of any of the instalments being delayed beyond the prescribed date.

(3) That the wells fail when most needed, *i.e.*, when the rains are deficient.

We meet with cases of wells dug from time to time by private persons, but it is almost always the well-to-do ryots who could afford to bear the loss in the event of the wells failing. The chief object of increasing wells is to make them serve as a protection against drought, but they are said to be not of much use in this district, firstly because when rains are sufficient, they are not much required except for saving garden crops, such as ragi, chillies, vegetables, sugarcane, etc., which are not cultivated on any large scale, while in seasons of deficient rains the supply in them is too low for irrigation purposes.

Then as to supplemental irrigation from tanks, it must be said that even supposing there is sufficient supply, they cannot irrigate more than a small avacut, and that to make the scheme really successful almost every ryot owning wet lands should provide himself with a well. This does not, I fear, seem to be practicable.

Next as to (2), viz., new wells dug by famine labour, the Tahsildar of Alúr considers that this should not be undertaken unless trial borings are first made to ascertain whether water can be had and if so, at what depth. If this is not done, he fears that the money spent on wells at random will be so much money spent in vain. I feel inclined to agree with him and to add that the digging of wells at Government cost on any large scale is not profitable or desirable. The Tahsildar of Adóni considers, on the other hand, that there is scope for digging useful wells in low lands adjoining vankas and streams which abound in the Adóni, Kosigi and Yemmiganur firkas and by the restoration of old doruvu wells on the banks of the Tungabhadra and of some vankas.

He has given a list of villages in which doruvu and other wells can successfully be dug (*vide* list attached to his arzi, Ref. on S.C. No. 1115, dated 3rd July 1901). It would appear that in all the villages specified therein except Kumbalamur, such wells have existed from a long time and have irrigable avacuts under them. He proposes that, if some favourable conditions are offered to the ryots with regard to rates or instalments or both, they would come forward either to dig new ones or to repair or restore the existing ones. It is not clear what the Tahsildar means by the offering of favourable conditions, as the rules regarding State loans are already favourable except that prompt repayments are insisted on with same rigour which must of necessity be enforced in the interests of Government. If the ryot really finds the wells profitable, he ought to be ready to dig or repair them by borrowing money either from Government or from rich persons.

Now, lastly as to deeper sinking of existing wells, I already observed that this might not be advantageous in Alúr taluk. The Tahsildar of Adóni states that deeper sinking may be encouraged in tracts where water from the surface is not very deep. I agree with him and beg to add that deeper sinking of already deep wells would necessarily involve heavy charges for baling water which may or may not be compensated for. In this connection I beg that my memorandum regarding wells in Kosigi firka may be consulted.

* * * * *

2. The Head-quarter Deputy Collector reports that no extension of well irrigation in his division seems likely.

3. It will be seen from the above reports that there is little prospect of extending well irrigation in Bellary district, the principal reason being, in my opinion, that the people are not likely to take to it. Irrigation from wells does not seem to be regarded in this district as affording protection in times of scanty rainfall and the extra labour and expense of cultivation is certainly a deterrent. It is undoubtedly a fact that in the black cotton soil tracts there is no likelihood of there being any great increase in the number of wells; but in others it seems to me that a considerable extension might be possible. Such extension would, owing to the conservatism of the ryot, be undoubtedly slow; but with the example of Kosigi before us, where there are numerous successful wells, I cannot but believe that great improvements could be made.

4. Certain areas likely to be suitable should be carefully explored and where a water-bearing tract is found wells should be sunk at Government expense as described elsewhere. I would suggest as likely fields for exploration the lower-lying red soil tracts of Adóni taluk, the western portions of Rayadrug taluk, and portions of the Kudligi taluk not taken up by tank cultivation.

5. The dearth of supplemental wells is an undoubted loss in the western taluks where wet cultivation is common. On this subject the Tahsildar of Kudligi reports as follows :—

> The ryots dig up temporary wells under the irrigation tanks to supplement water-supply when there is deficient supply in the tank. These wells are allowed to go into ruin when the tanks receive sufficient supply. The ryots prefer to incur small expenditure on these temporary wells. I am afraid that, in these circumstances, nothing can be done in the taluk to improve well irrigation."

6. The figures given by the Board of Revenue show that supplemental wells are not nearly as numerous as they might be, and I think that attention should be given to their extension where possible.

NELLORE.

The Collector of Nellore is in favour of constructing wells at Government expense and charging water-rate, the ryots to have the option of acquiring them if they wish to do so. He considers that it is useless to expect any great development of State loans in this district and suggests the appointment of a special well-paid Revenue Inspector to each division to encourage people to take loans.

2. He also recognizes the importance of extended use of supplemental wells. On this subject he writes as follows:—

* * * * *

It is important that people should be encouraged to supplement Government irrigation by means of private wells and the present rule seems to me not to afford sufficient encouragement. The rule I allude to is that which enforces levy of full wet assessment or full water-rate for the crop or both the crops whenever there is any supply of water sufficient to pass the sluices in the Government source of irrigation even if the crop has been mainly or wholly irrigated by means of private well water. I have heard complaints about the hardship caused by this rule and I believe them to be well founded. In my opinion it is advisable to charge only half the wet assessment or water-rate in cases where the water of private wells has been used to supplement irrigation from a Government source. Even if there is some supply in the tank or channel, the resort to the well renders that supply available to others.

It is curious how little advantage seems to have been taken of the favourable rates of composition allowed to lands containing wells allowed in Board's Proceedings, No. 96 (Revenue Settlement), dated 20th February 1894. I am giving wide publicity to that order which is probably not very well known.

3. From my own observations in the Udayagiri and Kanigiri taluks of this district I am inclined to think that as regards ayacut wells there will be great difficulty in persuading the ryots to construct or use wells far from their villages. The paramount consideration in sinking a well appears to be proximity to the village site and I believe that well cultivation might be largely increased if this feeling could be overcome.

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CHINGLEPUT DISTRICT.

I have no special recommendations or statistics from the Collector of this district. I have however consulted him and he agrees with me that there is probably room for great extension of supplemental wells. I would suggest, as the most suitable way of attaining this, the appointment of a special establishment for the distribution of loans in a selected area.

SOUTH ARCOT DISTRICT.

