



सत्यमेव जयते

**GOVERNMENT OF INDIA
PLANNING COMMISSION**

Report
OF
THE TECHNICAL COMMITTEE
FOR
THE OPTIMUM UTILISATION
OF THE
KRISHNA & THE GODAVARI
WATERS
AND CONNECTED PAPERS

1953

GOVERNMENT OF INDIA
PLANNING COMMISSION

Report
OF
The Technical Committee
FOR
the optimum utilisation of the Krishna
and the Godavari waters and
connected papers.

Sri. A. N. Khosla (Chairman).

1953

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LETTER OF TRANSMITTAL

To

The Secretary,
Planning Commission,
New Delhi.

Subject :—Technical Committee for the optimum utilisation
of the Krishna and Godavari waters

SIR,

In their letter No. PC(V) 59/1/51, dated December 17, 1951 (*vide* appendix A) addressed to the Madras Government, the Planning Commission appointed a Committee consisting of :—

Shri A. N. Khosla, I.S.E., Chairman, Central Water and Power Commission.	Chairman
Shri Moti Ram, I.S.E., Chief Engineer, Irrigation, Uttar Pradesh	Member
Shri G. R. Garg, I.S.E. (retired), Director Irrigation, Central Water and Power Commission	Member-Secretary

to examine and report on the most economical manner of utilising the waters of Krishna and Godavari rivers allotted to the Madras State (*vide* inter-State agreement—Appendix B).

The terms of reference to the Committee were as under :—

- “(a) How the waters of these rivers can be used to the best advantage, and recommend for inclusion in Part II of the Plan a project which would bring about extension of irrigation facilities to as large an area as possible on the most economic basis which can be completed in a reasonable time.
- (b) Whether there will be sufficient waters left for the needs of the Godavari and Krishna deltas after the utilisation proposed under the Krishna-Pennar Project.

- (c) Whether the Krishna-Pennar Project is technically sound and economically a better proposition than other schemes considered, and whether, having regard to the urgent need for increased food supply, especially of rice, this project should be included in Part II of the Plan ; and
- (d) Whether it can be completed within 3 to 4 years if funds can be provided."

2. The Committee assembled at Delhi on 28th January 1952 for preliminary discussions, study of the various projects and preparation of their tour programme.

The Committee left for Madras on the 17th February, 1952 and stayed in Madras and Hyderabad States till 5th of March, 1952. During their tour, the Committee inspected the sites of dams and other important works included in various projects prepared by the Madras and Hyderabad States for the utilisation of Krishna, Godavary and Pennar waters. They also met the Hon'ble Ministers of the Madras Government and held discussion with Madras and Hyderabad Engineers. Prominent people from all over the area and representatives of associations interested in the various schemes were interviewed. A large number of written representations were received. During their extensive journeys by road, the Committee visited areas proposed to be served by the project already submitted and also the vast dry tracts in the Guntur and Nellore districts for which no proposals for irrigation had yet been framed.

The Committee reassembled at Delhi in the middle of March, 1952 to examine the vast data supplied by the State Governments and collected by them during their tour and to prepare their report. Work on the preparation of the report has since continued.

3. The Committee have carefully examined the Krishna-Pennar Project (1951). It is intended to benefit the Kurnool and Cuddapah districts of Rayalaseema, districts of Nellore, Chingleput and Chittoor and to augment the Madras City water supplies.

The Committee are of the opinion that the project is generally technically sound but that the actual cost is likely to be considerably in excess of the estimated. The comments of the Committee on various features of the project are given in Chapter IV. Two of these main features are, the available supplies at Siddeswaram and the designed capacity of canals. The

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actual supplies available at Siddeswaram dam will be 15% less than those assumed in the Project to allow for the inflow between Siddeswaram and Vijayawada.

Owing to this reduction in supplies, the area which can be irrigated from the project will be considerably reduced. This in turn will adversely affect the financial returns as indicated in para. 4.20 of the Report.

The capacities provided for the various canals are excessive and can be considerably reduced without loss of efficiency. The Committee has suggested certain modifications which, if adopted, would reduce the probable excess on the estimate (*vide* para. 4.3 to 4.10).

Other adverse feature of the Krishna-Pannar Project (1951) is the submergence of 3 lakhs acres of land of which 1,82,000 acres are cultivated and the displacement of nearly 1½ lakhs of people by the Krishna and Pennar dams (*vide* paras. 4.0 and 4.1). Also the benefits will largely go to areas already served by canals or tanks while vast tracts lying close to the Krishna and having no alternative means of irrigation supplies will be permanently denied such supplies (*vide* para. 4.23).

4. With a view to eliminating the above mentioned adverse features of the Krishna-Pennar Project, getting quick results in food production and providing for the ultimate needs of all areas which can be physically served by the Krishna-river within limits of economic feasibility, the Committee have drawn up fresh proposals which are outlined in Chapter V of the report. The Committee have suggested three stages for execution of these proposals.

Stage I will comprise :

- (i) the remodelling of existing Kurnool-Cuddapah canal to serve famine stricken areas of Rayalaseema ;
- (ii) construction of Kaveli, Kanupur and Krishna-Pennar East Canals of the Krishna-Pennar Project (1951) to secure quick increase in rice production ;
- (iii) construction of a high dam on the Krishna at Nandikonda together with;
- (iv) canals on both banks to irrigate the dry and scarcity areas of Guntur and Nellore (Madras State) and Telengana areas of Hyderabad and extend irrigation

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south of Pennar to Madras ; (for areas south of Madras see paragraph 8 below) ;

- (v) also to ensure domestic water supply to Madras City.

The remodelling of Kurnool-Cuddapah Canal and construction of Kaveli, Kanupur and Krishna-Pennar East Canals can be taken up independently of the rest of works and may preferably constitute the first phase of the first stage. This phase can be completed quickly and can show results in about three years. The cost involved is about Rs. 8.68 crores, the area irrigated being 4.88 lakh acres and additional food production 91 lakh tons.

Stage II will comprise :

- (i) the construction of a dam (13.5)' lower than that contemplated in the Krishna-Pennar Project (1951) at Siddeswaram along with;
- (ii) a feeder channel leading to the Pennar (capacity of this canal will be only about 1/7th of that proposed in the Krishna-Pennar Project 1951) ;
- (iii) the Krishna-Pennar West Canal; and
- (iv) some of the branches of the Nandikonda right canal left out in the 1st stage.

Stage III will comprise the construction of a dam at Pulichintala to provide additional irrigation for 2nd crop in the Krishna delta.

5. These proposals of the Committee include all the areas which were proposed to be benefited by the Krishna-Pennar Project with the exception of about 7 lakhs acres (of which 3.64 lakh acres were to be irrigated) lying mostly in Chingleput district which were to be served by the proposed Pennar-South Canal. Out of these 3.64 lakh acres the irrigation of about 2 lakh acres is envisaged *vide* para. 8. (This area is served both by the South West and North East monsoons and receives an average annual rainfall of 46". There are numerous tanks for irrigation purposes and there is distress only when rains fail). The Committee's proposals provide in addition, for irrigation to about 37 lakhs acres of dry uplands in the Guntur and Nellore districts and to about 3 lakhs acres in Nandigama taluk which have low rainfall and lie in close proximity of the Krishna river

and have no alternative source of irrigation (*vide* para. 5·1). The possibility of further extending irrigation in Chingleput district is discussed in para. 8.

6. The Krishna-Pennar Project (1951) is intended to irrigate 21·96 lakh acres in the Stage Plan and 37·65 lakh acres in the Full Plan and give a return of 3·14% and 3·45% respectively 10 years after completion. These figures are, however, not likely to be realised on account of water supplies being less by 15% than anticipated. The revised calculations made by the Committee after allowing for this error in water supplies show that areas and return in the Stage and Full Plans will be as under :—

	Area Irrigated Lakh acres	Per cent return Decreasing
Stage Plan	21·06	2·61
Full Plan	28·65	2·58

The financial position will continue to get worse thereafter instead of improving because of the returns being lower than the interest charges (*vide* para. 5·14.)

7. The Committee have prepared approximate estimates of the cost of their proposals on the basis of available data. According to these estimates the areas irrigated and the return on the sum-at-charge 10 years after completion in the various stages of the Committee's proposals will be as under :—

	Estimated cost Rs. crores	Area irrigated Lakh acres	Per cent return Increasing
Stage I	84·82	30·36	4·29
Stage II	124·92	37·76	3·34
Stage III	132·43	41·26	3·39

In addition the approximate expenditure to be incurred by Hyderabad will be as under :—

	Estimated cost	Irrigation in lakhs of acres
Stage I	Rs. 32·22 crores	6·75 with dependable supply.
Stage II . . . . .	..	8·60 with more than dependable supply.

The Hyderabad Government attaches great importance to provision of irrigation facilities in the area commanded by Nandikonda reservoir in their territory and their participation may be taken as assured.

The above figures are based on rough estimates and may have to be suitably altered as a result of detailed investigation and survey which must be carried out. It is hoped that the difference will not be large (*vide* paras. 5·14 and 5·83 and tables VI and VII).

8. The Committee have considered the possibility of diverting Godavari waters into the Krishna. On the basis of present studies about 100 t.m.c.ft. (2·30 m.a.ft) can be so diverted. It is, however, felt that further studies in connection with the integrated use of Godavari and Krishna waters may disclose the possibility of substantially bigger diversion of supplies from the Godavari and establish the technical and economic feasibility thereof, thus enabling extension of irrigation to considerable areas south of Madras. These areas can otherwise be served by Bombay and Hyderabad not eventually using their full shares of Krishna waters, the unused balance thus becoming available for Madras, or by integrating the power systems on the Godavari and the Krishna thus releasing for purposes of irrigation supplies from Nandikonda and Pulichintala reservoirs which would otherwise be used for power generation. In this case it should be possible to divert on the basis of present studies (future studies may indicate more) another 30 t.m.c.ft. or about 130 t.m.c.ft. (2·98 m.a.ft) in all from the Godavari to the Krishna and take the entire Krishna delta 2nd crop irrigation on to the Godavari and thus release equivalent Krishna water for irrigation of about 2 lakhs acres south of Madras which is nearly half the figure of 3·64 lakh acres of the irrigation proposed in this tract in the Krishna-Pennar Project (1951) (*vide* para. 5·10).

The additional supply of 30 t.m.c.ft. (·68 m.a.ft.) referred to above will be definitely available till such time as water is required for full development of power. Thereafter it can be made available by integrating all the powers systems on the Godavari, the Krishna and their tributaries (*e.g.*, Tungabhadra). In the earlier years Madras will be able to get waters from the unused shares of Bombay and Hyderabad (to which it must be clearly understood Madras has no claim, but which can be used so long as it is running to waste in the sea).

Thus we can presume that 30 t.m.c.ft. (.68 m.a.ft.) will be available all the time. On this basis it is recommended that the Madras Canal should be constructed for a capacity of 6,000 cusecs from the very beginning. This will ensure irrigation to about 2 lakh acres south of Madras. The additional cost on this account will be about Rs. 2 crores. This has not been included in the estimate but if included, is not likely to appreciably change the financial picture. Further extension can be done if and when the results of further investigations mentioned in para. 9 below become available and are encouraging.

Notwithstanding the possibility of bigger diversions materialising from the Godavari, steps should be taken simultaneously to extend irrigation facilities to areas south of Madras by building more tanks and tapping underground waters where available. It is reported that large supplies of underground waters exist above and below the lignite deposits in this region. These should be explored and if proved, tube-well irrigation introduced to the maximum extent possible.

9. If the recommendations of the Committee meet with the approval of the Planning Commission and the Governments of Madras and Hyderabad, it is recommended that immediate steps should be taken to implement the 1st stage of the Committee's plan (*vide* para. 5.13 of the report) and the necessary surveys and investigations mentioned in paragraph 8 above.

It is further recommended that Superintending Engineer with a full complement of Executive Engineers and Sub-Divisional Officers and Circle staff should be appointed forthwith to carry out these investigations under the guidance and control of the Technical Committee.

The Technical Committee should continue to remain in being till the results of these surveys and investigations are available and the Committee is in a position to finalise their views in respect of extension of irrigation to areas not at present included in the Plan.

10. In concluding, the Committee desires to thank the Governments of Madras and Hyderabad for their co-operation, for the excellent arrangements made for the inspection of

REPORT OF THE TECHNICAL COMMITTEE

various sites and for the hospitality extended to the members during their tour. The Committee also thank all the officers and non-officials who have assisted them in their work.

A. N. KHOSLA,
Chairman.

MOTI RAM,
Member.

G. R. GARG,
Member-Secretary.

CHAPTER I

THE RIVERS KRISHNA, GODAVARI AND PENNAR

Introductory

1.1 WITH THE exception of the heaviest rainfall regions in the State of Assam, the Western Ghats in Peninsular India forming a great and continuous range of hills for a thousand miles and running close and almost parallel to the Arabian Sea on the West, receive the most abundant supply of rainfall in the whole of India, coming as they do under the regular influence of the S. W. monsoon. The region has several clearly marked zones with rainfall ranging between 50" and 350".

Drainage basin

1.2 This great barrier is nowhere pierced by rivers, and all the country eastward of its summit levels, has to send its surplus waters to the Bay of Bengal. It thus comes that the drainage from 47,827 sq. miles of the Bombay State, from the whole of the Hyderabad and Mysore States and from almost the whole of Madras State, besides that from upwards of 54,000 sq. miles of the Madhya Pradesh—a total area in all of about 338,100 sq. miles—has to find its way into the sea along the eastern coast of Madras State. The main rivers draining this area are the Godavari, the Krishna, the Pennar and the Cauvery with catchment areas of 116,366 sq. miles, 97,050 sq. miles, 20,000 sq. miles and 26,266 sq. miles respectively. It is by the full development of the vast amount of water resources potentially contained in these mighty rivers that the general welfare of the region and promotion of national interest can be advanced.

THE KRISHNA

1.3. The Krishna River is the second biggest river in Peninsular India having a total catchment area of 97,050 sq. miles during its course of 775 miles in the four States of Mysore,

Bombay, Hyderabad and Madras. The area drained by the river and its length in each of these States are as follows :—

	Sq. miles	Length
(a) Mysore	11,100	...
(b) Bombay	38,000	305
(c) Hyderabad	35,450	(175+180)
(d) Madras	12,500	(180+115)
TOTAL	97,050	775

Most of the runoff is contributed by its tributaries like the Koyna, the Bhima, the Tungabhadra etc. which rise in Mysore and Bombay and receive heavy rainfall from S. W. monsoon.