The Collector writes as follows :—

Wells dug by means of Government advances.—Wells of this class exist both in dry and in wet lands for the purpose of raising dry, garden or wet crops. Advances under the Land Improvement Loans Acts are freely granted wherever feasible, but several ryots abstain from resorting to State aid on account of the rigour of some of the present rules. The fact that collections of fixed instalments of principal and interest are made, as a rule, irrespective of the character of the season seems to be felt as a great hardship by the ryots. In bad seasons it may be very difficult for the ryot to maintain himself and his family and, in addition to this, he has to pay the land-tax if his case does not admit of the grant of remissions under the Remission rules. When, under such circumstances, he is called on to pay something also towards the liquidation of the loan previously taken by him, he generally makes default which brings about the sale of the land pledged as security for the loan. On the other hand, a ryot who takes a loan from the local money-lender does not apprehend this, as the money-lender does not press him for the payment of the principal so long as the interest is paid. Thus many ryots prefer to take loans from the local money-lender, however exhorbitant the interest may be, instead of from Government. To induce such persons to take Government loans, I would suggest that Collectors should be empowered to suspend the collection of the fixed instalment altogether in bad seasons.

Another hardship seems to be the collection of interest on the amount spent on unsuccessful wells. When we advance the loan, we force the borrower to dig a well and when it ultimately turns out to be unsuccessful we ask him to pay the amount in a less number of years with interest. In such cases, when the failure of the work is not due to the neglect or want of reasonable precautions on the part of the borrower, I would suggest that Government should forego its claim to interest altogether. The failure of the work should, of course, be certified to by the Tahsildar or other superior officer after personal inspection.

The Chidambaram Deputy Collector suggests that the rate of interest on all loans should be reduced and the Head-quarter Deputy Collector recommends that only a nominal rate of interest should be charged on amounts advanced for sinking wells. The Superintending Engineer is of opinion that interest on the amount spent on wells executed by famine labour should be charged at 4 per cent. Originally, the rate of interest under the old Special Well rules was 3 per cent. and it was increased to 4 per cent. This rate has, after mature consideration, further been increased to 5 per cent. which is the rate now in force. It is necessary in the interests of Government to charge interest, but it may be reduced from 5 per cent. to a lower rate in the larger interests of the extension of wet cultivation. If the concessions above suggested are granted, most of the ryots who abstain from applying to Government will probably have no hesitation to seek State aid for the extension of well irrigation.

Encouragement of well Irrigation other than by the grant of State loans.—Under existing rules, wet lands irrigated from private wells are liable to the same charge as land not so irrigated, if there was water in the recognized irrigation source during the fasli. I think a reduction of the charge in such cases would be likely to encourage the construction of more wells. There is certainly no danger of all the wet land-holders under a tank constructing wells and claiming to be charged at reduced rates.

Construction of wells by Government.—There are no wells in this district dug by famine labour. All Divisional-officers, except the Deputy Collector, Chidambaram Division, are in favour of the scheme. The Chidambaram Deputy Collector deprecates it on the ground that it is not feasible: he states that the extension of well irrigation is no doubt the surest protection from famine; but considers that this object can more properly be achieved by simplifying the present loans rules. His wholesale condemnation of the scheme of construction of wells by Government is, in my opinion, undeserved.

Localities suited for extension of wells by famine labour.—Of the eight taluks of this district, the whole of Chidambaram taluk and the coast parts of the Cuddalore, Villúpuram and Tindivanam taluks are comparatively well off for irrigation works and are not suited for well irrigation. In Cuddalore taluk, the tracts which are liable to be affected by famine are reported to be the whole of the Kurinjipadi and Vallam firkas and parts of the Kusba and Panruti firkas bordering on the former two firkas. Of these, it is only in the Kurinjipadi firka that the extension of well irrigation is possible, as in the other firkas water is not available at a small depth. The wells dug by the ryots, at present, are generally small pits without any strong masonry work and consequently do not withstand the annual rains. The reason is that in some cases the ryots are too poor and in others too short sighted to spend money on a pucka well. The whole of the Tirukkóyilúr and Kallakurchi taluks are reported to be well suited for extension of well irrigation. In the former taluk water is generally available at a small depth, while in the latter water is found at an average depth of 5 to 6 yards during normal seasons, and in times of drought at 2 or 3 yards deeper. In Vriddhachalam taluk, there is much scope for improvement in well irrigation where water is available in ordinary seasons at a depth of about 5 yards and the wells require further deepening in order that the supply may not fail even in bad seasons. The Tahsildar is of opinion that the extension of well irrigation in this taluk will not prove remunerative, but he

has not assigned reasons for it. He states, however, that the Siruvakkam and Nallur firkas are not suited for the experiment, as water is not available near the surface and as ryots do not find it profitable to bale water from the deep wells of these places. In the Tittagudi, Kammapuram and Kusba firkas there is much scope for well irrigation. The Sub-Collector reports that there are no insuperable difficulties in the way of employing famine labour in sinking wells throughout his division, which consists of the Tiruvannámalai, Tindivanam and Villúpuram taluks. Although sinking wells in Tiruvannámalai taluk is more costly than in Tindivanam or Villúpuram owing to the rocky and hard nature of the soil, the number of wells has, of recent years, increased largely in this taluk. The greater cost of wells may be a good reason for not employing famine labour, but the Sub-Collector thinks that the experiment is worth a trial *after* experience has been gained of localities where they can be constructed most easily and cheaply. In Villúpuram taluk the parts liable to be affected by famine are the whole of Anniyur firka and the western part of Vikravandi firka. The cost of a well in this taluk varies from Rs. 70 to Rs. 250 and the work of construction is very simple. In Tindivanam taluk, water exists at a small depth only in a few villages of the Merkanam division near the coast. In any taluk whatever, before the experiment of constructing wells by famine labour is tried, people should gain some experience of the benefits of well extension and for this end it is, I think, desirable that wells should be constructed by Government in a few typical places before a famine actually occurs. For this purpose, the selection of Government, bought in lands for digging wells does not appear satisfactory. Bought-in-lands are generally valueless and it is only in very rare cases that really valuable lands are allowed by the villagers to be sold for a nominal price. Government waste lands or poramboke lands, in the midst of tracts where there are not many wells constructed by ryots, may be selected for this purpose. Land relinquished by ryots is in the same category as bought-in-land with regard to its agricultural value. Ryots relinquish only such lands as are unfit for cultivation even with the poorest crop, owing to distance from the village, difficulty of irrigation or the saline nature of the soil, etc. Of course there are some lands bought in or relinquished which, valueless as they are, may acquire some value when a well is dug on them. Such cases being rare, care should be taken that only lands possessing some real value are selected.

The Collector is in favour of constructing wells at Government expense and a precis of his opinion on this subject will be found on page 6. The extension of supplemental wells should be fostered in this district.

NORTH ARCOT DISTRICT.

The following note by the Collector is of great interest :—

G.O., No. 1202 W., dated 29th April 1901, directs that the possibilities of extending irrigation should be considered under the heads of

(1) Main rivers. | (2) Small streams. | (3) Wells.

2. As regards (1) the Public Works Department opinion (Mr. S. D. Pears, Executive Engineer) is that "the ordinary rainfall of the district is already utilized to the utmost." Broadly speaking it may be said that no water is allowed to go to waste except in years of abnormally heavy rains which are too far between to be taken into consideration. But I do not think that Mr. Pears considered the case of zamindari areas. In Kálahasti, for instance, there is said to be a possibility of bringing a pretty large area under wet cultivation by restoring on an improved scale the dam across the Swarnamukhi near Kálahasti town which appears to have been washed away years ago. Even as to Government taluks, I am not certain whether more dams or anikats) are altogether impracticable. For instance, the Tahsildar of Pólúr talks of the possibility of ensuring the supply to many of the tanks to the south-west of Pólúr by the completion of a nearly finished dam (but left incomplete) across the Cheyár near Yelathur village. It may also be possible to have more anikats on the Ponnai and on the Pálár provided they are not required to be "Productive" works.

3. As regards (2) Minor streams, their supply (which now ultimately finds its way into the main rivers, such as the Ponnai and the Pálár) is more or less precarious, but by bunding them up at suitable points some supply may be got to minor tanks here and there. The streams have already been utilized in this way in most places. That any still remain unutilized is probably because the cost of damming up and diverting would be disproportionate to the advantage to be derived.

4. Real protection from the effects of drought, however, should be sought for mainly under item (3) *Wells*.

5. The only people that we see pulling through a bad season with the minimum of difficulty are the owners of "well" protected lands. The green and thriving patches of cultivation which gladden the eye in the district in the course of inspection even in the worst of seasons are only due to well irrigation.

6. Diagram I and statement II bring out clearly the benefits of wells in seasons of drought. It will be seen that while the area irrigated by tanks shows very large fluctuations, the area under wells is fairly constant through good and bad seasons. The steady increase noticeable under wells is due to the ryot realizing that his salvation consists in "more wells"—*vide* statement III which shows that their number has been steadily increasing since fasli 1301, which was the first seriously bad season after the great famine that knocked it into the ryots' head that he must needs bestir himself to protect himself against the evil day. The statements however grossly understate the benefit of wells as the area shown as irrigated by them includes only lands (mostly dry) not entitled to a supply from other sources, and leaves out of account the large area (say about 100,000 acres) of wet land under tanks, etc., which are undoubtedly benefited by the 50,223 wells situated in wet ayakats. In what way then and in what places could we locate more wells with the greatest advantage?

7. For dry crops the rainfall is not so precarious here as in most parts of the Ceded districts where they fail in almost every bad year. The rainfall has never been less than 25·68 inches in this district subsequent to 1876—the great famine year—when it was 18·38 inches. In only one year during the 24 years that have gone by since then has the fall been less than 27½ inches; and in only 2 years less than 30 inches. From statement IV it will be seen that while in the Ceded districts the average rainfall in the majority of stations is less than 25 inches, it exceeds 35 inches in the majority of stations in this district. Taking the figures of the bad years again, it will be seen the minimum fall in the majority of stations in this district has been not less than 20 inches, while the same in the majority of stations in the Ceded districts has been less than 10. The rainfall during the six consecutive months between July and December has been as follows in the worst years subsequent to 1876 :—

1879	21·20	In every other year it has been more than this.
1890	22·83	
1891	22·44	
1899	18·62	
1900	23·23	

Even the lowest of the above figures (18·62 inches in the course of six consecutive months) may be regarded as ordinarily sufficient to raise a successful dry crop. The outturn in parts may, to a certain extent, be poor but there has never been anything like a *general failure of dry crops* over any considerable tract. In none of the bad years aforesaid was there any necessity felt to solicit sanction for the grant of dry remission, whereas in parts of the Ceded districts it is one of the commonest measures of relief suggested during almost every unfavourable season. It will be seen also from diagram V that the fluctuations in the case of unirrigated crops are small as

compared with the irrigated. Thus there is ordinarily not much cause for anxiety regarding dry cultivation in this district. It is our wet (irrigated) cultivation that is directly and principally affected by deficient rainfall. Dry cultivation moreover requires comparatively much less labour than wet and little of it is hired. On the other hand much of the labour required for wet cultivation is hired, the owners of wet land being as a rule better to do and wet cultivation more paying. What upsets the labouring classes therefore, far more than anything else, in a year of drought is deficiency in wet (chiefly paddy) cultivation, the distress that supervenes varying in proportion to such deficiency.

8. The greatest part of this fluctuation under *wet* is as already observed contributed by *tanks*. Nearly all the tanks in the district are rainfed, including the large ones connected with the Pálár anicut, as freshes in the river are wholly absent or very scanty in years of short fall. There are altogether 3,087 tanks in the district, but most of these are very small ones. The decrease in irrigation under tanks in unfavourable years will be even more marked if you subtract the extent on which crops became shavi and also that on which dry crops were raised instead of wet (*vide* statement VI). The decrease in paddy cultivation as compared with the average (on which as already explained the bulk of the demand for agricultural labour exists) in bad years is respectively noted below :—

1891	82,671	These figures do not include the extent on which the crop became shavi.
1899	*58,083	
1900	116,000	

* Was really more than this but much of the second crop of fasli 1308 was in the account treated as first crop of this year.

The fluctuations would be greater and more disastrous were it not for the 50 and odd thousands of wells that already exist in wet ayakats (*vide* statement III).

9. *The chief question connected with the problem of famine protection therefore, so far as this district is concerned, is how best can tankfed wet cultivation be protected by wells so as to make it less dependent on rainfall.*

10. The bulk of the tank-filling rains fall in the six months, July to December. The average fall in these months is 30·13 inches. Past experience shows that wet cultivation under tanks begins to suffer whenever the fall in these six months is even slightly less than the average, *e.g.*, 1896† (28·85) and 1897 (27·17 inches) which though not bad years were more or less unfavourable ones—*vide* statement VI. In what have been known as good years (1895 and 1898) the fall has been considerably higher than the average—42 inches and 34 inches respectively. In years in which there was considerable distress the fall in the abovesaid months was far below the average, *e.g.*—

† i.e., faslis 1306, 1307.

1890	22·83 inches.
1891	22·44 „
1899	18·62 „
1900	23·23 „

11. In unfavourable years wet cultivation under tanks is usually affected in the following ways :—

(1) Leaving lands waste owing to more or less total failure of supply.
(2) Leaving lands waste owing to supply being insufficient.
(3) Cultivation of dry crops in the ayakat owing to non-receipt of sufficient supply in time and impossibility of raising a wet crop subsequent to the dry harvest.
(4) A failure of wet crops after being sown in hope of further rains.