The course of the river

1.31. The source of the Krishna and the sources of its affluents are spread over an area which covers six degrees of latitude and lies along the eastern slopes of the Western Ghats almost touching the headwaters of the Godavari in the north and over-lapping those of the Pennar and the Cauvery in the south. The traditional fountain head of the Krishna is a spout fashioned into the image of a cow's mouth in an ancient temple of Mahadeo at the foot of a steep hill near the Bombay Sanitorium of Mahabaleshwar, some 4,000 ft. above sea level. From this the Krishna runs southward in a rapid course, flowing through the Bombay districts of Satara and Belgaum, the cluster of States which till recently formed the south Marahatta Agency, and the district of Kaladgi. Then it turns east to enter into the Hyderabad State. In this reach it receives many tributaries, of which the chief are the Yerala, Warna, Idenge, Ghataprabha and Malprabha. All these, like the main stream, are typical rivers of the Deccan Plateau. They run in deep channels, from which it is almost impossible to lead off channels for irrigation. In the rainy season they swell into bringing torrents, but during the remaining eight months of the year they shrink to mere threads of water struggling through a sandy waste.

On entering the Hyderabad State, the Krishna drops in a rapid to the alluvial Doabs of Sholapur and Raichur. The fall is as much as 400 ft. in about 3 miles. These falls are known as Jaldrug Falls. The first of the Doabs mentioned above is formed by the confluence of the Bhims, which brings down the drainage of Ahmednagar, Poona and Sholapur; the second by the confluence of the Tungabhadra, which drains the north and west of Mysore and the Ceded districts of Bellary and Kurnool. After junction with the Tungabhadra, the Krishna comes into the Madras State and still flowing east, forms for a considerable distance the boundary between Madras and Hyderabad. Its last important tributary is the Musi, on whose banks stands the city of Hyderabad.

At Siddeswaram a few miles east of Kurnool, the Krishna meets ranges of hills and flows through hilly country and gorges for nearly 180 miles before entering the plains of the Coromandel coast at Pulichintala. Scattered hill out-crops, however, continue on both banks upto Vijayawada. Beyond this point stretching away on both sides of the river lies the alluvial deltaic plain formed by its silt. Through this the river continues in a single channel of great width for another 40 miles, when it sends off to the left a branch known as the Puligadda which forms, the Island of Divi, and after a course of 20 miles enters the sea at the point of that name. The main stream continues for another 15 miles and then breaks up into three mouths, the Narasagunta Krishna, Lankevanirichi Krishna and Venisagara Krishna separated from one another by two small islands which are covered for the greater part by dense mangrove jungles and are more or less submerged during spring tides and high floods, but have nevertheless some 2,000 inhabitants and a few hundred acres of precarious cultivation.

Characteristics of the river

1.32. The drainage basin of the Krishna lies chiefly under the influence of the south-west monsoon and it is therefore from June to October that it brings down by far the greater quantity of water occasionally swelling into floods, in the highest of which as much as a million cusecs sweep past Vijayawada, a quantity more than twice as great as the maximum discharge of the Nile or the Cauvery. After October the water in the river decreases rapidly till by the end of January or the beginning

of February it does not overflow the anicut at Vijayawada if the head sluices of the canals are open. During the following three months it dwindles to a petty stream meandering through a wide expanse of sand, its minimum discharge falling as low as 100 cubic ft. per second. Low dry-weather water level, narrow and rocky bed, great flood lift sometimes as much as 100 ft. are some of the more distinctive characteristics of the greater part of the river above Vijayawada anicut.

The tributaries of Krishna

1.33. The following statement furnishes a list of the important tributaries of the Krishna with their catchment areas and the distance of their confluence with the parent river from Vijayawada :—

Tributary	Catchment area (sq. miles)	Distance of confluence with main river from Vijayawada (miles)
Koyna	800	604
Yerla	1,172	564
Pancha Ganga	977	498
Yerna	940	520
Dudh Ganga	995	487
Ghataprabha	3,628	421
Mallaparabha	4,580	398
Bhima	26,964	297
Tungabhadra	27,259	219
Dindi	1,530	132
Pedda Vagu	780	119
Halia	1,540	101
Musi	3,330	86
Palleru	1,310	45
Muneru	2,610	20
Krishna main river and other minor tributaries	18,536	...
TOTAL CATCHMENT AREA	97,050	...

Lower Krishna basin

1.34. The valley of the river between the confluence of Tungabhadra and the sea may be called the "Lower Krishna Basin" which has a length of about 280 miles. In this basin sites exist at Siddeswaram, Nandikonda and Pullichintala for construction of high dams for integrated and unified development of the country side. The bed level at Siddeswaram is +770 and at Pulichintala a distance of 186 miles below Siddeswaram it is +80.0.

• There is thus a steep fall of 690 ft. in 186 miles (*i.e.* about 3.70 ft. per mile) affording immense possibilities of development of cheap hydel power. There are wide areas adjacent to the river where rainfall is precarious, erratic and flashy. It was recognised by the famous Indian Irrigation Commission even as early as in 1901-03 that "within this catchment lies a larger extent of exceptionally insecure country than is to be found in any other river basin in India". Integrated development of the river for irrigation, power and other purposes should solve the problem of this basin.

Estimation of annual runoff and dependable yield

1.35. The discharge of Krishna river varies within a wide range. The peak discharge ever recorded at Vijayawada was 11.94 lakh cusecs on 7th October, 1903. During summer the flow shrinks and often falls below 100 cusecs. For the formulation of river valley projects for conservation and utilisation of water resources, it is essential to know the total yield of water that would be available from the catchment of the river. Statement I gives the catchment area, the annual rainfall, runoff and the yield in m.a. ft. in different regions of the Krishna catchment for a normal year based on Khosla's formula for runoff. According to this formula, the annual runoff in the Krishna catchment is estimated to be 38 m.a. ft. (1656 t.m.c.ft.) during a normal year.

STATEMENT NO. 1

14

Kistna Catchment—Year of Normal Rainfall

Serial No.	Name of River	Catchment area in sq. miles	Normal rainfall inches (annual)	Mean temperature Degree F (annual)	Loss inches (annual)	Run-off inches (annual)	Run-off million acre feet (annual)
1	Krishna up to Bhima (exclusive Bhima) .	20988	36·51	76·4	23·50	13·01	14·53
2	Bhima	26335	30·67	78·9	24·27	6·41	9·00
3	Tungabhadra up to Dam site	11121	40·31	76·5	27·67	12·64	7·50
4	Tungabhadra from Dam site to its confluence with Krishna	15877	22·53	79·6	22·43	0·15	0·13
: Rest of Krishna :—							
	(a) from its confluence with Bhima to Siddeswaram	4142	26·66	...	21·62	5·04	1·11
	(b) from Siddeswaram to Nandikonda	4674	25·40	...	21·60	3·80	0·91
	(c) from Nandikonda to Pulichintala	7563	28·69	...	22·75	5·94	2·36
	(d) from Pulichintala to Vijayawada	6400	30·09	...	23·77	7·32	2·47
	TOTAL of Krishna at Vijayawada	97050					38·01

Say

38·0
Say m. a. ft.

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Dependable yield

1.35. The annual dependable yield at Vijayawada based on actual supplies reaching Vijayawada is about 1715 t.m.c. ft. (39.37 m.a. ft.). This is available in 44 years out of 51. After allowing for the local inflow according to the last column of statement I the annual dependable yields at the three dam sites viz. Siddeswaram, Nandikonda and Pulichintala are :—

Site	Annual dependable yield in	
	t.m.c. ft.	m.a. ft.
1. Siddeswaram	1458	33.47
2. Nandikonda	1496	34.34
3. Pulichintala	1603	36.80

While the annual dependable yield is taken as 1715 t.m.c. ft. (39.37 m.a.ft.) it is interesting to note that the annual runoff of the Krishna catchment varies from a maximum of 3500 t.m.c.ft. (80.35 m.a.ft.) to a minimum of 800 t.m.c. ft. (18.26 m.a.ft.).

Allocation of Krishna waters

1.37. The waters available in the Krishna basin for future utilisation and development by the riparian States of Bombay, Mysore, Hyderabad and Madras have been allocated to these States as given below :—

State	Allocation of flows up to 1000 t. m. c. ft. above present utilizations		Allocation of excess flows	
	(percentage)	t.m.c. ft.	m. a. ft.	percentage
Bombay	24	240	5.51	30
Hyderabad	28	280	6.43	30
Mysore	1	10	0.23	1
Madras	47	470	10.79	39

The basis of apportionment of the waters of Krishna and Godavari basins, agreed to at the inter-State conference convened by the Planning Commission in July 1951, is given in the "Memorandum of Agreement" Appendix B.

THE GODAVARI

General description of the river

1.4. The Godavari—the largest river in South India and the second largest river in the Indian Union rises in the Western Ghats at Trimbak near Nasik about 70 miles north-east of Bombay and only 50 miles from the Arabian Sea. After descending the Western Ghats it flows generally in a south-easterly direction across the Peninsula and then falls into the Bay of Bengal about 250 air miles (or about 325 miles as measured along the coast) north of Madras and 50 miles east of Rajahmundry. The total catchment of the river is 1,16,300 sq. miles which is very nearly equal to the area of the Madras State. The distribution of its catchment and length in the riparian States through which it flows are as under :—

State	Catchment sq. miles	Length miles
Bombay	6,563	80
Madhya Pradesh	52,050	36
Hyderabad	46,750	(36+425+135)
Madras	10,937	(135+90)
TOTAL	1,16,300	

The high flood discharge at the Dowleshwaram Anicut varies generally between one million and two million cusecs. The maximum discharge so far recorded occurred on the 6th August 1942, and was 21,77,550 cusecs. The annual runoff of the river average about 09 m. a. ft. (3450 t.m.c.ft.).

The main tributaries of the Godavari

1.41. These are the Manjira, the Pranhita, the Indravati and the Sabari. The Pranhita is in its turn formed by the confluence of the Wardha, the Penganga and the Wainganga. The Manjira runs through Hyderabad State and has a catchment area of about 11,000 sq. miles. The Penganga starts in Berar and for the last 220 miles of its length forms the boundary between Hyderabad and Berar. The Pranhita serves as the boundary between Hyderabad and Madhya Pradesh. The catchment areas contributed by the main tributaries are as follows :—

	sq. mile
(1) Godavari upto its confluence with Pranhita	44,500
(2) Penganga and Wardha	17,300
(3) Wainganga and Pranhita	22,800
(4) Indravati	15,700
(5) Sabari	7,500
(6) Other minor streams	8,500

The Godavari river within the Madras State

1.42. The Godavari enters Madras State at Lotipita-Gandi about 88 miles north-west of Bhadrachalam and forms the boundary between Madras and Hyderabad upto a point a few miles below its confluence with the Sabari beyond which it lies completely in Madras.

1.43. Shortly after the confluence of the Sabari, the Godavari begins to wind amongst the spurs of the Eastern Ghats, which gradually close in on it till it has to force its way through a picturesque gorge which for two miles is only 200 to 300 yards in width against a width of nearly a mile at Polavaram, 20 miles lower down. The hills on either side of the gorge rise to a level of 2000 to 3000 ft. with steep but not precipitous sides which are clothed with vegetation. The depth of the river in the gorge during non-flood season varies from 100 to 200 ft. Flood lift here is 50 ft. so that there is a torrent varying in depth from 150 to 250 ft. in the monsoon. After emerging from the Eastern Ghats at Polavaram the width of the river rapidly increases and is nearly 2 miles at Rajahmundry—20 miles lower down and nearly four miles at Dowleswaram.

Flow in the river

1.44. As the greater portion of the area drained by the Godavari river receives much more rain during the south-west monsoon (June to September) than in the north-east monsoon, the river brings down most of its waters between June and September. The water level begins to rise at Dowleshwaram some ten days after the south-west monsoon sets in at Bombay, usually about the middle of June, and it is almost continuously high till the end of September. High floods during October are rare. The flood season ends by October, but during the next two months there are occasional freshes caused by the north-east monsoon over that part of the catchment which comes under its influence. After the north-east monsoon rains have ceased, the river gradually goes down, falling to the crest level of the anicut sometime in March and going down below the crest by the end of May when the discharge may be as low as 1500 cuses.

Of the total flow of the Godavari, nearly 40% is contributed by Pranhita, 20% by Indravati, 10% by Sabari and comparatively little by other tributaries and the Western Ghats, that is, the conditions are quite the reverse of those on the Krishna where the main contribution is from the Western Ghats.

Average annual runoff and the dependable yields

1.45. According to the actual observations extending over 66 years, the average annual runoff at the site of the Dowleshwaram anicut in Madras is 3433 t.m.c. ft. (78.81 m.a.ft.) and the average annual dependable yield is about 2500 t.m.f. ct. (57.39 m.a.ft.) Deducting from this 505 t.m.c. ft. (13.66 m.a.ft) on account of existing utilization plus supplies required for projects under construction in various States, a balance of 1905 or say 1900 t.m.c.ft. (43.2 m.a.ft) is available and this has been allocated between the various States (*vide* Memorandum of Agreement : Appendix B) as under :—

Bombay	57 t. m. c. ft.	(1.31 m. a. ft.)
Hyderabad	494 t. m. c. ft.	(11.34 m. a. ft.)
Madhya Pradesh	456 t. m. c. ft.	(10.47 m. a. ft.)
Madras	893 t. m. c. ft.	(20.50 m. a. ft.)

This allocation was made in the inter-State conference convened by the Planning Commission in July 1951.

THE PENNAR

1.5. The river Pennar, also called Uttars Panakini, has its source in the Chennakeswa Hills, north-west of Nandidurg in Mysore State. In its course of about 370 miles, it drains a total area of 20,000 sq. miles, made up of 1880 sq. miles in Mysore and 18,150 sq. miles in Madras State.

I

Course of the river

1.51. The Pennar enters Madras State from Mysore and after flowing in a general south-eastly direction through the districts of Anantapur, Cuddappa and Nellore joins the Bay of Bengal. During its course in Madras State, it cuts through ranges of hills at Gandikota and Somasila where suitable sites for dams exist and have been investigated in detail. Several important tributaries such as the Jaimangli, the Chitravati, the Kunderu, the Papaghani, the Segileru, the Cheyyar and the Karean meet it within Madras borders.

Drainage basin

1.52. The river receives its supplies from both the south-west and north-east monsoons. The portion above Gandikota gorge comes within the sphere of the S. W. monsoon while in the lower portion the north-east current is more important. The precipitation in the catchment is generally low and ill-distributed and there is a wide variation in the annual yield from year to year. The average flow even in July and August and November and December is low with peaks of short duration. After December the discharge falls to a few cusecs and in the summer the stream is practically dry.

There are a large number of tanks in its upper catchment, especially in Mysore State. Fairly considerable area of 1st crop is irrigated in the delta from channels taking off from the Sangam and the Neollore anicuts. There are also some spring channels in the Anantapur, Cuddapah and Nellore districts which irrigate small blocks of ayacuts.

Maximum discharge and annual dependable yield

1.53. The maximum flood discharge of the river as observed at the Sangam anicut in 1909 was 4.47 lakhs cusecs, but the annual dependable yield after making allowance for established irrigation is less than 90 t.m.c.ft. (2.0 m.a.ft.) and a large reservoir cannot, therefore, be constructed on the basis of Pennar supply alone. The dependable yield at the Gandikota site is only 11,500 m.c.ft. (0.26 m.a.ft.) and a reservoir of limited size only is possibly at this place.