In cases (2) to (4) [and this is true though in less degree in case (1)] if every acre of his were protected by a well the ryot would not need to waver or to procrastinate through fear of the future but could promptly commence his wet cultivation in time. If he did so, he would get no less than 15 inches of rain (even in the worst of years), whilst the paddy is on the ground, and he would have to bale hard only for a short time at the commencement or towards the close or both. It is in *supplementing tank irrigation* that wells are of the greatest use. To raise a crop entirely by well would tax the ryots' resources to the utmost and the area that could be so cultivated would be very much less than with tank help. *It is therefore of far greater importance to have more wells in tank ayakats than in dry lands.* It is seldom that a tank altogether fails to get a supply. Tahsildars recommending remissions are in nine cases out of ten driven to find an excuse for their recommendation in the plea "supply received piecemeal." It is just this "piecemeal" supply that is best supplemented by the aid of wells, with the minimum of trouble and loss to the ryot and to Government and with the maximum of benefit to the country. There would also be much less room for fraud in connection with remissions for waste and shavi which it has been impossible to check; and altogether the more one thinks of it the more does the wisdom of a liberal policy as regards wells show itself. It is at the same time the cheapest famine protective measure one can think of for this district notwithstanding the more liberal terms and methods suggested below.

wells could be successfully sunk (provided they did not interfere with existing irrigation rights); the well and the land irrigable thereby being afterwards assigned on temporary terms pending sale in auction or on special permanent patta on terms similar to those laid down in the old special well rules. The selection of these localities might be done by Tahsildars subject to the final approval of Divisional officers. Great caution would be necessary in doing this in order that eventually they would be tempting enough to people to take up on special patta. As to employment of famine labour, however, this would be of little value on account of cost of revetment as compared with amount of unskilled labour it would afford. Even as an item of "protective" this would have an insignificant effect.

18. As regards the question of sinking wells for the purpose of protecting dry crops in times of scarcity and of the incidental famine labour that would be afforded in their construction and in the cultivation thereunder, it may be observed that dry cultivation is sufficiently protected in this district and any shortage of food-supply is promptly made up by importation by rail. Nor is there much scope for the employment of famine labour in connection with the said cultivation. It seems needless to discuss this point any further, so far at least as this district is concerned.

19. Another point connected with "well" protection is the affording of increased facilities for deepening wells when the supply runs short after a long drought

(1) The practice of jumper-boring to tap water below rock prevalent in Coimbatore might be made known and taught.

(2) Ryots in many cases meet rock and their wells prove failures as they are unable to proceed further. The boring into rock is beyond the means of ordinary ryots and the Public Works Department could overcome this difficulty when there was a good chance of water with a rock-drill for boring or blasting and could thereby turn many such failures into a success.

(3) Ryots in most parts of the district cannot be induced to go down digging beyond a certain depth, as their picottas and manner of baling make lifting impossible when the depth exceeds a maximum limit. Local picotta-users say that lifting is not possible when the water level is deeper than 19 or 20 feet from the ground level. Improved picottas and improved methods of water-lifting might be introduced and familiarized so that wells could be dug when necessary deeper than the people here would venture to.

(4) Small loans not exceeding Rs. 50 might be made grantable on personal security after summary enquiry for the purpose of deepening old wells as opposed to constructing new ones.

It may however be mentioned that water-supply in wells is generally not materially affected by a single year of deficient rainfall. It is only about the end of a second bad year that it begins to be. The question of the further deepening of wells is thus neither so pressing nor so important as the digging of new wells.

STATEMENT showing average and actual irrigated cultivation in the North Arcot district from fasli 1301 to 1309.

Items.	Average.	Actual cultivation in fasli.								
		1301.	1302.	1303.	1304.	1305.	1306.	1307.	1308.	1309.
1. Government canals ..	48,480	50,788	59,083	51,414	48,652	49,335	44,136	46,746	49,397	37,476
2. Private canals ..	2,265	678	574	1,213	4,064	2,260	3,636	3,581	2,878	2,612
3. Tanks	267,301	192,072	236,602	199,145	217,013	206,776	194,797	197,919	246,717	178,589
4. Wells	105,773	64,436	79,598	100,416	115,852	110,902	119,014	116,001	129,558	116,388
5. Other sources ..	5,431	12,121	5,206	3,777	4,814	4,103	3,605	3,696	4,189	6,764
Total irrigated area ..	369,250	321,096	380,863	355,965	390,195	373,376	365,970	366,243	430,737	341,809

STATEMENT showing the number of wells used for irrigation in the North Arcot district during fasli 1301 to 1307.

Faslis.	Wells supplementing irrigation from registered sources.	Wells having independent ayakats.	Total wells in repair.	Wells out of repair.
1301	47,885	31,417	79,302	1,073
1302	41,813	47,719	89,532	1,877
1303	42,523	48,745	91,268	2,608
1304	44,414	51,351	95,765	2,713
1305	44,537	53,103	97,640	4,000
1306	49,463	55,414	104,877	1,528
1307	50,223	56,123	106,346	3,946

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IV.

COMPARATIVE Statement of rainfall of the North Arcot district and the Ceded districts.

Districts.	Number of stations in which rainfall ranges from							Average rainfall for district.	Number of stations in which the minimum fall in bad years ranged from							
	40 to 45 inches.	35 to 40 inches.	30 to 35 inches.	25 to 30 inches.	20 to 25 inches.	15 to 20 inches.	Total stations.		5 to 7½ inches.	7½ to 10 inches.	10 to 12½ inches.	12½ to 15 inches.	15 to 17½ inches.	17½ to 20 inches.	20 to 25 inches.	25 to 30 inches.
North Arcot ..	5	8	4	1	..	..	18	37·1	..	1	1	3	..	1	9	3
Cuddapah ..	..	1	3	8	2	..	14	27·7	5	5	..	1	2	1	..	..
Kurnool ..	..	..	3	5	6	..	14	26·3	6	2	3	1	1	1	..	..
Bellary ..	..	1	..	2	7	2	12	21·0	9	3	2	1	..	..	..	..
Anantapur ..	..	..	..	..	11	..	11	22·4	6	4	1	..	..	..	..	..

VI.

STATEMENT showing the wet area on which remissions were granted during faslis 1301 to 1309.