CHAPTER II

PROJECTS INVESTIGATED ON KRISHNA AND GODAVARI

PROJECTS ON KRISHNA RIVER

2·0. TWO PROJECTS have been investigated by Madras State on the river Krishna *viz.* Krishna-Pennar Project and Pulichintala Project and one by Hyderabad State *viz.* Lower Krishna Project.

Krishna-Pennar project

2·1. The scheme comprises :—

- (i) a dam and reservoir at Siddeswaram on the Krishna ;
- (ii) a dam and reservoir at Someswaram on the Pennar ;
- (iii) a link canal called Krishna-Pennar Canal from Siddeswaram to Someswaram ;
- (iv) a barrage or pick-up weir across the Pennar $\frac{3}{4}$ mile downstream of Someswaram ;
- (v) a canal on the north of Pennar taking off from the barrage ;
- (vi) a canal on the south of Pennar taking off from the barrage ;
- (vii) two small canals Kanupur and Kaveli from the existing Sangam anicut on the Pennar to irrigate areas adjoining the Pennar Delta ;
- (viii) two canals called Krishna Pennar East and Krishna Pennar West canals taking off from the Krishna Pennar link canal.

2·11. The project is estimated to cost Rs. 130 crores and is proposed to be carried out in two stages.

Work item	Irrigation benefits in lakh acres			Cost in crores rupees
	1st crop.	2nd crop	Perennial	
STAGE I—				
Siddeswaran dam on Krishna without power installation, reservoir capacity 279·0 t. m.c. ft. (6·40 m.a. ft.) . . . . .	...	7·15 (in delta)	*25	19·06
Pennar dam on the Pennar without power installation reservoir capacity 260·0 t. m.c. ft. (5·97 m.a. ft.) . . . . .	...	1·29 (in delta)	*25	23·40
Pick-up barrage below Pennar dam (part) . . . . .	...	...	...	1·22
Krishna Pennar canal link (Part) . . . . .	...	...	...	11·56
Madras canal—a branch of South Pennar Canal	3·68	3·68	...	12·00
Krishna Pennar West Canal	1·90	...	...	6·03
Kaveli and Kanupur canals.	1·88	1·88	...	4·33
	7·46	14·00	0·50	77·60
STAGE II—				
Krishna Pennar Canal Part . . . . .	...	...	...	2·90
Pick-up barrage part . . . . .	...	...	...	0·07
Krishna Pennar East Canal	3·00	...	...	6·06
Pennar North Canal	4·87	...	...	15·10
Pennar South Canal	7·32	...	...	28·50
GRAND TOTAL	22·65	14·50	0·50	130·30

2·12. *Benefits*—The scheme will irrigate 21·96 lakhs acres equivalent to 19·47 lakhs acres wet in the 1st stage and 37·65 lakhs acres equivalent to 32·94 lakhs acres wet in the 2nd stage and

will be capable of generating 1,00,000 k.w. continuous power when generators are installed. The costs given above relate to irrigation works only and do not include cost of generation, transmission and distribution of electricity.

The scheme also provides for feeding of Mylawaram reservoir of New Gandikota Project on the Penner with a discharge of about 1800 cusecs through the Krishna-Penner West Canal. This reservoir will irrigate 1.5 lakhs acres in Cuddapah district. Neither the cost of the Gandikonda Project nor the revenue from it has been allowed for in the Krishna-Pennar scheme. A credit, however, of two crores of rupees has been given to the Krishna Pennar Project on account of the cost incurred on the feeder mentioned above.

The project has been investigated in great detail and has been estimated to give a return of 3.14% in the 1st stage and 3.45% in the final stage on the sum at charge in the 10th year after completion.

The increase in food production in terms of rice is estimated to be 1 million tons in the 1st stage and 1.6 million tons in the Full Plan in addition to small amounts of millets, fish and perennial crops, etc.

Pulichintala project

2.2. This project was investigated in 1908-11 and comprises the following:—

- (i) Construction of a reservoir and a dam across the Krishna at Pulichintala Village.
- (ii) Construction of an upland canal system taking off from the reservoir for the irrigation of 6,10,000 acres of new area in the Guntur district.
- (iii) Additional irrigation of 1,25,000 acres of new 1st crop and 1,67,000 acres of 2nd crop in the Krishna delta.

The dam was to be nearly two miles long with a maximum height of 150 ft., the gross capacity of at F.R.L. 224.5 being 1,63,586 m.c. ft. (3.75 m.a. ft.)

The estimated cost of the scheme at the rates then prevailing was 833.64 lakhs and a return of 5.99% on the outlay was anticipated. At present (1952) rates the cost will be 25 crores.

Lower Krishna project

2.3. This scheme has been recently prepared by Hyderabad State and comprises :—

- (1) a dam across the river Krishna at Nandikonda village;
- (2) a canal on the left bank of the river 140 miles long for irrigation of 1·0 million acres in Nalgonda and Warangal districts of Hyderabad and Nandigama Taluka of Madras State upto Katiloru valley.

The dam will be 6000 ft. long and 325 ft. high above the lowest foundation level with a gross capacity of 269 t.m.c. ft. at f.r.l. 540. The net capacity above cill of canal head sluice will be 97 t.m.c. ft. (2·23 m. acre. ft.)

The scheme according to 1951 rates is estimated to cost Rs. 49·00 crores including 22·80 crores for the dam and 26·20 crores for the canal. Deducting an anticipated receipt of 1150·51 lakhs from betterment fees and debiting half the cost of the dam to power generation, the amount chargeable to irrigation is Rs. 2609·28 lakhs. The estimated revenues at the end of the 15th year from the start of construction is estimated to be Rs. 127·75 lakhs which will give a return of 4·9% on the outlay ; the deficit on account of interest charges in the first 15 years is expected to be cleared by the end of the 27th year.

The additional cost of providing 1,40,000 k.w. power including high tension lines and sub-stations has been roughly worked out to be Rs. 870 lakhs. This will increase to Rs. 1380 lakhs if the power installation is raised to 2,45,000 k.w. These do not include debit of half the cost of the dam which if included, will raise the figures to Rs. 2010 lakhs for the first stage and Rs. 2520 lakhs for the 2nd stage. The rate of energy per unit delivered works out to 0·34 anna in the 1st stage and 0·25 anna in the 2nd stage.

Projects on the Godavari

2.4. Two projects have been investigated by Madras State on this river viz. Ramapadasagar on the main river and Sabari Project on the Sabari—a tributary of Godavari.

Ramapadasagar project

2.5. This consists of :

- (a) a dam 428 ft. high at the deepest portion across Godavari near Polavaram 20 miles above the town of Rajahmundry;

- (b) a canal 130 miles long on the left side intended to irrigate 4.66 lakhs acres of 1st crop and 3.1 lakhs acres of 2nd crop. This canal will empty into Vishakapattam Port;
- (c) a canal 213 miles long on the right side, of which 89 miles will lie across the Krishna river which it will cross by an aqueduct. This is designed to irrigate 7.2 lakhs acres of 1st crop and 2.0 lakhs acres of 2nd crop. Out of 7.2 lakhs, 4.2 lakhs will be in Guntur district across the Krishna ;
- (d) a power station to develop, 1,50,000 k.w. of firm power.

In addition, the project is designed to irrigate 3.5 lakhs acres of new 2nd crop in Godavari delta and 6.4 lakhs in Krishna delta. It may be added here that Krishna-Pennar Project also provides for 2nd crop irrigation in Krishna delta. Hence there is overlapping so far as 2nd crop irrigation in this delta is concerned.

The dam will be in two sections with the existing Mahanadi hill in the centre. The length of the right section will be 3400 ft. and of the left section 3200 ft. The storage capacity between the diversion level of +145 and f.r.l. of +198 will be 529.25 t.m. cft. (12.15 m.a. ft.) and it is expected that the reservoir will fill up 2½ times during the year.

The project has been estimated to cost Rs. 127.42 crores at 1948 rates and to yield a return of 2.8% on the sum-at-charge at the end of 10 years after completion and of 3.75% at the end of 17 years after completion. The anticipated revenue of Rs. 566.97 lakhs after full development includes Rs. 128.58 lakhs from power at the rate of Rs. 60 per k.w. installed. The period of construction is envisaged as 12 years.

The river at the site of the dam flows through a sunken gorge, the lowest rock level being 2.30 ft. below the sandy bed. The river is perennial and the sand being coarse, excavation of the foundations, dewatering and concreting will present unusual difficulties. Cofferdam methods and a very large amount of construction machinery are proposed to be used. The work is of such a stupendous nature that the framers of the project propose to import foreign contractors specially from the U.S.A. with experience of a construction of such huge dams. On account of very great depth of foundations below

the river bed level, no storage will be possible even for 2nd crop irrigation in the Godavari delta for some years after start of construction.

Sabari project

2.6. Sabari is one of the major tributaries of the Godavari and joins it just below the village of Kunavaram, about 80 miles up the river from Dowleshwaram anicut. The Sabari project provides for the following:—

- (a) constructing a masonry dam and a reservoir across the Sabari about 1 mile above the village of Chintur with an effective capacity of 1,14,434 m.c. ft. (2.63 m.a. ft. at f.r.l. 236.0 ;
- (b) constructing two irrigation canals one on either side of reservoir to irrigate new area of 71,893 acres ;
- (c) improving the water distribution and supply in the Godavari delta, ensuring good 1st crop and resulting in an increase of 3 lakhs acres of 2nd crop; and
- (d) constructing a hydro-electric power station at the dam for the development of 8500 k.w. primary power and 40,000 k.w. secondary power.

The approximate cost of the scheme as estimated in 1951 is Rs. 10.93 crores or Rs. 10.91 crores after deducting amount likely to be realised by the sale of Government waste land.

The return on the capital outlay works out to 1.74%. But if no canals are constructed and the storage is utilised for generation of hydro-electric power and irrigation of 2nd crops in the delta, the return goes up to 2.04%. No betterment fee has been allowed as it is not likely to be realised. The amount being small, its inclusion does not materially effect the return.

The population in the ayacut and surroundings is sparse and except at the river margin the land is largely covered by forests. Development of irrigation in the new areas is likely to be very slow and may take 20 to 30 years if not more. The project report further mentions that the necessity and usefulness of the reservoir should be measured more by the development of second crop irrigation in the existing delta and other benefits proposed in the delta.

This project will not be possible if Ramapadasagar Project matures as the entire area of the ayacut including Sabari reservoir itself will be submerged under the latter

CHAPTER III

AREAS AFFECTED BY VARIOUS PROJECTS

3.0. PLATE I shows the areas that will be directly benefited by the various projects.

Areas included in the Krishna-Pennar scheme

3.1. This project includes

- (a) portions of Kurnool and Cuddapah districts forming the valleys of the Kunderu, Pennar and Papaghani rivers and lying between Nallamalais range of hills on the east, Erramalais hills on the west and Palakonda range on the south. The area is generally covered with black cotton soil which is very fertile and highly retentive of moisture. The climate is very hot and average yearly rainfall is about 25". The population is sparse and the project Report mentions that colonization will be needed both for execution of works and development of irrigation.
- (b) Coastal areas of Nellore, Chittoor and Chingleput districts. The climate of this tract is generally temperate. Rainfall varies from 35" in Nellore to 40" in Chingleput. The soils are black, red or sandy and well suited for cultivation. The population in the northern areas commanded by the canals is 234 per sq. mile while in the taluks of Chingleput it is 589 per sq. mile. There are a large number of tanks in the Nellore district having generally small ayacuts while in Chingleput where also tanks form the the principal source of irrigation some of the bigger works have ayacuts of 7500-13000 acres.

Areas included in Pulichintala project

3.2. This is intended to irrigate upland areas of Guntur district contiguous to the Krishna delta up to Gundal-Kamma river. The soil generally consists of black clay overlying kankar, gravel, decomposed lime-stone or decomposed granite. The general slope of the country is north-east or east and good drainage is assured. The climate is hot and dry and the annual

rainfall is of the order of 30-32". The main crops grown are cotton, tobacco, chillies, cereals and pulses. The cultivation is almost entirely dry and there is hardly any facility for artificial irrigation except from wells.

Areas included in the Lower Krishna project

3.3. This will provide irrigation in Nalgonda and Warrangal districts of Hyderabad and Nandigama taluq of Madras upto Kateru Valley.

The soil of the ayacut is mostly red earth with patches of light black cotton soil here and there. The principal crops grown at present are jawar, bajra, cotton, gram and castor etc. which are cultivated dry and rice, sugar cane, chillies and garden crops which are irrigated from tanks and wells. The rainfall is precarious and uncertain and satisfactory harvests are rare.

Areas included in Ramapadasagar project

3.4. The proposed irrigated area in this scheme wholly lies in the northern Circars viz., the districts of Vishakapattam, East Godavari, West Godavari, Krishna and Guntur.

The left canal will provide irrigation to a strip of land in East Godavari and Vishakapattam districts contiguous to the Godavari delta and extending upto Vishakapattam Port.

The right canal will similarly irrigate a strip of land in west Godavari and Krishna districts contiguous to the Godavari and Krishna deltas and extending upto Vijayawada.

The Guntur canal will irrigate a portion of the upland in Guntur district across the Krishna extending from Vijayawada to Gundalkamma river.

The soil of the ayacuts of left and right canals is generally light black which is suitable for all crops including paddy. The climate is hot and dry and the annual rainfall varies from 37" in Krishna district to 42" in East Godavari and Vishakapattam, most of which is received during north-east monsoon. The irrigation is generally from rain fed tanks, or wells and is very limited. There are a few anicuts on small streams in Vishakapattam districts. The irrigation, is, however, small.

Areas included in Sabari project

3.5. This project proposes to irrigate a strip of land on both banks of the Sabari river from the reservoir upto its confluence with the Godavari. On the right bank the strip extends

along the Godavari up to Bhadrachalam. The predominating type of soil is light black cotton or red or clay loam with an add mixture of sand and silt in varying proportion. Below the top soil which is 3 ft. or more thick there is a gravel mixture which will facilitate drainage. The crops grown at present are cholam, pulses, chillies, maize, tobacco and other dry crops. Paddy is raised to a small extent. Nearly one-third to one-fourth of the ayacut on both the canals consists of reserved and unreserved forests. The annual rainfall varies from 43" to 55". The population is only 174 per sq. mile.

Areas left out of irrigation

3.6. Plate I shows that a large area bounded by the Nallamalais in the west, the Krishna and Pennar deltas in the east, the Krishna river and proposed Pulichintala canal in the north and the proposed Pennar North Canal in the south has not been included in any project. The climate of this tract is hot and dry, rainfall is low and uncertain and a few small tanks provide the only source of irrigation. Cultivation is in the circumstances precarious and scarcity conditions frequently occur. The need of this area for State irrigation is genuine and pressing and should receive consideration in any scheme of utilisation of Krishna water.