Faslis.	Extent of waste		Area on which other remissions were granted, viz., for			
	Charged.	Remitted.	Shavi.	For dry crop on wet land, tirvakamai.	Other seasonal remissions.	Total.
1301	2,677	34,416	27,528	31,679	7,009	66,207
1302	10,979	3,990	1,776	3,127	1,201	6,104
1303	13,247	1,134	1,751	182	1	1,934
1304	15,766	9,440	3,600	1,660	67	5,267
1305	15,671	4,862	277	1,484	577	2,338
1306	16,853	12,878	1,187	13,742	2,111	16,990
1307	13,207	9,706	7,510	4,697	303	12,510
1308	11,861	497	81	107	212	400
1309	17,183	38,160	23,896	15,885	7,842	47,623

12. There is another advantage in directing our first attention towards protecting every possible acre of tank ayakat by means of wells. Most of these ayakats are already studded with wells here and there. The nature of the sub-soil and the quantity and quality of the underground supply are already fairly known. The ryot as well as Government would have something tangible to go upon and need not be so anxious as to the result. Wells in wet ayakats are known to hold a far more copious and certain supply on account of their proximity to the tank than wells elsewhere. An expert officer (with an experienced local revenue subordinate, if necessary) might examine the condition of each ayakat and record its needs and possibilities whether and how far the number of wells therein could and should be increased. This could be done once for all. Special staffs under the Collector (or in places where it would be feasible, the ordinary revenue establishments) might afterwards work out the "well-scheme" on the lines so laid down beforehand. The *experiment might be advantageously restricted to lands continuously held on patta on wet assessment for not less than 10 years* (a condition which would be a guarantee that they are fairly valuable).

13. What is the *modus operandi* that may be adopted to secure this end.

The several plans suggested are --

(i) Government, through its own servants (a well-sinking party or parties) to dig the wells and treat the outlay as loan to the ryot.

(ii) Specially stimulating the grant of loans under the existing rules.

(iii) Offering specially favourable terms of assessment, water charge, &c., to "well" protected lands so as to give an effectual incentive to well-digging by private capital.

14. As regards plan I the possible objections are —

(*a*) Government would not do the work so cheaply as the ryot can.

(*b*) Ryots would not consent to accept liability.

(*c*) A costly special staff would be required and would have to be carefully supervised.

(*d*) It would be a wasteful method.

Objections (*a*) and (*b*) could be overcome by offering some such concessions as the following :—

(1) Charging to the ryot only (or slightly less than) what the cost would have been if a private owner had dug the well himself; *i.e.*, at rates to be laid down for each ayakat as the "ryot's rates" beforehand and accepted by him.

(2) Not making the ryot liable if the well should prove a failure. (This is however improbable in wet ayakats unless very unfavourable sites are selected.)

(3) Trial borings being done free.

(4) Employing the ryot and members of his family on the work and paying them by the piece as far as practicable.

(5) Fixing the maximum amount to be spent on the well with the consent of the ryot beforehand, and not charging him more, however much the actual charge may exceed it.

(6) Fixing the annual instalment at not more than *one anna* in the rupee of the total liability.

(7) Charging only 4 per cent. interest from date of completion of well. (This would clear off the loan in 26 years at one anna in the rupee.)

(8) Postponing (and if need be remitting) the annual instalment in unfavourable seasons.

(Other conditions to be nearly the same as those contained in the late special well rules.)

Objections (*c*) and (*d*) are more or less inevitable. The ordinary revenue establishment can only help and cannot wholly undertake the execution of so elaborate a scheme. A special staff would be indispensible. Whatever may be the qualifications required of these special men, I would place them entirely under the Collector as he and the superior Revenue officers under him would have the best means of controlling and guiding their work and as it is, they who will have to settle the final terms with each ryot. Further, picked men would be needed for the work and the Collector would better get them. Though Government might have to forego a part of the outlay, the superior Revenue officers ought to be able gradually to bring it down as low as possible, and the absence of all chance for misapplication by the borrower and lesser opportunities for receipt of illegal gratification by the underlings would be a fair setoff; and there is also the direct and large additional revenue to Government resulting from decrease in claims to remissions. The Government of India are prepared (*vide* paragraph 4 of their resolution) to secure the object in view by "expert advice" and by "grants-in-aid," and the recent Famine Commission has also recommended liberality in the matter of loans. The above proposals cannot therefore be called extravagant, considering the object in view.

15. As regards plan II, it must be admitted the loan rules have not been successful in the past. The number of wells due to loan operations in the district during the seven years ending with 1897 has only been "newly constructed 4,686 wells, and repaired or improved 3,252;" while the number of new wells constructed during the same period unaided by State loans was 25,231. This I believe to be partly due to corruption on the part of underlings, but it is also largely due to lack of interest on the part of all officers from Revenue Inspectors upwards. Wherever officers have taken a personal and intelligent interest some success has attended their efforts. It must be admitted, however, that Revenue officers have very large charges from Revenue Inspectors upwards, and their range of duties is all-comprehensive, and it is unreasonable

to expect any very great results in this direction from these overworked officers. If a special staff were employed, say, two or three Revenue Inspectors for a taluk and a Special Deputy Tahsildar for one or two taluks, we might look for a tangible improvement, as they would have nothing else to do and would be bound to show good progress.

This plan (No. II), viz., specially stimulating the grant of loans under the existing rules should be worked side by side with plan I, as it would take too long if No. I alone were adopted. Plan II need not be restricted (though it should be chiefly directed) to wet ayakats, and loans may be given to the sinking of wells in suitable dry lands as well.

Another cause of the failure of the rules in the past is said to have been the complexity of the procedure followed—the elaborate enquiries as to encumbrance, value, etc. These enquiries, however irksome, are in the main indispensible. But much of this objection could be removed if Tahsildars and Deputy Tahsildars carried the money to the very doors of the ryots as they are authorized to do and if they showed greater promptness in disbursement and refrained from dragging parties to long distances from their homes as at present. The special staff of Deputy Tahsildars and Revenue Inspectors above proposed would not only minimize these drawbacks, but could also be utilized in partly carrying out and in supervising the execution of plan I. The concessions proposed in paragraph 14 in the case of wells dug under plan I might be granted to these wells also *mutatis mutandis*, and special stimulus might be given in unfavourable years by declaring that the commencement of instalments of repayment would be postponed for an extra period to enable borrowers to recover from the effects thereof in the meanwhile. Also, considering that the Government of India is prepared to give "grants-in-aid" and that plan I would involve so much more cost to Government, a sum equal to, say, 10 per cent. might be foregone out of every loan granted in a bad season, as an extra incentive.

The Government of India's sanction is awaited to a rule that encumbrance certificate might be dispensed with for loans of not more than Rs. 100 and that personal security might be accepted in the case of petty loans of Rs. 50 repayable within two years. These would simplify the procedure to some extent.

16. As regards plan III (offering of special terms to well-owners) we should make the rules such that the advantages of having well-land should be obvious to every ryot.

(1) We might well forego the charge for second crop in respect of every survey field or sub-division in which there is a well if the same is not more than, say, 1½ acres in extent (the area which is usually irrigable by a well) and up to 1½ acres if the field or sub-division is of a larger extent. The present rule (Board's Proceedings, No. 497, Revenue Settlement, dated 23rd November 1894) is that such second crop should be charged fasaljasti whether water was or was not taken from the Government source, provided the latter contained some supply during any portion of the time that the crop stood on the ground. The reason for this rule is that it is impossible to tell whether water was or was not taken to the land. Wells in a wet ayakat are a sure indication of the precariousness of the tank-supply—it is scarcely to be expected that a ryot would ever dig a well when the supply from the Government source is assured; and Government for this reason has already authorized the composition of the second crop charge at specially reduced (half) rates in the case of well lands. This in many cases only comes to ⅛th or ¼th (and in some only to $\frac{1}{16}$th) of the first-crop charge—so small an amount that it might well be foregone, not only as an incentive to well-digging but to save the ryots from needless annoyance by petty officials and superior Government officers from the trouble of enquiring into and having to charge and account for such sundry items. It is in any case unjust to charge fasaljasti in cases when the total supply received in the year is no more than sufficient by itself to raise a single wet crop (say, four months). The concession above mentioned may be fairly granted without undue sacrifice of Government revenue, at last in such cases.

(2) We might declare well lands entitled to tirvakammi remission even if wet crops were raised thereon, provided such remission was allowed on other lands (without wells) in the same ayakat on the ground that the tank-supply was itself not sufficient for maturing a successful wet crop. Under Board's Standing Order No. 16, the well land is liable to be charged full wet assessment even though not a drop of the water was utilized for the crop.

(3) We might grant part-field waste or shavi remission in the case of well lands, provided the crop on the remaining portion has been raised or saved by means of the well. As the rules stand, A, who has no well and leaves his whole field waste, is granted remission, while B is charged full assessment on his entire field merely because he has endeavoured to raise a crop on a small portion of the field with the aid of his well.

17. The next question is how far well-digging might be executed by famine labour.

In the first place such immediately useful measures cannot be put off for future utilization as famine relief works. Their justification is "protection" against famine and the latter is better avoided than brought on and fought. In the next place only a very small proportion of well-digging is fit for unskilled labourers—the upper layers and the lighter soils. The rest may be useful for the relief of *professionals* like Oddars, etc, who, though comparatively few in number, are also often in need of labour in times of distress; and as much of well-digging as is available at the time under plans I and II might be utilized for their relief. There is another class of wells which, for want of anything better, may be reserved for execution in famine times, viz.: wells proposed to be sunk in *bought-in-lands** at the disposal of Government, and other Government lands such as beds of abandoned tanks, lands fit for wet cultivation at the foreshore or tail-ends of tank ayakats and the like in which

* These are usually the most inferior lands verging on the "margin of cultivation."

COIMBATORE DISTRICT.

The utilization of wells in this district is more prevalent and successful than in any other part of the Presidency. The holders of land are keenly alive to the advantages of wells for garden crops and are not deterred either by expense or by distance from villages, from sinking wells in suitable sites. The Tahsildar of Palladam considers that in that taluk there is room for considerable extension of well cultivation, and apparently advocates their construction at Government expense to protect the whole taluk. The Head Assistant Collector recommends that the ryots should be encouraged to carry out this extension themselves by -

(a) Less stringent recovery of loans.

(b) A geological survey.

(c) Experimental borings at the expense of Government.

These points have been alluded to already.

2. The Deputy Collector, Kollegal, states that the extension of supplemental wells in that taluk would be advantageous, but appears to consider that it would have to be done by the State. He does not, however, speak very hopefully of the owners and occupiers of land being induced to take advantage of any such scheme.

3. The following are the Collector's remarks regarding Coimbatore and Satyamangalam taluks :--

With regard to well irrigation it is reported that in all wet lands where there are no supplementing wells, and in dry lands for the cultivation of dry or garden crops, wells may be sunk usefully, wherever practicable and that the difficulty felt in well sinking in some tracts containing rocky soil may be got over by blasting the rocks and making borings in them. But the conditions under which this scheme is to be carried out, the Deputy Collector reports, will be reported on with reference to your letter No. 142 dated 11th September 1901. As regards the possibility of improving wells by deeper sinking, the Tahsildar of Coimbatore reports that in some places adjoining the Noyil river such deeper sinking is unnecessary, and in some others it is impracticable on account of the situation near the hills, the sandy nature of the soil and the existing depth being already 60 to 100 feet. I agree with him.

There seems to be much scope for extension of well irrigation in the Satyamangalam taluk, for out of an extent of 205,920 acres of cultivable dry lands, 170,920 acres have no wells. Though the Tahsildar reports that this extent of 170,920 acres is either rocky or unfit for garden cultivation and that wells cannot be easily sunk, I think extension of well irrigation is possible and more wells can be sunk even in rocky beds by effecting borings wherever possible. The average cost of each well sunk in this taluk is reported to be Rs. 282.

4. The Board of Revenue have called especial attention to the increased supply gained by deepening wells in the neighbourhood of Coimbatore. I was only able to inspect a few wells myself and I have no other information to go on. At the time of my inspection there was a considerable amount of water in the wells and it was impossible to say how much was due to springs from beneath, but it was stated that in certain cases the yield had been largely increased sometimes by 250 per cent. by the simple process of jumping a few bore holes about 15 feet deep.

As far as I could see the conditions of these wells are peculiar. They are very deep and after passing through a stiff *morum* of decomposed gneiss enter on a highly fissured stratum of gneissic rock. This rock seems to contain a great deal of water in these fissures and the water doubtless finds its way from the hills which are not far off, so that where tapped it is not surprising that it sometimes rises with a considerable head. Where similar conditions exist jumping holes at the bottom of wells would no doubt be equally successful, but I do not think that they will often be found.

MADURA DISTRICT.

The Collector writes as follows :—

Dindigul.—There are 15,850 wells in this taluk. Of these, 2,515 were constructed in wet lands to supplement the existing sources of irrigation and for irrigating wet crops. There are fifty wells sunk with the aid of State loans. In this taluk the ryots depend mainly on wells for cultivation. The Tahsildar of Dindigul says that there is no scope for trying the sinking of new wells as water is very rarely found at a smaller depth than 15 feet in any part of the taluk.