CHAPTER IV

REMARKS ON THE TECHNICAL AND OTHER ASPECTS OF THE KRISHNA-PENNAR PROJECT

Siddeswaram dam and reservoir

4.0. THE DAM is proposed to be located near the village of Siddeswaram where the river enters a gorge and the site is satisfactory. According to the geological report the rock on which the dam will be founded is good and free from major defects on the right flank and the river bed. On the left flank, however, conditions are not so satisfactory but here also no insuperable difficulties are likely to occur. The surplusing arrangements for dealing with the probable flood discharge are adequate. F.R.L. of the reservoir is proposed at +898.5 with storage capacity of 279 t.m.c. ft. (6.40 m.a. ft) and when full it will submerge an area of 1,74,080 acres of which 1,13,892 is cultivated. It will also fully or partly submerge 98 villages 60 in Hyderabad including the town of Alampur and 38 in Madras State and displace about 50,000 people. Some protection will also be needed for the low lying portion of Kurnool town. The submersion of valuable cultivated land can be reduced by cutting down the height of the dam but this is not possible as according to the working tables prepared by the Madras Engineers full height is necessary to store the quantity of water needed for the proposed canals. The cost of compensation for the submerged area will amount to the large sum of Rs. 7.36 crores.

Someswaram dam on the Pennar

4.1. The site of the dam is satisfactory from the storage point of view as the dam is proposed at the upper end of a gorge, above which the valley opens out and good capacity can be secured with a moderate height. The foundations are, however, unsatisfactory as the gorge is filled with sand and gravel for a depth of about 100 ft. below the bed of the river and it is not definitely known at what depth sound rock suitable for a masonry dam will be found. It is, therefore, proposed to build an earthen dam in the river portion and provide surplusing arrangements on a saddle on the left flank. Earth dams under similar conditions have not been built anywhere in India but there are examples

REMARKS ON THE TECHNICAL AND OTHER ASPECTS OF 31
THE KRISHNA-PENNAR PROJECT

of such works in the U.S.A. There will be difficulties in constructing the dam but it should be possible to overcome them by suitable arrangements. Further detailed investigations about design and costs are necessary. Maximum flood discharge provided for is on the safe side.

The F.R.L. proposed is +378 with a gross capacity of 260 t.m.c. ft. (5.97 m.a. ft). When full, the reservoir will submerge fully or partially 117 villages and displace about 1,00,000 persons. It will also drown 68,400 acres of cultivated area of which no less than 4,000 acres are under gardens and 56,000 acres of poramboke lands. The cost of compensation for submersion above is Rs. 7.7 crores—almost a third of the total cost of the dam.

Pick-up barrage on the Pennar

4.2. This will be built on sand foundations about a mile below the Someswaram dam and should present no difficulties.

Krishna-Pennar canal

4.3. This canal has been designed to irrigate 4.90 lakhs of mixed dry and wet crops on Krishna-Pennar East and Krishna-Pennar West canals and also to feed the Someswaram reservoir on the Pennar. The total discharge of all the canals included in Krishna-Pennar project is 47,100 cusecs but the capacity of the Krishna-Pennar Canal has been kept as 75,000 cusecs to enable Krishna water to be diverted into Pennar for storage at Someswaram and avoid surplusing at Siddeswaram. A study of working tables, however, shows that a discharge of over 60,000 cusecs would be run for only 8 days in a year and even for this period it can be reduced to 60,000 cusecs without any loss or inconvenience. The discharge of this canal, therefore, appears to be on the high side and is capable of reduction with corresponding saving in cost.

The total volume of the Mittakundala cutting is 25 million cubic yards consisting mainly of shales. The rate provided for rock cutting is Rs. 200 per 1000 c.ft. This appears to be considerably on the low side and may have to be increased to Rs. 300 or so judging from the rates allowed on the Tungabhadra project. According to the geological report (page 157 of Volume III of Krishna-Pennar project report) the top 5½ ft. consists of gravily soil, next 2 ft. of disintegrated rock, while the rest is all shale. It is further, stated that even top soil might require slight blasting. The estimate has provided a rate of 44 per

thousand c.ft. for a large portion of the cutting. This is considered low. The expenditure on the rock portion alone may amount to Rs. 10-12 crores instead of Rs. 5.5 crores provided, even without taking into account the greater section which might be required and assuming only the present proposals of fluming. The rate below Vempanta anicut for all soils with a lead of 1 furlong is only Rs. 28 per 1000 cft. and out of this again 10% is deducted on account of use of machinery. This rate is considered low. A lining of 6" of concrete is provided in the deep cutting. This is inadequate as shale rock cannot be cut upto depths of 100 ft. without overbreak. A thickness of 1 to 1½ ft. would have been more appropriate.

There is a drop of 520 ft. nearly between water levels of both the reservoirs and this will become greater if Pennar reservoir is omitted. A sum of Rs. 17.29 lakhs is provided to allow for this drop in a canal designed to carry 75,000 cusecs. This provision is obviously very low.

The Kunderu river at present carries a flood discharge of 6000-7000 cusecs only. Considerable widening and deepening will be necessary especially in the upper reaches to enable a discharge of 75,000 cusecs to be passed down with no increase in flood levels. As this will be very costly it has been assumed in the project that water levels 5 ft. higher than the marginal lands will be run and only a part of the section required excavated. It is assumed that when big discharges flow down, the channel will scour out a section for itself. It is possible that this expectation may not be realised and on the other hand running of high discharges for long periods in a channel of very steep slope may result in formation of ravines and damage to the country side. It seems advisable in the first instance to construct a channel of full section with properly designed masonry drops to absorb the excess slope.

Krishna-Pennar east canal

4.4. This canal has been designed for a discharge of 4800 cusecs. It is proposed to irrigate 3.00 lakhs acres *i.e.*, 1 lakh wet and 2 lakhs dry (equivalent to 2 lakhs wet) for which according to working tables a maximum discharge of 2993 cusecs or say 3000 cusecs only is required in the month of August for 1st crop. Reduction in discharge to 3000 cusecs can, therefore, be made without loss of irrigation. Out of 3.0 lakhs acres, a considerable portion is already under the command of existing Kurnool-Cuddapah canal which is proposed to be abandoned.

REMARKS ON THE TECHNICAL AND OTHER ASPECTS OF 33
THE KRISHNA-PENNNAR PROJECT

It is suggested that established irrigation should not be disturbed and the Krishna-Pennar East Canal should cater for new areas only. If this is done, head discharges will be further reduced resulting in considerable saving in cost.

Krishna-Pennar west canal

4.5. This canal has been designed for a discharge of 5400 cusecs of which 1800 cusecs are intended to feed the new Gandikota reservoir on the Pennar. The total area proposed on this canal is only 1.90 lakhs acres (wet and dry) equivalent to 1.265 lakhs wet for which a discharge of only 1900 cusecs is required according to the working tables. If Gandikota Project is treated as a separate scheme fed by Pennar waters only, it would become unnecessary to pass 1800 cusecs through this canal by constructing an expensive feeder. For irrigation alone, the canal should be designed for a discharge of 1900 cusecs only. On this canal also there is a small part of the command already served by the Kurnool Cuddapah canal. This should continue on that canal and necessary adjustment made in the head discharge of the new canal.

Madras canal

4.6. This canal takes off at mile 13/7 of the Pennar South Canal and in the stage plan it is proposed to construct only this Canal and leave the construction of Pennar South Canal below mile 13/7 to the Full Plan. The Madras Canal is expected to irrigate 3.68 lakhs acres in each of the 1st and 2nd crop periods while the stage plan is in operation. But in the full plan the area of 2nd crop will be reduced to roughly half.

The canal has been designed to carry enough water to irrigate 3.68 lakhs acres in 2nd crop and has been allowed a discharge of 7000 cusecs at its head. Discharge required for the 1st crop alone works out to 3130 cusecs only, while that for half of this area in the second crop is 3710 cusecs. It is evident that the capacity of 7000 cusecs would be too much after the first few years when the Full Plan starts to operate. It is, therefore, suggested that this canal should be designed for a discharge of 3710 or say 4000 cusecs only to avoid waste of money on works which will prove unnecessary later on.

This reduction will not effect the supply to Madras city, which requires only a small fraction of the discharge. Moreover it can always be arranged to fill the Red Hills Reservoir in periods of slack demand.

In the project it is proposed to design the portion below mile 165 for a maximum discharge of 2000 cusecs to enable the large tank at Chamberambakam to be filled. This appears to be unnecessary. Capacity in the lower reach should only be enough to act as an escape in periods of low demand. In a canal of this size, a capacity of 500 cusecs in the tail reach should be adequate.

Pennar south canal

4.7. This is designed for a discharge of 23,000 cusecs including share of the Madras canal upto mile 13/7 and for 16,000 cusecs lower down. The area proposed to be irrigated is 7.32 lakhs acres in the 1st crop and 3.61 lakhs acres in the 2nd crop. The discharge on the basis of 1st crop comes to 9030 or say 10,000 cusecs only after making allowance for precarious wet areas served by the existing tanks. For the 2nd crop the discharge works out to 7324 cusecs. The canal, therefore, should be designed for 10,000.

Both these big canals run practically parallel to each other within a distance of a few miles. The Madras canal has been proposed as a separate unit for execution in the Stage Plan to enable the benefits of assured supply to be given at an earlier date to areas in the eastern part of the ayacut, which is inadequately served by tanks at present and to supply water to Madras town. The period of completion of this canal has been assumed to be 5 years. The Pennar south canal which will follow in the final plan is expected to take 7 years to construct. It should be possible to reduce this period to 6 or even 5 years as its size can be considerably reduced as indicated above. In any case irrigation cannot commence until the dams and pick-up barrage and the Krishna-Pennar link are ready. It would, therefore, seem reasonable to construct only Pennar south canal from the very beginning and to omit the Madras Canal which will not be necessary. As far as Madras City is concerned, this will make no difference as the Pennar south canal passes through the Poondi Reservoir which is linked up with Red Hills tank.

Pennar north canal

4.8. This is designed for a discharge of 9900 cusecs. The area proposed to be irrigated is 4.87 lakhs acres in the 1st crop and 2.4 lakhs acres in the 2nd crop. The discharge at head on the basis of 1st crop comes to 7165 cusecs

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and of 2nd crop to only 4847 cusecs. A reduction in the head discharge from 9900 cusecs to 7500 cusecs is therefore possible.

The project report mentions that a large area of about 2 lakhs acres included in the ayacut of this canal is at present irrigated from tanks and the present supply is precarious, but in the statement 'B' of Irrigable areas as adopted *vide* page 184 of Volume I of Krishna-Pennar Project Report, a figure of 47,100 acres only is shown as precarious wet. This discrepancy is not understood.

Kaveli canal

4.9 This canal is intended to irrigate 1.1 lakh acres in 1st crop and the same area in 2nd crop (*vide* Stage Plan) and is designed for a discharge of 2200 cusecs, based on 2nd crop requirements. In the full plan the 2nd crop area is reduced to half for which a discharge of 1100 cusecs would be required. For irrigating 1.1 lakhs acres of 1st crop discharge works out to 1424 cusecs or say 1500 cusecs. The canal should therefore, be designed for 1500 cusecs only.

Kanupur canal

4.10. This is comparatively a small canal and is intended to irrigate 0.78 lakhs, acres in the 1st crop and the same in the 2nd crop in the Stage Plan. In the Full Plan area in the 2nd crop is reduced to half for which a discharge of 787 cusecs is required. The discharge required for 1st crop works out to 984 cusecs or say 1000 cusecs. The canal, therefore, should be designed for 1000 cusecs only against 1800 proposed.

4.11: *Utilisation of supplies in excess of those assumed in the working table.*—Table II below gives the discharges of the various canals as proposed in the Projects and as modified by the Committee. It also shows the areas of the 1st and 2nd crops proposed in the project and the 2nd crop which can be irrigated if the discharges based on the 1st crop are run in the 2nd crop also.

TABLE

Name of Canal	Discharge at head according to K. P. Projects	Discharge required on	
		1st crop basis	2nd crop basis (full plan)
I	2	3	4
Krishna Pennar East Canal .	4,800	3,000	...
Krishna Pennar West Canal .	5,400	1,900	...
Pennar North Canal . .	9,900	7,165	4,870
Pennar South Canal . .	16,000	9,030	7,324
Madras Canal . . .	7,000	3,130	3,710
Kaveli Canal . . .	2,200	1,424	[1,180
Kanupur Canal . . .	1,800	884	787
TOTAL

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II

Proposed area in full plan

Discharge recommended	Proposed area in full plan		Area of 2nd crop which can be irrigated with discharge as per column 5
	1st crop	2nd crop	
5	6	7	8
3,000	3.0	...	...
1,900	1.90	...	...
7,500	4.87	2.40	3.70
10,000	7.32	3.61	4.90
4,000	3.68	1.80	1.90
1,500	1.10	0.53	0.74
1,000	0.78	0.37	0.49
28,900 or 30,000 including losses		8.71	11.73

It will be seen that the canals excluding Krishna Pennar East and Krishna Pennar West on which no 2nd crop is proposed can do another 3 lakhs acres of 2nd crop provided water is available.

The working tables are based on a total yield of 1656 t.m.c.ft. (38.02 m.a.ft.) at Vijayawada against 1450 t.m.c. ft. (33.29 m.a. ft. assumed as dependable yield excluding projects under operation. Statistics show that in 50 years out of 100, the yield is not likely to be less than 1900 t.m.c. ft. (43.62 m.a.ft.) The Madras share of the excess of about 250 over the working table figure at 39% comes to 97.5 t.m.c. ft. (2.24 m.a.ft.). Of this about 37 t.m.c. ft. (0.85 m.a.ft.) will be the inflow below Siddeswaram and will not be available for this scheme. The balance of about 60 t.m.c. ft. (1.38 m. a. ft.) will suffice for only 3 lakhs acres of 2nd crop and can be fully utilised as explained above. Any further excess can also be used by running Krishna-Pennar East and West Canals for 2nd crop.

Irrigable areas

4.12 The irrigable areas have been worked out from the gross commanded areas on a percentage basis which has been assumed as 50 % in case of Krishna Pennar East and Krishna Pennar West, 60 % in case of Pennar north and Pennar south and 70 % in the case of Kanupur and Kaveli. The Committee consider them as reasonable.

Irrigation intensities

4.13 The entire irrigable areas as calculated above have been proposed to be irrigated in the 1st crop under paddy except in the case of Krishna Pennar East and Krishna Pennar West canals where the irrigation will be 1/3 wet and 2/3 dry. In addition, 2nd crop paddy is proposed to be done in case of all the canals below Someswaram. The annual intensities will thus be 150 % on all the canals except Krishna-Pennar East and Krishna-Pennar West where it will be 100%. The 2nd crop intensity may even go higher in years of good supplies. This will mean that fields will be able to get rest for one season only in two years and their fertility may in time be impaired. It will, therefore, be necessary to adopt suitable measures by way of manuring along with the introduction of irrigation to maintain crop yields.

Duties

4.14 Table III below gives the duties adopted at the heads of off-taking distributaries and rates of losses per million sq. ft. Column (4) of the table gives the corresponding duties at the canal heads while column (5) shows duties as per working tables during the month of August when demand is keenest.

TABLE III

Name of Canal	Duty at distributary head	Losses in canal per m. sq. ft.	Duty at canal head	Duty as per supply allowed in working tables
Krishna Pennar West Canal.	45 for wet 90 for dry	6 cusecs	35.3	67
Krishna Pennar East Canal	do.		41.7	67
Pennar North Canal .	53 for wet	6.5 cusecs	47.7	66
Pennar South Canal .	do.	do.	36.2	68
Kaveli Canal	do.	5.0 cusecs	43.0	67
Kanupur Canal	do.	5.0 cusecs	37.0	69

Table IV is a statement showing the average monthly duties on the Godavari, Krishna and Pennar delta canals system.

TABLE IV

Period	Godavari Delta			Krishna Delta		Pennar Canal System	
	East	Central	West	East	West	Sangam	Nellore
June	118	109	137	173	145	...	...
July	57	60	71	83	71	88	63
August	64	66	81	97	83	79	66
September	64	66	81	106	102	73	41
October	73	74	85	112	100	126	48
November	109	101	97	124	120	89	55
December . . . . .	...	...	...	...	...	117	140
January	34	44	42				
February	26	53	49				
March	34	61	54				
April	47	88	66				

From the above it will be seen that the duties obtained during the months of August agree fairly well with those given in column (5) of Table III which are considered to be reasonable. The duties adopted for the design of the canals in the Krishna-Pennar Project are on the low side and the discharges suggested by the Committee for the various canals on the basis of working tables are justified.

Water rates

4.15 The water rates proposed are reasonable. In the case of assured wet lands on the Pennar as also on Krishna-Pennar West and East it is proposed to levy an additional charge of Rs. 4/6 to Rs. 4/12 per acre. This does not appear to be justified. The fact that they are classed as assured wet indicates that they receive adequate supplies from existing sources.

Power provisions

4.16 It is proposed to generate 60,000 k. W. continuous power at Siddeswaram and 40,000 k. W. at Someswaram in the Stage Plan. The position will be reversed in the Full Plan. There is no mention in the Project Report that any load survey has been done. The Chief Engineer, Electricity, Madras, however, informed the Committee, during the course of discussion, that there was serious shortage of power in these areas and that any one of these power stations would suffice for the time being. The other stations could be erected later on when load developed.

In the financial forecast of the project credit at the rate of 6/10/8 per k. w. of continuous generation has been taken. This appears to be very low rate and there is room for considerable increase.

Navigation

4.17 The project does not make any specific provision for navigation but Madras Canal, Pennar North and Pennar South are proposed to be made partially navigable *i.e.*, adequate free board in case of all road and foot bridges has been provided so that they may require no alteration if and when navigation is introduced. The extra expenditure involved in high bridges and long ramps will be justified only if there is reasonable possibility of navigation developing in the future. The matter requires careful consideration at this stage.

Irrigation development

4.18 In the financial statement the period required for irrigation to develop fully has been taken as under :—

	Years
Krishna-Pennar West	3
Krishna-Pennar East	3
Kaveli-Kanupur and Madras	4
Pennar North	8
Pennar South	10
Krishna Delta.	3
Pennar Delta	1

The Committee consider that these figures are too optimistic, especially in the case of Krishna Pennar East and Krishna Pennar West canals which run through an area already partially served by the existing Kurnool Cuddapah canal. This canal has not yet fully developed even though constructed about 80 years ago. The Committee consider that development will take not less than 10 years except in the Deltas where 5 years would suffice.

Food production

4.19. In the project it has been assumed that each acre of wet irrigation will yield half a ton of additional rice. This assumption is not justified. Average outturn of rice for an irrigated field in the 1st crop is a little over half a ton. For the 2nd crop it is about 2/3 of that of the 1st crop. Even if all the areas proposed to be irrigated were lying waste, an additional overall yield of half a ton per acre would not be obtained. Actually most of the land is already cultivated either dry or wet. The additional yield is, therefore, not likely to be more than 1/4 ton per acre and the extra yield of food grains from the project would, therefore, be half of that anticipated.

Working tables

4.20. According to the working tables of Siddeswaram dam the amount drawn in the year 1929-30 (in which yield was about 200 t.m.c. ft. (4.59 m. a. ft.) more than the dependable figure) was about 52.5 t.m.c. ft. (1.61 m.a.ft.) more than the inflow. Moreover the working table has been prepared on the assumption that the discharge of Siddeswaram will be the same as that at Vijayawada. This assumption is not justified as it does not allow for the inflow between Siddeswaram and Vijayawada.

According to calculations based on isohyets this inflow amounts to 15% of the total discharge reaching Vijayawada. Revised working tables after taking these two factors into consideration have been prepared by the Committee which show that actual diversion from Siddeswaram to Pennar will be 14.7 t. m.c. ft. (0.337 m.a. ft.) less in Stage Plan and 90.3 t. m.c. ft. (2.07 m. a. ft. less) in Full Plan than the figures assumed in the project and irrigation in consequence will be 0.90 lakh acres less in Stage Plan and 8.50 lakhs acres less in Full Plan. The return on the capital will correspondingly fall as there will be no reduction in the outlay.

As supplies will be inadequate even for the areas proposed, there can be no question of feeding the new Gandikota reservoir from the Krishna river.

Estimates and financial forecasts

4.21. Fairly detailed estimates have been prepared for the dams and main canals while the estimates of branches and distributaries have been worked out on acreage basis. This is sufficient for a project report. The rates and lump sum provisions are presumably based on the local knowledge of the framers and may be generally accepted. A reference may, however, be made to the Committee's remarks under the Mithakundla cutting. Provision for the following items appears low:—

- (a) The allowance for maintenance during construction has been taken on a lump sum basis instead of the usual 1% of cost of works excluding land, which will give a much higher figure.
- (b) Capitalisation of abatement of land revenue has been taken as 0.2% of the works outlay excluding land, instead of 20 times reduction in land revenue. The latter would come to a higher figure and should be adopted.
- (c) The working expenses have been assumed to be Rs. 1/8 per acre against the actuals of Rs. 1.82 in case of Godavari delta and Rs. 2.9 in case of Krishna delta where the ground is flat and proportion of irrigation to the gross command is high. The new canals will run

through undulating country and will not irrigate the same percentage of command. The length of channels per acre would be greater and the working cost correspondingly higher. The Committee consider that allowance for this should not be less than Rs. 2/8 per acre.

- (d) No provisions for remission of revenue has been made for bad seasons for the first few years after completion. A provision of 12½% has, however, been made after the full anticipated revenue has been realized for 2 or more years. It does not appear to be correct. In committee's view a deduction of 10% instead of 12½% should be allowed from the very beginning.

For reasons mentioned above, the capital cost of the project may be appreciably higher than estimated but the excess can be largely counter-balanced if the Committee's suggestions about reduction in discharges of various canals are accepted.

In the financial statement No. 21 received from Madras a return of 3·14% in the Stage Plan and 3·45% in the Full Plan is estimated on the sum-at-charge at the end of 10th year after completion. Revised statements have been prepared by the Committee after excluding inflow below Siddeswaram (*vide* para 4·20) and allowing for higher working expenses and lower remissions mentioned above. These show that the return on the sum-at-charge at the end of the 10th year after completion would be only 2·61% in the Stage Plan and 2·58% in the Full Plan, assuming the cost of works same as estimated in the Krishna-Pennar Project. The net revenues being less than the interest charges, the return will go on decreasing and the sum-at-charge will go on increasing in future years.

Betterment fees

4·22. It is a fact that the introduction of canal irrigation increases and stabilises the out-turn from lands, the value of which goes up very considerably in consequence. The Planning Commission has laid down that Government should receive a part of unearned increase in assets. This share can be taken by levying a betterment fee in one or more instalments on the owners of all lands benefited by a project. The rates for betterment

fee proposed in the Krishna Pennar Project *vide* para 19·14 Volume I of the report are reasonable and it should be possible to recover them without difficulty. Necessary legislation in this respect may be undertaken by the State Government as early as possible.

General

4·23. The above remarks relate to the details of the scheme as prepared by Madras but the project as a whole has got several unsatisfactory features as stated below:—

- (1) The map enclosed as Plate I shows the areas to be benefited by the various projects under consideration on the Krishna, Godavari and Pennar rivers. It will be seen that a large tract comprising portions of Guntur and Nellore districts which is dry and has few tanks and little irrigation facilities is not included in any project and will be debarred for ever, as all the available water will have been utilised by the project under contemplation. In the opinion of the Committee, it is unreasonable to deprive land lying between the Krishna and Pennar rivers of irrigation facilities and to take Krishna water for the benefit of areas across the Pennar, which are already served by a large number of tanks and do not normally suffer much distress.
- (2) About two-third of irrigation in the Stage Plan and 2/5th in the Full Plan will consist of 2nd crop on areas which already grow 1st crop early in the year. This may be all right as a short term expedient, as the canals being already in existence, food production due to 2nd crop can be secured quicker, but it cannot be justified in the overall scheme where the same water given to new areas—which have at present no water even for one crop will produce 50% more food per acre. Extension of 2nd crop will moreover mean improving the condition of people who are already comparatively well off and doing nothing for others.
- (3) The Siddeswaram and Someswaram reservoirs especially the latter, will submerge very large areas of valuable cultivable land and gardens and displace about 1·5 lakhs of people from their homes and lands (*vide* paras 4·0 and 4·1 above).

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The Committee have, therefore, framed alternative proposals which are designed to avoid the above objections and to make the fullest use of the available supplies of the Krishna river and extend its benefits to as large an area as possible. These proposals are explained in detail in the next chapter.

CHAPTER V

COMMITTEE'S PROPOSALS

General principles followed

(1) THE SCHEME should provide for the most economical and optimum use of the waters of Godavari and Krishna rivers from a broad national point of view.

(2) That the scheme should provide irrigation to 1st crop in as large an area as possible.

(3) In allocating water for 2nd crop some preference should be given to delta areas where maximum benefit from the food production point of view can be secured earlier.

(4) As far as possible the water allotted to Madras State should be utilized fully.

(5) Provision should be made for generation of adequate power without sacrificing essential irrigation interests.

(6) Areas liable to frequent famine and distress should receive special attention and at an early date.

(7) Relief should be afforded to Madras city where the drinking water supplies are inadequate and there are no alternative sources augmenting the supplies.

(8) The project should be capable of being executed in stages.

Areas in need of irrigation

5.1. No large canals at present take off from the Krishna river between the confluence of the Tungabhadra and the delta at Vijayawada. On the Godavari and Pennar also, irrigation is confined almost entirely to the delta areas. The upland areas which are either not provided or are inadequately provided with

Irrigation facilities are as under:—

	Lakh acres
(1) Rayalaseema area	9·80
A small portion of this is at present irrigated by Kurnool-Cuddapah Canal. The rest is cultivated dry.	
(2) Area between Pennar and Krishna	51·22
There are no canals but there are a few tanks. Cultivation is mostly dry.	
(3) Area between Krishna and Godavari	31·43
Here also there are only a few tanks and the cultivation is mostly dry.	
(4) Areas south of Pennar	14·74
There are no canals but the tract is well served by a large number of tanks and difficulty is experienced only when the rains fail.	

Of (3) above, 12·28 lakhs acres lie in the Telangana area of Hyderabad State.

In making recommendations for utilisation of waters of the Krishna and Godavari, the committee have attached more importance to areas (1), (2) and (3) above.

Like all other South Indian rivers, the Godavari, the Krishna and the Pennar are not snow-fed but depend entirely upon the rain fall for their supplies. They carry enormous quantities of water during July, August and September but in the dry weather, the flow dwindles to insignificant amounts. The diversion anicuts at present in existence can, with difficulty, mature the 1st crop of the canal ayacut. It is, therefore, evident that in order to make use of the vast quantities of water brought down by these rivers in the monsoon season a number of storage reservoirs will be necessary.

Possible sites of reservoirs

5.2. Studies of possible sites of the reservoirs have been made by Hyderabad and Madras engineers and it has been found that reservoirs can be constructed at the following sites :

GODAVARI

- (i) At Polavaram about 20 miles above Rajahmundry. This can store water for (a) power purposes, (b) irrigating 2nd crop in delta, (c) diversion to Krishna

and irrigating small areas on the way, and (d) irrigating a strip of upland on the left upto the port of Vishakapatam. There will however be very serious difficulties in constructing the dam here as already indicated in an earlier chapter.

- (ii) At Inchhampali—a little below the confluence of Indravati with the Godavari. This is mainly a power scheme with very little irrigation. Diversion work will be necessary near Polavaram for using the water for irrigation. Only preliminary studies have been made here so far by Hyderabad.
- (iii) At Indravati near Bhopalpatnam—this site is being investigated by C.W. & P.C. It is purely a storage scheme with large power possibilities. Preliminary studies show that storage capacity of over 16 m.a. ft. (69.77 t.m.c. ft.) would be available at this site. Diversion works will be needed at Polavaram for irrigation purposes.
- (iv) On the Sabari about 15 miles above its confluence with the Godavari. This is possible only if the dam at Polavaram is not constructed as the site lies in the submerged area of the Ramapadasagar reservoir. This will irrigate limited areas on both banks and generate a small amount of power.

KRISHNA

- (i) At Siddeswaram, where the river Krishna enters a gorge and then flows through ranges of hills on both sides for a distance of 186 miles. This can generate power and also divert water for irrigation in Rayalaseema and feeding the Pennar river.
- (ii) At Nandikonda about 88 miles below Siddeswaram. This can irrigate a very large area of upland country on both banks by diversion and has got a large potential for power.
- (iii) At Pulichintala just before the river leaves the hills and enters the coastal plain. This can divert water for irrigating Guntur uplands on right bank and also generate power.

[PENNAR

- (i) At Gandikota—a reservoir was proposed here in the old Gandikota Project. The storage can be used for irrigation of areas in Rayalaseema on both banks.
- (ii) At Someswaram near the village of Somasila. This reservoir can store water for irrigation by canals lower down and can also generate power. It cannot be filled up by the Pennar river and considerable assistance will be necessary from the Krishna. There will be serious construction difficulties as there is a filling of sand about 100 ft. deep on the bed rock.

Development by stages

5.3. The Committee propose that the waters of Godavari, Krishna and Pennar should be used in three stages as under :—

STAGE I

(a) Krishna Pennar East Canal and the Kaveli and the Kanupur canals as contemplated in the Krishna-Pennar Project may be constructed but their head discharges should be limited to the following :—

Kaveli canal	. . . . .	1450 cusecs
Kanupur canal	. . . . .	1000 cusecs
Krishna-Pennar	. . . . .	East canal 3000 cusecs (including the ayacut of the present Kurnool- Cuddapah canal).