Palni—All lands where wells can be dug with success have already been occupied and wells dug in them. There are several wells in patta lands supplementing other sources of irrigation, but their number can be increased. The owners of wet lands under tanks will gladly allow wells to be dug in their lands and will allow the fields to be cultivated by famine labour, provided the wells are handed over to them on the cessation of the famine. There may be a few localities where wells may be sunk by famine labour on Government lands, but they are so few that it is not worth the trouble of discovering the localities.

Periyakulam Taluk.—There are 4,692 and 367 wells sunk in patta dry and wet lands, respectively. The wells in dry lands are used to irrigate garden crops and those in wet lands supplement the existing irrigation sources when the water in them becomes insufficient. In this taluk the sinking of wells is very expensive as the soil is rocky and the supply of water is scanty even in good seasons.

The Sub-Collector reports that water is not within easy reach in the wells in all the three taluks of his division even in favourable seasons and thinks that the sinking of wells in times of scarcity would therefore be a vain task. In Kodaikánal, no wells can be dug.

Mélúr.—The Deputy Collector states that wells may be sunk with advantage in selected villages of Kottampatty and Natham firkas as it appears that water can be had at depths varying from three to seven yards below the surface even in the driest years.

Construction of wells in Government lands by famine labour, the exaction of proper tasks from those engaged in cultivation, the conditions on which cultivation is to be carried out, the disposal of the crop and the well on the cessation of famine.

As regards Mélúr taluk, it is reported that there may not be great difficulty in the exaction of proper tasks from agricultural labourers or others, provided the intensity of distress is such as to attract labour from able-bodied well-sinkers. When wells of this description are sunk in poramboke or unoccupied Government assessed waste lands for the irrigation of patta lands in the vicinity, the water-rate prescribed for second-class sources may be charged, provided the lands benefited are classed as dry. In such cases the wells with their irrigable area not included in the holdings may be disposed of by public auction after the cessation of famine or otherwise utilized for communal purposes. In cases where the wells on Government lands merely serve to supplement the irrigation of wet lands, the levy of any additional charge may not be justifiable; but there may not be much difficulty in prevailing upon the owners of wet lands to purchase the wells though it may not be possible to realize the full value of the wells.

In Dindigul, Periyakulam and Palni, it is stated that it would be difficult to exact proper task from the labourers. Water-rate may be charged on the irrigated dry lands if the wells are sunk on poramboke and Government assessed waste lands. Such wells may be handed over to the ryots if they are not required for communal purposes after recovering the value thereof.

The Head Assistant Collector says that there is no scope for extension of irrigation in the four Government villages in his division. The Madura Deputy Collector has not reported at all. The Deputy Collector, Madura division, has since submitted the report regarding Tirumangalam taluk.

Tirumangalam Taluk.—In selected localities wells may be dug as relief works from Government funds and eventually made over to the adjoining land owners on payment of the cost of construction until they are so made over; water-rate less baling deduction may be levied for the use of the well in addition to the usual land assessment whether the land is Government assessed waste or patta land. The Tahsildar adds that extension of well irrigation is possible; but whether there are suitable localities and facilities for sinking wells by famine labour has not been reported.

Madura Taluk.—Only the 36 villages north of the Periyár Main channel are subject to occasional scarcity of water. Large acres of land situated therein are supplemented by well irrigation as the tanks have to be filled in more than once before the crops are brought to maturity. It is therefore desirable that more wells should be sunk in these villages. However, as most of these villages adjoin the slopes of hills, the sinking of wells will have to be done at great cost. Water is available at a small depth in a few villages on the south of the Madura town bordering on the Vaigai river, but wells can be sunk only if the ryots consent.

I am sceptical about the development of well irrigation by famine labour. So far as my experience goes, wells, as a rule, require skilled labour and the ordinary coolies would not be able to dig them. Even if they could, only a very small number could be employed on each well at one time and such work is unsuitable for relief. It may be taken as certain that all places where water is readily obtainable have already been utilized for wells and that in the event of famine labour being used, only deep and expensive wells could be dug. The results would probably be quite incommensurate with the exertion.

In patta lands no doubt every pattadar would gladly allow experiments to be tried. In waste lands the wells would probably be abandoned unless very successful. Few of them could be sold afterwards.

TINNEVELLY DISTRICT.

The Collector supplies the following remarks and statements :—

• • • • •

Two statements showing the number of wells in dry and wet lands, with the areas irrigated by them in faslis 1299 and 1309, are enclosed. The numbers have risen in the past ten years from 28,925 and 4,619 to 40,502 and 7,153. This shows that the ryots are already fully alive to the advantages of well-sinking, and require no special encouragement. The number of both classes of wells sunk with the aid of State loans is only 973. This is but a small proportion of the general increase. The impediment to any large demand for State loans is the rule that the property offered as security must be unencumbered. As long as this rule exists, and it seems imperative to retain it under present conditions, the grant of loans must always be restricted. The only way out of this difficulty is to make the loan a first charge on the land, which will require legislation. The portion of the district, which is probably most unsuited for grain production, is the sandy fringe of several miles in breadth extending along the sea coast. In this area water can, as a rule, be obtained readily by sinking small holes in the earth. Deep wells are unnecessary and would probably not pay. Besides this, this area depends upon the palmyra industries for its wealth. The question of sinking wells on these lands need not be considered. This area includes parts of Ottappidáram, Srivaikuntam and Nangunéri taluks. The remainder of Srivaikuntam and the whole of Ambasamudram with their river system, and palmyra industries, and parts of Tenkási and Tinnevelly with their river irrigation may also be left out of account. Of the remaining area Sáttúr and the remainder of Ottappidáram are devoted mainly to the growing of cotton, and are likely to remain so. The sinking of wells is a costly matter in black cotton soil, and is done only for the cultivation of garden crops, which are not likely to be largely extended. In Srivillipattúr, Sankaranayinárkóvil, and parts of Tenkási, Tinnevelly and Nangunéri wells will be of undoubted use, but, as already said, the ryots fully realize this and are increasing their wells rapidly without special encouragement, and if anything more is necessary, it can, I think, be best brought about by making State loans a first charge upon the land protected by the well which is built.

Deepening of wells is said to be resorted to in parts in times of failure of supply in them and bore holes are also occasionally jumped to increase the supply in wells. The Sub-Collector considers that deep sinking will be of no practical use in red soil areas, while the Head Assistant Collector is of opinion that deepening of existing wells ought, certainly, to form part of the protective scheme in Nangunéri and in parts of Tenkási. The grant of loans for deepening wells may be encouraged, but the cost being generally small it is doubtful whether loans will be sought for to any large extent.