The reasons for the limitation of the discharge have already been explained in detail in the previous chapter. No new works will be necessary for these canals as all can be fed from the existing Kurnool-Cuddapah canal which should be remodelled to take a discharge of about 6,000 cusecs at the head. Any necessary remodelling of the anicut at the head of the canal may also be done.

The works enumerated above can be carried out within three years and, on completion, will afford great and speedy relief to Rayalaseema and increase production of rice which will be the main crop on Kaveli and Kanupur. As explained in a separate note *vide* Appendix C, supplies will be available for these additional requirements of the Kurnool-Cuddapah canal from the Tungabhadra river after meeting the requirements of the Tungabhadra Project.

(b) *A storage dam at Nandikonda on the Krishna river with canals on its right and left banks may be constructed.*—An excellent site with granite rock in the bed exists at this place and detailed investigations for a dam have already been carried out by Hyderabad Engineers. The F.R.L. of the dam should, however, be 590 instead of 540 proposed by Hyderabad. Along with the construction of the dam, work on canals on the right and left bank should also be started. The right bank canals should have a capacity of about 24,000 cusecs for the irrigation of the entire tract lying east of the Nallamalais hills and extending up to Krishna and Pennar deltas. This area is completely dry at present and is not densely populated. Development of irrigation would take several years and during the intervening period the full supply is not likely to be required. The canal should, therefore, tail into the Pennar and the tail reach should be capable of passing a minimum discharge of 4000 cusecs, to be picked up at a diversion barrage on the Pennar and used by a canal on the south bank of that river.

The left bank canal would irrigate 10.65 lakh acres in the Hyderabad State including 2.05 lakh acres of Madras enclaves and would be generally in accordance with the details furnished by Hyderabad State in their Lower Krishna Project.

This dam can also generate 60,000 k. W. of firm power, machinery for which can be installed as and when demand arises.

(c) *Construction of Madras canal.*—This canal would generally be in accordance with the proposals of the Krishna-Pennar Project but its discharge would be limited to 4000 cusecs as explained in paragraph 4.6. It will initially be fed from Nandikonda right bank canal while that canal has water to spare and later, from the Siddeswaram dam proposed in the 2nd stage. It will materially help rice production in the Chittoor district and permanently solve the problem of Madras city water supply.

(d) *Construction of a diversion barrage on the Pennar river.*—This would be at the site proposed in the Krishna-Pennar Project to divert the water brought by the Nandikonda Right Bank Canal into the Madras Canal.

STAGE II

(e) *Construction of a storage dam at Siddeswaram on the Pennar river.*—This would be at the site proposed in the

Krishna-Pennar Project but its full reservoir level would be +885 instead of +898.5 proposed in that Project. The modification will reduce the area of land submerged from 1,74,080 acres to 127,500 acres and correspondingly reduce the number of people displaced. This dam will divert Krishna water into the Pennar and will also be able to generate 40,000 k.W. of power.

(f) *Construction of Krishna-Pennar canal.*—This would be generally along the line proposed in the Krishna-Pennar Project but its capacity would be limited to 10,000 cusecs *vide* paragraph 5.49. It will tail into the Pennar and will pass supplies for the Madras Canal when it cannot be fed by the Nandikonda right bank canal, and for the Kaveli and Kanupur canals. It will also feed the Krishna Pennar West Canal mentioned below and partially feed the Krishna Pennar East Canal if at any time there is difficulty in passing the full remodelled discharge into the Kurnool-Cuddapah Canal.

(g) *Construction of Krishna-Pennar west canal.*—This canal would have a discharge of 1900 cusecs for irrigation only. No water would be passed down to the proposed Gandikota Reservoir.

STAGE III

(h) *Construction of a storage dam at Pulichintala on the River Krishna.*—This would provide water for increased 2nd crop irrigation in Krishna delta and for generation of more power. This reservoir will be useful later also when a storage dam on the Godavari is built and water is diverted from that river into the Krishna for irrigating a part of the 1st and most of the 2nd crop in the Krishna delta. A canal on the right bank above Pulichintala will then be needed for irrigation of 1st and 2nd crops in a part of the Guntur area which will be served by Nandikonda Right Bank Canal in the 1st and 2nd stages.

It may be mentioned here that the dam would be founded on jointed shales and slates which would require careful geological examination and probably extensive foundation treatment would be necessary.

(i) *Construction of a Storage reservoir on the Godavari.*—This would be sited near Inchhampali on the main Godavari or on the Indravati near Bhopalpatnam or at some place on the Pranhitta. This reservoir would store water for generation of power and for irrigation lower down.

(k) *Construction of a diversion barrage on the Godavari.*—This would be at the place where the Ramapadasagar dam is proposed but its height would be just sufficient to enable it to feed a canal discharging into the Krishna at Vijayawada.

(l) *Construction of right bank canal of Godavari.*—This would take off from the barrage referred to at (k) above and tail into the Krishna above Vijayawada to provide water for irrigation of 1st and 2nd crops in the Krishna delta. It would also provide direct irrigation on the way.

(m) *Construction of left bank canal on the Godavari.*—This would also take off from the proposed barrage and end near Vishakhapatnam. It would irrigate lands lying between the canal and the Godavari delta.

5.4. All these works are described in detail below :—

Siddeswaram dam

5.41. General features of this dam have been given in the Krishna-Pennar project prepared by Madras and need not be repeated here. The design will remain the same but F.R.L. will be reduced to +885 against +898.5. The lower level now proposed will suffice for the diversion required. The principal levels and particulars of the two proposals are given below :—

	Dam with F.R.L. + 898.5	Dam with F.R.L. + 885
Average bed level	770.0	770.0
Maximum reservoir level	+900.0	+887.5
Proposed minimum reservoir level		
m. f. l. in rear of dam	+854.0	+846.0
Cill of river sluice	+848.0	+848.0
Length of spillway	+780.0	+780.0
Length of spillway	1740'	1740'
Length of non-spillway	1566'	1510'
Length of dam	3306'	3250'
Height of dam above deepest foundation level		
	173.5'	160.0'
Anticipated continuous power	60,000 k.w. (1st stage)	40,000 k.w.
	40,000 k.W. (2nd stage)	

Area of water-spread under—

f.r. l. condition . . .	272 sq. miles	200 sq. miles
m.w. l. condition . . .	284 sq. miles	214 sq. miles
Quantity of masonry in dam . . .	1.2 m.c. yds.	1.04 sq. miles
Foundation excavation rock . . .	0.41 m.c. yds.	.39 m. c. yds.
Excavation in other soils . . .	0.5 m.c. yds.	.39 m. c. yds.
Gross capacity of reservoir at m.w. l.	293 t.m. c. ft.	205 t.m. c. ft.
Gross capacity of reservoir at f.r. l.	279 t.m.c. ft.	190 t.m. c. ft.
Dead storage	70 t.m.c. ft.	70 t.m. c. ft.
Effective storage	209 t.m.c. ft.	120 t.m. c. ft.

The great disadvantage of the higher dam is the submersion of a very large area of nearly 174,080 acres and displacement of nearly 50,000 people. Submersion with the lower F.R.L. will be reduced to 127,500 acres only.

The dam is proposed to be built in the second stage and will feed Kaveli, Kanupur and Madras canals and also give assistance when necessary to Krishna Pennar East and Krishna Pennar West Canals which otherwise would receive supply from the remodelled Kurnool-Cuddapah canal. In addition to this, it will pass down the river sufficient water for generating 40,000 k.w. continuous power and for irrigation lower down. This power is the same as will be available in the Full Plan of the Krishna-Pennar Project.

Drawings and abstract estimate for the dam have been prepared and are given (as Plates 18, 19 in Appendix G.)* The cost of the dam excluding power generation but inclusive of the civil works comes to Rs. 15.23 crores.

Nandikonda dam

5.42. The dam site has been investigated fairly thoroughly by the Hyderabad State and has been described fully in their Lower Krishna Project Report.

The site is unique and has many advantages as detailed below :—

- (1) The foundation rock is excellent ; being sheet granite.
- (2) Diversion and construction will be comparatively easy.
- (3) It is easily accessible both from Madras and Hyderabad sides and is well connected by road and rail.

() * Not printed

- (4) It commands very large areas extending between Krishna and Godavari in the north and between Krishna and Pennar in the South.
- (5) The submerged area consists mostly of waste lands and very few villages will be affected.

In the Hyderabad Scheme F.R.L. of +540 was proposed as this was sufficient to provide adequate storage for the needs of areas lying on the left bank of the river. The Committee propose to raise this level to +590 to bring under irrigation large upland areas lying south of the river Krishna in the Madras State.

The main data of the two proposals are given below :-

	Dam with f.r.l. 540	Dam with f.r.l. 590
Average bed level	+ 245	+ 245
Crest level of spillway	+ 510	+ 560
Maximum water level	+ 540	+ 590
Minimum reservoir level	+ 500	+ 520
Cill of river sluices	+ 275	+ 275
Cill of left canal sluice	+ 490	+ 490
Cill of right canal sluice	+ ...	+ 490
Length of spillway	1885'	1880'
Length of non-spillway	1530'	2420'
Earthen dam and dykes	2100'	1900'
Height of dam above deepest foundation level	325'	375'
Anticipated continuous power	(not given)	40,000 k.w. in 1st stage and 2nd stage .
Area of waterspread at F. R. L.	80.2 sq. miles	110 sq. miles.
Gross capacity of reservoir at f. r. l.	269 t.m. c. ft.	400 t.m.c.ft.
Dead storage	172 t.m. c. ft.	172 t.m.c. ft.
Live storage	97 t.m. c. ft.	228 t.m.c.ft.
Quantity of masonry in dam	4.4 m. c. yds.	6.01 m.c. yds.
Rock excavation	0.71 m. c. yds.	0.56 m.c. yds.

Drawings and abstract of estimate for the increased height of the dam have been prepared and are given (as Plates 21 and 22 in Appendix G)*. The cost of the dam inclusive of civil

works but excluding power plant works out to Rs. 35.03 crores against 22.9 crores for F.R.L. 540 estimated by the Hyderabad State.

This dam is proposed to be built in the 1st stage and being a joint work of Madras and Hyderabad, its execution should be carried out jointly to ensure easy and quick construction.

Working tables for both the 1st and 2nd stages have been prepared and are given (in Appendix F)*. These show that in the first stage this dam will irrigate an area of 28.48 lakhs acres of 1st crop, 3.5 lakhs acres of 2nd crop and 0.25 lakh acres perennial. Generation of power will be 60,000 k.w. continuous. In the 2nd stage irrigation will increase to 35.10 lakhs acres in the 1st crop but the 2nd crop will be reduced from 3.5 lakhs to 1 lakh. The continuous power will also be reduced from 60,000 k.W. to 40,000 k.w.

CANALS

Kurnool-Cuddapah canal

5.43. The existing Kurnool-Cuddapah Canal (K.C.C.) takes off from the Sunkesula anicut on the Tungabhadra and irrigates an area of about 1.lac acres annually in the Kurnool and Cuddapah districts of Rayalaseema. It was originally designed to carry a discharge of about 3000 cusecs but at present carries only 1800-2000 cusecs. This canal is proposed to be remodelled for a discharge of 6000 cusecs from its head at Sunkesula to nearabout mile 73 where a regulator would be constructed. A link channel carrying a discharge of 4000 cusecs will be taken from the regulator to the Vempeta anicut site of the Krishna-Pennar Project where the head sluices of the Krishna-Pennar East and West Canals are proposed to be located. The old course of the canal will be followed except where better alignment may be indicated by actual detailed survey. Below the regulator the Kurnool-Cuddapah canal will follow its present alignment, so that the existing anicut remains unaffected. This remodelled capacity of 6000 cusecs will be more than sufficient to meet the requirements of both Kaveli and Kanupur canals on the Pennar and Krishna-Pennar East Canal, which will be fed from the Kurnool-Cuddapah canal in the 1st stage. Studies have been made regarding the availability of water in Tungabhadra river and a note dealing with the subject is given in Appendix C. This shows that ample supplies would be available to meet the full revised

demand of the Kurnool-Cuddapah canal after the requirements of Tungabhadra project are met on completion of the Tungabhadra dam.

At Vempanta anicut, a discharge of 1390 cusecs will be passed into Krishna-Pennar East Canal and the balance let down into Galeru river (which ultimately joins the Pennar river) for the use of Kaveli and Kanupur canals.

The cost of the remodelling has been estimated roughly from the cross-sections of the canal received from the Madras P.W.D. (which are incomplete and do not show ground levels) and comes to Rs. 4.27 crores for a lined canal and Rs. 2.99 crores for unlined section.

The ayacuts on Krishna-Pennar East and Krishna-Pennar West canals according to Krishna-Pennar proposals are 3.00 and 1.90 lakhs acres respectively. Keeping the ayacut on the Kurnool Cuddapah canal undisturbed (this is 1.94 lakhs acres) the revised ayacuts on the Krishna-Pennar East and Krishna-Pennar West would become 1.40 lakhs acres and 1.56 lakhs acres respectively and the head discharge of the three canals would be as under :—

	cusecs
Kurnool-Cuddapah canal below Vempanta	1940
Krishna-Pennar Canal (East)	1390
Krishna-Pennar Canal (West)	1560
	4890
	or say 4900

Krishna-Pennar east canal

5.44. This canal will take off from the left bank of Vempanta anicut and follow the same alignment as proposed in the Krishna-Pennar project. The irrigable area on it will, however, be reduced from 3,00,000 acres to 1,40,000 acres by deducting the ayacut on the existing Kurnool-Cuddapah canal. The head discharge of this canal for the reduced area comes to 1390 cusecs. It is easy to construct and is capable of quick development as the soil in the command is of the best type in Rayalaseema. It is, therefore, proposed to include it in the 1st stage in preference to Krishna-Pennar West Canal which (according to the Krishna-Pennar Project Report) will be a "difficult and costly canal" and can be put off to the 2nd stage.

Krishna-Pennar west canal

5.45. This canal will take off from the Vempanta anicut on the Krishna-Pennar link canal and will have a discharge of 1560 cusecs at the head for irrigation only. The F.S.L. at its head will be +835.0 and it will cross the existing Kurnool-Cuddapah canal at mile 3/4. The F.S.L. of Kurnool-Cuddapah canal at this point is +829.75 but there is a big drop in that canal about 3 furlongs higher up. It will, therefore, be possible to provide a level crossing by adjusting the drop and raising the banks in the intervening portion. It will follow the same alignment as proposed in the Krishna-Pennar project but its length will be reduced as a feeder upto Pennar will not be required. It will have an irrigable area of 1.56 lakhs acres only against 1.90 lakhs acres of Krishna-Pennar Project.

Kaveli canal

5.46. No change in its alignment or area is proposed. The discharge required for 1st crop is only 1424 cusecs and it should be designed for 1500 cusecs against 2170 cusecs proposed in the Krishna-Pennar Project. This discharge of 1500 cusecs will be ample to provide 2nd crop irrigation to the extent of 0.71 lakhs acres if water becomes available in any year.

Kanupur canal

5.47. The irrigable area on this canal is 0.78 lakh acres, the discharge for 1st crop irrigation of which comes to 984 cusecs. It is, therefore, proposed to design this canal for a discharge of 1000 cusecs, which will be ample for a 2nd crop irrigation of 0.47 lakh acres.

Both the Kanupur and Kaveli canals are proposed to be taken up in the 1st stage as a large part of their area is already being fed from existing tanks and development will be rapid.

Pick-up weir or barrage on the Pennar

5.48. This will be constructed as proposed in Krishna-Pennar Project and taken up in the 1st stage.

Krishna-Pennar link canal

5.49. According to the Committee's proposal this canal will be constructed in 2nd stage and will supply water for Kaveli, Kanupur and Madras canals and also give assistance to Krishna-

Pennar East and Krishna-Pennar West canals in case of necessity.
The maximum requirements of these canals are :—

Kaveli	1500	cusecs
Kanupur	1000	"
Madras	4000	"
K. P. East	1390	"
K. P. West	1560	"
TOTAL	9450	or say
	10,000	cusecs including
		losses in the rivers Kunderu
		and Pennar.

The Kurnool-Cuddapah canal as mentioned previously is proposed to be remodelled for a discharge of 6000 cusecs against its own requirements of 1940 cusecs. Hence 4000 cusecs will always be available for use of the above mentioned 5 canals from Kurnool-Cuddapah canal and thus only the balance discharge of 6000 cusecs will be needed from the Link Canal. However to meet all exigencies it is proposed to design it for the full requirement of 10,000 cusecs. The head regulator of the canal will have its sill at R.L. 840 *i.e.* 45 ft. below F.R.L. of Siddeswaram reservoir and will be located in the Mittakondala cutting on the left bank of the Bhavansi as proposed in the Krishna-Pennar Project. The F.S.L. of the canal at the head will be +865. The long (20 ft. high) earthen bunds near the regulator provided in the Krishna-Pennar scheme will not now be needed except in a short length ; even here their height need not exceed 5 ft. The cutting through the Bhavansi river for the approach channel will also be considerably reduced.

The canal will be taken partly in cutting and partly through a tunnel. The exact lengths of these will be arrived at after detailed investigations and economic considerations. Rough calculations, however, show that tunnelling would be cheaper when the depth of cutting exceeds 80 ft. The maximum depth of cutting in this case comes to about 100 ft.

The estimated cost of this link canal comes to Rs. 8.94 crores including the works on the Kunderu against the Krishna-Pennar project figure of Rs. 14.53 crores which in the Committee's view is very much under-estimated. The river Kunderu, according to the Krishna-Pennar project report, is capable of passing 6500 cusecs. Hence no widening of its section will be required.

Lower Krishna right canal

5.50. This canal will be the largest of the new canals proposed in the Project and will have a head discharge of 24,400 cusecs and will be taken on the contour for nearly 224 miles before tailing into the Pennar river. It will take off from the foreshore on the right flank of the Nandikonda dam and go generally in a south-eastern direction upto R.D. 240000 which is about 4 miles to the west of Nekrakallu. There will be a reverse bend near Nekrakallu and the canal will then run in a south-westerly direction upto about R.D. 550000. From R.D. 550000 to R.D. 1025000 the general direction will be southerly with occasional diversions to the east or west. At R.D. 1125000 the supply will be dropped into the Vagu going in the Anantasagram tank. After going through the tank the canal will be dropped into Pennar above the site proposed for the barrage in the Krishna-Pennar Project. The alignment below the Anantasagram tank can be improved and its length considerably shortened if a suitable site for the barrage can be found a few miles lower than that selected at present. This will have to be investigated before the final choice is made.

District traversed.—During its course the canal will pass through the following districts :—

Guntur	from R.D. 0 to 420000
Kurnool	from R.D. 420000 to 585000
Nellore	from R.D. 595000 to 1220000

Designed discharge and slopes.—At its head at Nandikonda Reservoir, the canal will have a discharge of 24,400 cusecs, bed level R.L. 490 and F.S.L. R.L. 504.3. The bed slope from head upto R.D. 6,41,000 will be 1 in 15,000. Below R.D. 6,41,000 where the discharge is reduced to 9811 cusecs the slope will be kept. One in 10,000 with occasional reaches of flumed sections in cuttings where the slope will be increased upto 1 ft. per mile. In selecting the alignment, efforts have been made to take in the largest possible ayacut. It may be possible to effect considerable economy in cost and improvement in location after detailed survey of the canal.

Ayacut.—As the canal runs on the contour, the entire ayacut lies to the east of it and is bounded by the Krishna river in the north, the Pennar river in the south and the Buckingham and Commamore canals and the proposed Kaveli canal on the east. The gross area commanded is 48.8 lakhs acres, and after deducting high lands and area unsuitable for irrigation, the culturable area is 45.47 lakh acres of which 50% or nearly 23 lakh acres is proposed to be irrigated ultimately. In the first stage it is proposed to pass 4000 cusecs from the tail of this canal into Pennar river for feeding the new Madras canal on the south bank of the Pennar. Allowing for this and for the time taken to develop irrigation in a new tract, the area expected in the first stage has been taken to be $\frac{2}{3}$ rd of 23 lakh acres or say 16 lakhs. One third of the area on this canal is proposed to be irrigated wet and the remaining two-third dry.

The acreage of irrigable area for each major water-shed has been worked out separately and is given below :—

Krishna-Cadidala Vagu	3,53,719
Cadidala Vagu-Vogaru Vagu	10,43,213
Vogaru Vagu-Kandieru	7,83,091
Kandieru-Gundalakama	1,00,000
Gundalakama-Musi	6,98,082
Musi-Paleru	4,36,515
Paleru-Maneru	5,10,012
Maneru-Uppu Vagu	29,491
Uppu Vagu-Pillaperu	48,365
Pillaperu-Boggeru	4,50,363
Boggeru-Pennar	1,09,824

Tanks in the ayacut.—There is a large number of small and large tanks in the area commanded by the lower half of the canal and these will have a favourable influence on the rapid development of irrigation. The total ayacut of the tanks is about 2 lakhs acres but the supply is at present precarious. Conditions will be stabilized when assured supplies pass down into the tanks.

Duty.—The duty at distributary heads has been assumed to be 13.75 cusecs per 100 acres of wet irrigation and the transmission losses in the main canal have been taken to be 6.5 cusecs per million sq. ft. of wet areas.

Canal sections.—The sections in the different reaches have been designed according to practice adopted in the Krishna-Pennar Project. The canal has been taken through cutting wherever it has been found advantageous or unavoidable. Cuttings have been introduced in the reaches where alignment along the contour would have been long.

Regulators.—These are proposed below the heads of important branches and a few other places where they were considered necessary.

Falls.—There is a fall of about 100 ft. between the bed level of the canal and the bed level of Keta Manneru river which flows into Anantasagram tank. To negotiate this a series of 10 ft. drops have been proposed and have been estimated on the basis of similar structures in the Krishna-Pennar Project.

Cross drainages.—Owing to its alignment along the contour the main canal has to cross 128 drainages. Acqueducts, syphons or other works suited to local conditions and levels have been proposed. The more important of these drainages are the following :—

Nagleru Vagu	at R. D.	181000
Kandieru	at R. D.	421000
Gundalakama	at R. D.	585000
Musi	at R. D.	678000
Paleru	at R. D.	830000
Maneru	at R. D.	912000
Uppu Vagu	at R. D.	933000
Pilaperu	at R. D.	972000
Boggeru	at R. D.	1130000

Bridges.—Two rail-bridges will be necessary where the meter gauge lines of the Southern Railway are crossed. 12 district road bridges and 72 village road bridges are proposed to facilitate communication. Estimates have been framed on the basis of similar works in the Krishna-Pennar Project. Wherever possible bridges should be combined with regulators.

Madras canals

5.51. This canal will take off above the pick-up barrage across the Pennar and will follow the alignment of the proposed Pennar South Canal of the Krishna-Pennar project upto mile 13/7 and thereafter follow the alignment of the proposed Madras Canal of that project. It is proposed to be taken up in the 1st stage and will be fed initially from the lower Krishna Right Canal, development on which is likely to take time and which will be able to spare enough water for some years after meeting its own irrigation requirements. In the II stage this canal will draw its supplies from the Siddeswaram Dam through the Krishna-Pennar Link Canal. The irrigable area is 7.36 lakhs acres : 50% of this is proposed to be irrigated in 1st crop, for which a discharge of only 3130 cusecs is required. The canal is, however, proposed to be designed for a discharge of 4000 cusecs, which will be sufficient to irrigate an area of about 1.90 lakhs acres of 2nd crop if and when water becomes available in years of good supply.

The cost of the canal is roughly estimated to be Rs. 8.42 crores against Rs. 12.00 crores provided in the Krishna-Pennar Project.

Estimates of cost

5.61. The total cost of the Siddeswaram dam and Reservoirs comes to Rs. 15.23 crores and that of Nandikonda dam and reservoir Rs. 35.03 crores. The latter will supply irrigation to both Madras and Hyderabad States and hence will be a joint concern of these states. In a year of dependable

field in the Krishna the consumptive use of water in Hyderabad is 125 t.m.c. ft. (2.87 m.a. ft.) and in Madras 326 t.m.c. ft. (7.48 m.a. ft.). The Madras share of the cost of dam and reservoir based on this proportion will be Rs. 23.35 crores.

These costs do not provide for works relating to power development. Nandikonda dam will be built in the 1st stage and Siddeswaram dam in the 2nd stage.

DIVERSION WORKS

Pick-up barrage on the Pennar

5.71. The cost has been assumed to be the same as that given in the Krishna-Pennar Project. Deduction has been made from the figure given in that Project for the head regulator of the Pennar North Canal which will not be constructed and reduction in size of the Madras canal head regulator. The figure adopted is Rs. 1.13 crores against Rs. 1.29 crores of Krishna-Pennar Project.

Krishna-Pennar link canal

5.72. This has been roughly estimated, and the cost work out to Rs. 8.94 crores. The main item is the Mittakondala cutting, in which the canal is proposed to be taken partly in cutting as open channel and partly through a tunnel. The cost of this portion alone of the canal accounts for Rs. 6.99 crores out of Rs. 8.94 crores. As the discharge has been considerably reduced i.e. from 75,000 to 10,000 cusecs, little improvement will be needed in the Galeru and Kunderu rivers, etc.

CANALS

Kurnool-Cuddapah canal

5.81. The cost of enlarging this canal for a carrying capacity of 6000 cusecs has been roughly estimated from cross-sections and comes to Rs. 4.27 crores for lined section and Rs. 2.59 crores for unlined section.

Lower Krishna right canal

5.82. This is a contour-canal and its cost has been roughly estimated on the basis of a long-section prepared from G.T. sheets and comes to Rs. 48.75 crores. Earth-work estimate has been worked out in detail and it has been assumed that 4% of the total quantity will consist of rock excavation on the analogy of the Krishna-Pennar Project. No deductions have been made for possible savings resulting from use of machinery. Lump sum provisions have been made for preliminary expenses, escapes, buildings, plantations, special tools and plants, miscellaneous and maintenance. Provision for these items in the Krishna-Pennar Project have been taken as a guide.

Branch canals have been estimated at half the rate per acre obtained for the main canal, while distributaries and minors have been estimated at Rs. 40 per acre. The latter rate is slightly lower than that adopted in the Krishna-Pennar Project but it is justified because a large proportion of the irrigation will be dry and channel dimensions will be comparatively smaller. It may be added that detailed survey will have to be done before a correct estimate can be prepared. This may probably take six months or so.

As stated in paragraph 5.50 only two-third of the proposed area is intended to be irrigated in the 1st stage and part of the supply will be passed down to the Pennar river. A few of the major branches included in the full project will, therefore, be omitted in the 1st stage and the canal dimensions will also be somewhat smaller to suit conditions in that stage. The branches omitted will be constructed and sections widened in the second stage. The masonry works, however, will be built to suit the final discharges in the first instance. The cost of the canal and works in the 1st stage has been roughly worked out and comes to Rs. 37.59 crores.

Lower Krishna left canal

5.83. This has been estimated in detail by Hyderabad State and the cost comes to Rs. 26.20 crores which may be accepted. This cost is somewhat high on account of difficult

country involving construction of tunnels and other expensive works. Details have not been scrutinized.

Krishna-Pennar east, Krishna-Pennar west,

Kaveli, Kanupur and Madras canals

5.84. The estimates of these canals have been prepared by reducing the figures given in the Krishna-Pennar Project to allow for the reduced discharges now proposed. Details of these deductions are given in the Table V (pages 66-67).

V

Madras Canal			Kanupur			Kaveli		
Q=7000 cusecs			Q=1800 cusecs			Q=2170 cusecs		
q=4000 cusecs			q=1000 cusecs			q=1500 cusecs		
As per K. P. project	Per cent.	Reduced cost	As per K. P. project	Per cent.	Reduced cost	As per K. P. project	Per cent.	Reduced cost
5.42	100	5.42	1.00	100	1.00	1.19	100	1.19
34.00	85	28.85	6.00	85	5.10	7.50	90	6.75
13.21	77	10.20	1.00	78	.78	1.40	83	1.16
..	..	..	.05	78	.04	.05	83	0.04
202.00	85	172.00	18.00	85	15.30	24.00	90	21.60
38.50	77	29.60	5.00	78	3.90	5.00	83	4.15
8.00	65	5.20	1.00	65	.65	1.00	72	0.72
18.00	85	15.30	3.60	85	3.06	4.00	90	3.60
441.90	69	305.00	39.60	70	27.72	47.25	77	36.40
2.38	100	2.28	.35	100	.35	.40	100	0.40
34.00	77	26.20	3.10	78	2.42	3.41	83	2.83
4.84	77	3.72	1.80	78	1.40	2.00	83	1.66
114.50	69	79.00	30.00	70	21.00	36.00	77	27.70
184.00	..	92.00	54.60	..	31.20	97.23	..	44.00
1100.65	..	774.77	166.10	..	114.92	231.43	..	153.20
99.06	..	67.83	14.90	..	9.88	20.82	..	13.18
1199.71	..	841.90	181.00	..	124.80	252.25	..	166.38

Table VI below gives an abstract of cost of the dams and canals, etc., by stages.

TABLE VI

Name of dam or canal	Cost in crores of rupees			Remarks
	1st stage	2nd stage	Total	
Siddeswaram Dam . . . . .	..	15.23	15.23	
Nandikonda Dam	35.03*	..	35.03	Hyderabad = 11.68* Madras = 23.35
Pick-up Barrage	1.13	..	1.13	
Krishna-Pennar link canal . . . . .	..	8.94	8.94	
Krishna-Pennar East canal	3.17	..	3.17	
Krishna-Pennar West canal . . . . .	..	4.77	4.77	
Kurnool-Cuddappah Canal	2.59	..	2.59	
Kaveli Canal	1.67	..	1.67	
Kanupur Canal	1.25	..	1.25	
Lower Krishna Left Bank Canal	26.20**	..	26.20	Hyderabad = 20.54** Madras = 5.66
Lower Krishna Right Bank Canal	37.59	11.16	48.75	
Madras Canal	8.42	..	8.42	
TOTAL	117.05	40.10	157.15	
Madras	84.82	40.10	124.93	
Hyderabad	32.22	..	32.22	

Table VII (pages 70-71) gives the irrigation and power benefits and food production on full development.