The sinking of wells by the State is a question upon which it is difficult to give an opinion. It is easy to criticise the proposal. Assuming famine labour is suitable for sinking wells, each well can employ but a limited number and the works must be scattered. It is useless merely digging holes; the holes must be completed with the necessary stone work, which is costly and may require special labour. Unless Government is prepared to give wells free, no such scheme can be introduced on a large scale until Government makes the cost to be recovered a first charge on the land benefited, for, otherwise, there will be delays in finding if a land is unencumbered. Finally, what arrangement is to be made with the pattadar as to payment? No well will, of course, be begun without the pattadar's consent. Considering that the well will be sunk to find employment for famine labour, and that the work is undertaken as an insurance against future famine, the pattadar may be tenderly dealt with, and half to two-thirds of the estimated cost of the work at normal rates may be chargeable on the pattadar. As above suggested, this cost must be a first charge on the land, and may be recovered by instalments as provided by the Loans Act; or, if the pattadar desires it, a special well rate may be imposed on the land. The scheme is certainly worth a trial, but experience alone can show the value of it. A suggestion has been made that lands bought in by Government should have wells sunk in them. Such lands are usually the least valuable; and it is doubtful if the wells on them would ever be useful and remunerative.

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I.—[illegible]

Taluk.	Number of wells and area irrigated.						The approximate depth below the surface at which water is available.	The effect of well irrigation in any special year when there was a failure or partial failure of rain.	The number of wells that have been constructed or improved by State loans during the past ten faslis 1299—1309.	Remarks.
	In fasli 1299.	Area irrigated.		In fasli 1309.	Area irrigated.					
1	2	3		4	5		6	7	8	9
		ACS.	C.		ACS.	C.				
Tinnevelly	678	2,938	53	1,362	8,167	85	17 to 45 ft.	This being mainly a river-fed taluk, well irrigation is very scarcely resorted to.	55	Extension and improvement of wells, especially in dry parts, will, no doubt, be of use in times of famine and drought. There are very few lands depending entirely on well irrigation.
Nángunéri	2,810	5,698	0	4,269	6,942	0	10 to 20 ft.	In fasli 1300, there was failure of rain and remissions were granted. Area irrigated by well in that fasli, was 16808·65 acres.	Newly constructed, 109 Improved, 21.	As there was no water in the irrigation sources in fasli 1300, the ryots diverted their exertions towards cultivating lands protected by wells. Hence the large extent of cultivation in fasli 1300. The ryots do not generally care to sink wells unless they are in distress.
Ambásamudram ..	904	944	82	1,457	1,237	66	10 to 25 ft.	......	28	Out of 1,457 shown in column 4 only about 900 wells situated in ten villages lying north of the Tinnevelly-Pottalpudoor road, are said to be used for growing crops. It is said that in times of scarcity, the extent irrigated by well does not show any appreciable increase, as the people in those parts who are generally Shanars partly depend upon palmyrahs and partly work as field labourers.
Tenkási	1,774	2,397	34	2,549	3,591	0	6 to 10 ft.	It is said that in faslis 1300 and 1304, when there was a drought, the crops on garden lands and on the wet ayakut were saved with the aid of wells.	88	
Sankaranayinárkóyil ..	5,437	15,778	27	6,678	16,924	8	8 to 12 yds.	......	175	The wells in this taluk contain generally good supply of water. In Niladanallur and Karuvanallur firkas, the wells are said to contain sufficient water for irrigation even in times of full or partial failure of rain.
Srivillipattúr	8,970	19,699	8	12,451	22,929	66	6 yds.	In fasli 1309, when there was partial failure of rain, the wet crops raised with the aid of tank water were afterwards irrigated a good deal by the wells on wet lands. The wells on dry lands did not dry up and consequently yielded a fair outturn.	121	....
Sáttúr	3,988	9,164	0	5,676	12,536	[illegible]	12 to 24 ft.	......	156	It is said that in times of partial failure of rain, the crops are irrigated a good deal by the supply from wells, but when there is thorough failure of rain the well supply becomes short and the extent of cultivation is [illegible].
Ottappidáram	2,864	5,533	0	3,018	6,391	0	15 to 20 ft.	In years of drought supply in existing wells becomes diminished and the wells are deepened to increase the supply.	53	....
Srivaikuntam	2,010	1,790	9	3,672	2,839	0	6 to 10 ft. 12 to 18 ft.	.....	[illegible]	Irrigation by wells has been much useful in the southern parts of the taluk during bad years, but in the northern parts it was useful only for a small area as there are no wet lands depending on well irrigation.
Total ..	28,925	63,042	54	40,502	78,598	14			[illegible]	

II.—*Wells in Wet Lands.*

Taluks.	Number of wells and areas irrigated. In 1299.	Area irrigated.	In 1309.	Area irrigated.	The approximate depth below the surface at which water is available.	The effect of well irrigation in any special year when there was a failure or partial failure of rain.	The number of wells that have been constructed or improved by State loans during the past ten faslis 1299—1309.	Remarks.
1	2	3	4	5	6	7	8	9
		ACS. C.		ACS. C.				
Tinnevelly	330	299 2	896	791 90	10 to 20 ft.	..	..	The effect of these supplemental wells which are found in the ayakut of almost all tanks, whose supply is precarious, is certainly very great in years in which the season is hopeful in the beginning, but proves bad latterly.
Nánguṅéri	403	200 0	720	379 0	10 to 20 ,,	..	..	
Ambásamudram ..	122	101 70	516	559 69	6 to 16 ,,	..	..	
Tenkási	385	121 88	781	20 84	6 to 10 ,,	..	..	
Sankaranayinárkóyil ..	417	350 0	635	520 0	5 to 8 ,,	..	6	
Srívilliputtúr ..	916	1,090 99	1,299	1,798 28	6 yards.	..	37	
Sáttúr	164	266 0	214	331 0	10 to 16 ft.	..	2	
Ottappidáram ..	87	304 0	122	428 0	15 to 20 ,,	..	..	
Srívaikuntam ..	1,795	1,600 0	1,970	2,716 0	6 to 10 ,, 12 to 18 ,,	..	..	
Total ..	4,619	4,333 59	7,153	7,544 71	....	..	45	

The only addition I have to make is that the supplemental and ayakut wells do not appear to have been sufficiently differentiated and I would urge the extension of the former in all places where the supply to tanks is at all precarious.

தமிழ்நாடு ஆவணக்காப்பக நூலகம்,
எழும்பூர், சென்னை-600 008.

தவணைத்தாள்.

சே எண் : ப. எண் :

வழங்கிய நாள். (1)	திரும்பிய நாள். (2)	வழங்கிய நாள். (1)	திரும்பிய நாள். (2)
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