STAGE III (FINAL)

5.10. (a)—In this stage it is proposed to construct a dam on the Krishna at Pulichintala to make use of the inflow into the river between Nandikonda and Pulinchintala. Working tables have been prepared for this dam operating in conjunction with the two upper dams at Siddeswaram and Nandikonda and are given in Appendix 'F'. These show :—

- (i) that the second crop irrigation in the Krishna delta can be increased from 1 lakh acres in the II stage to 5 lakhs acres, if no firm power is generated at Pulichintala, or
- (ii) that the 2nd crop can be increased from 1 lakh to 4.5 lakhs acres if 20,000 k.w. of firm power is also generated.

The cost of the dam is expected to be about Rs. 7.5 crores only and the cost per acre of irrigation would be Rs. 150 which is comparatively low.

After the construction of the Pulichintala dam the entire Madras share of Krishna water allotted under the inter-State agreement will be fully utilised. If water could be obtained from the Godavari by diversion and dropped into the Kistna above Nandikonda or into the Hyderabad canal system taking off from Nandikonda it could be used for :—

- (i) irrigation of lands commanded by the Pennar South Canal of the Krishna-Pennar Project and areas south of Madras which have not been included in the Committee's proposals ;
- (ii) increasing 2nd crop in Krishna delta ;
- (iii) converting dry irrigation into wet irrigation in the ayacut of lower Krishna right canal and for 2nd crop irrigation in that area. A right bank canal from Pulichintala will in this case be necessary.

(b) *Irrigation south of Madras.*—The Committee's proposals provide irrigation for all the areas included in the Krishna-Pennar project with the exception of about 7 lakhs acres forming the ayacut of the Pennar south canal of that project. This had to be left out as all the Madras share of

TABLE

Dam or Canal	Irrigation in	
	1st crop	
	Dry	Wet
I STAGE—		
Krishna-Pennar East and Kurnool, Cuddapah Canals	2.00	1.00
Kaveli Canal	...	1.10
Kanapur Canal	...	.78
Madras Canal	...	3.68
Right Bank Canal	10.67	5.33
Left Bank Canal (Hyderabad)	.65	6.10
Left Bank Canal (Madras)	.20	1.85
Krishna Delta	...	...
TOTAL	13.52	19.84
II STAGE—		
Krishna-Pennar East and Kurnool, Cuddapah Canals	2.00	1.00
Krishna-Pennar West Canal	1.27	.63
Kaveli	...	1.10
Kanapur Canal	...	.78
Madras Canal	...	3.68
Right Bank Canal	16.00	8.00
Left Bank Canal (Hyderabad)	1.30	7.30
Left Bank Canal (Madras)	.20	1.85
Krishna Delta	...	...
TOTAL	20.77	24.34

NOTE.— One acre wet is assumed to yield 1/4th of a ton of additional 2nd crop it has been taken as 1/2-d.

VII

lakh acres					
2nd crop	Perennial	Total	Equivalent in wet	Power firm continuous in k. w.	Extra food production in lakh tons
...	...	3.00	2.00	...	.50
...	...	1.10	...	...	.24
...	...	.78	3.70	...	.17
...	...	3.68	...	...	.52
...	...	16.00	10.67	...	2.70
...	...	6.75	6.425	...	...
...	...	2.05	1.95	...	2.10
3.5	.25	3.75	3.75	...	1.17
...	...	37.11	28.495	60,000	7.40
			22.07	Madras	5.80 Madras
			6.425	Hyderabad	1.60 Hydera-
			<u>28.495</u>		<u>7.40</u> bad.
...	...	3.00	3.13	...	.52
...	...	1.90	...	...	.32
...	...	1.10	...	...	.24
...	...	.78	3.70	...	.17
...	...	3.68	...	...	.52
...	...	24.00	16.00	...	4.00
...	...	8.60	7.95	...	...
...	...	2.05	1.95	...	2.47
1.0	.25	1.25	1.25	...	.33
...	...	46.36	33.98	80,000	8.55
			26.03	Madras	6.56 Madras
			7.95	Hyderabad	1.99 Hydera-
			<u>33.98</u>		<u>8.55</u> bad.

food against 1/2 assumed in Krishna-Pennar Project. In the case of

the Krishna was required for the areas included. The land left out can, however, be served if :

- (i) field investigations show that diversion of Godavari water above Nandikonda dam or into the Nandikonda left bank canal is feasible. This will release Krishna water for use elsewhere ; or
- (ii) if Hyderabad or Bombay do not use their full share of Krishna water and pass down the balance for use by Madras.

The Committee's proposals anticipate that the water which will have to be passed below Nandikonda and Pulinchintala after generation of power will suffice for irrigation of two lakhs acres of 2nd crop irrigation in the Krishna delta. If by suitable integration of power systems the generation of power at Pulichintala is stopped and at Nandikonda restricted for a part of the year it should be possible to divert the water saved to areas south of Madras for irrigation there. There will be no trouble in the Krishna delta as more water can easily be diverted from the proposed Polavaram diversion barrage on Godavari to make up the deficit. The amount of diversion from Godavari will in this case become about 110 t.m.c.ft. or 2.52 m.a. ft.

The construction of Madras canal proposed in the 1st stage of the Committee's proposals is likely to be taken up in the 4th year after start of construction. By that time field investigations about the possibility of diverting Godavari water into Krishna should be completed. If these show that more Godavari water than is anticipated by the Committee at present can be diverted, the size of the Madras canal can be increased accordingly and its tail extended to serve areas south of Madras. If, however, investigations do not hold any hope of further diversion, it would still be desirable to construct the Madras canal with a capacity of 6000 cusecs. It would be possible for several years to run additional supplies into this canal from the unused balance of the shares of Bombay and Hyderabad where full development is likely to take considerable time. Later on it should be possible to save water at Nandikonda and Pulichintala and divert it into the Madras canal by integration of power systems on the Godavari and the Krishna and their tributaries (e.g. Tungabhadra). The extra cost involved in increasing the capacity for extension of irrigation to areas south to Madras is likely to be about Rs. 2 crores. This has not been included in the estimate but its inclusion is not likely to make any appreciable change in the financial picture.

The irrigation proposed in the areas left in the Committee's proposal is 3·64 lakh acres. It is expected that by increasing the capacity of Madras Canal and making use of the water from sources mentioned above, it would be possible to irrigate a large proportion of this 3·64 lakh acres.

(c) *Use of Godavari waters.*—According to the inter-State agreement Madras is entitled to 893 t.m.c. ft. or 20·5 m.a. ft. out of the Godavari flow, in addition to the amount already being used in the Godavari delta. In the year 1948 the Ramapadasagar Project was prepared by the Madras Government to :—

- (i) provide water for 2nd crop irrigation to Godavari delta ;
- (ii) feed Krishna river for irrigation in delta ;
- (iii) irrigate areas in Guntur district beyond the Krishna river,
- (iv) irrigate strips of uplands lying to the west of the existing Godavari and Krishna deltas on both banks of the Godavari ;
- (v) generate power.

It was intended to use 936·76 t.m.c. ft. or 21·50 m. a. ft. to irrigate 27·46 lakhs acres and generate 1,50,000 k.w. of power.

As the Ramapadasagar Project (1948) would have required more Godavari water than was allotted to Madras, a modified proposal (1951) was handed over to the Committee. According to this the utilization is worked out as under:—

Water used in irrigating 7·2 lakhs acres of 1st crop and 12·6 lakhs acres of 2nd crop	. 449·30 t.m.c. ft. or 10·26 m.a. ft.
Water required for firming of power	. 204·50 t.m.c. ft. or 4·7 m.a. ft.
Navigation and evaporation	. 61·20 t.m.c. ft. or 1·4 m.a. ft.
TOTAL	715 16·36

As the total Madras Government share is 20·5 m.a.ft. a little over 4 m.a. ft. or 174·24 t.m.c. ft. would remain unutilised according to the modified scheme.

The construction of the dam and the connected canal system is contingent on the excavation and dewatering of the west arm of the river having proved feasible in actual practice. Although

Consulting Board of Engineers have declared the scheme to be feasible, they have admitted that the work would present unusually difficult river diversion and foundation excavation problems. It is also stated that the work will have to be done by foreign contractors using machinery wholesale as no one in India has got experience of execution of works on a highly mechanised scale. Also the capital outlay will be very high and the drain on the personnel and material serious.

The irrigation of 2nd crop in the delta and generation of power can be secured by a reservoir built at a suitable site on the Godavari or one of its main distributaries, *vide* paragraph 3·3 (j). Diversion of supplies into the Krishna for delta irrigation and irrigation of strips of uplands lying to the west of the Godavari and Krishna deltas on both banks of the Godavari, can to a large extent be arranged if only a low level diversion barrage instead of a high dam is built at Polavaram. Under the circumstances, the Committee do not consider Ramapada sagar dam to be necessary.

The Committee have carefully considered the possibility of diverting Godavari waters to Krishna, and they have found that by constructing a storage dam at a suitable point in the upper reaches of Godavari or on one of its tributaries and a diversion weir at Polavaram it would be possible to divert a little over 80 p.t.m. c. ft. or 1·84 m. a. ft into the Krishna in a year like 1929-30 and to increase 2nd crop irrigation in the Krishna delta to the desirable maximum of 5·4 lakh acres against 2 lakhs proposed by the Committee without aid from Godavari.

According to the Committee's proposals the Madras share of the Godavari water would be used as under :-

(i) *If firm power is generated at Nandikonda and Pulichintala throughout the year and the water is used for 2 lakhs acres of 2nd crop irrigation in Krishna delta.*

For irrigating 4·55 lakhs of acres of 1st crop and 10·68 lakhs acres of 2nd crop in Godavari and Krishna deltas	340·00 t. m. c. ft. or 7·81 m. a. ft.
For firming up power	204·5 t. m. c. ft. or 4·7 m. a. ft.
For evaporation, navigation etc.	<u>61·2</u> t. m. c. ft. or <u>1·4</u> m. a. ft.
TOTAL	605·7 t. m. c. ft. 13·91 m. a. ft.

(ii) If by suitably integrating power systems no 2nd crop irrigation is done in Krishna delta with Krishna water :

For irrigating 4.55 lakhs of acres of 1st crop and 12.68 lakhs of acres of 2nd crop	382.2 t.m.c. ft. or 8.77 m.a. ft.
For firming up power	204.5 t.m.c.ft. or 4.70 m.a. ft.
For evaporation, navigation etc.	61.2 t.m.c.ft. or 1.4 m.a.ft.
TOTAL	647.6 t m.c.ft. or 14.87 m.a. ft.

As the share of Madras is 20.5 m.a. ft. or 893 t.m.c.ft. a considerable quantity will remain available for diversion into the Krishna from some higher point on the Godavari if field investigations show that such diversion is economically feasible. A part of the surplus can be used for irrigation by pumping of high lands in the Godavari and Sabari valleys which have no means of irrigation at present. The Committee have not gone into the economics of proposals for making use of Godavari waters. No opinion can be expressed without detailed field investigations and preparation of estimates.

A study of maps and available information has shown that Godavari waters can also be diverted into Krishna from the dam proposed by the Hyderabad Government at Kushtapuram but the catchment area above this dam is small and inflow would be hardly adequate for the needs of Hyderabad itself and there would be nothing left for diversion. There seems to be no other suitable site but detailed field investigations are necessary to reach a definite conclusion. If investigations show that Godavari water can be diverted and delivered above Nandikonda or into the Hyderabad canal system taking off from Nandikonda at a reasonable cost, it would be possible to provide irrigation to a corresponding extent in the areas south of Madras left out in the Committee's proposals.

In working table (ii) of the Committee's report the inflow into the Nandikonda reservoir was taken as 39.1% of the flow at Vijayawada assuming complete utilization of allotted waters by different States. If, however, Bombay and Hyderabad do not eventually utilize their full shares, the unused balances can be used in extending irrigation to areas proposed on the Pennar South Canal of the Krishna-Pennar Project and land south of Madras which are not included in the Committee's proposals. To that extent diversion from Godavari will become

unnecessary. In the meantime, and as a short-term arrangement the unused water of Bombay and Hyderabad can be used for 2nd crop irrigation without any change in the Committee's proposals and without adding to their cost.

(d) *Utilization of Krishna water by Hyderabad.*—The Hyderabad Government has been allotted 6.43 m. a. ft. or 280 t. m. c. ft. out of the dependable flow of the Krishna. According to the Lower Krishna Project Report they propose to utilize this as under:—

Name of Project	Utilization from dependable flow in t. m. c. ft.	Utilization from excess flow in t. m. c. ft.
Upper Krishna	80	20
Bhima	35	10
Lower Krishna	125 or (2.87 m.a. ft.)	35 or (.8 m.a. ft.)
Extra required for Tungabhadra .	20	15
Medium Projects	20	10
Minor Projects . . . . .	...	10
	280 or (6.43 m. a. ft.)	100 or (2.3 (m. a. ft.)

If any part of Hyderabad share remains eventually unutilised, it can be used for irrigation in Madras State as indicated in the preceding paragraph.

(e) *Use of Tungabhadra water.*—The Tungabhadra dam which is approaching completion will store 113.12 t.m.c. ft. or 2.59 m. a. ft. which will be shared by Madras and Hyderabad. The canal systems to make use of this water are in an advanced stage of construction, but it will take 10 to 15 years for irrigation to develop until such development takes place, a considerable amount of storage will be available for use elsewhere. This water can as a short-term measure be used for 2nd crop irrigation in the Krishna delta and in the new canals

(Kaveli, Kanupur and Krishna-Pennar East) proposed by the Committee to be constructed in the first phase of the first stage. By the time supplies from the Tungabhadra cease to become available it would be possible to irrigate the 2nd crop with water stored at Nandikonda.

According to information supplied by the Madras Government *vide* their D. O. No. 74459 P & D IV/51-1 dated 11th July, 1951 to the address of the Planning Commission, the irrigation expected on Tungabhadra canals in Madras State and in the Krishna delta with surplus Tungabhadra waters is expected to be as under :—

Year	Tungabhadra Project (acres)	II crop in Krishna Delta (acres)
1951-52 . . . . .	...	...
1952-53	21,000	...
1953-54	43,000	60,000
1954-55	65,000	55,000
1955-56	87,000	50,000
1956-57	1,08,000	45,000
1957-58	1,29,000	40,000
1958-59	1,49,000	35,000
1959-60	1,69,000	30,000
1960-61	1,89,000	25,000
1961-62	2,09,000	20,000
1962-63	2,23,000	12,000
1963-64	2,37,000	4,000
1964-65	2,50,000	...

The Committee considers that the anticipated irrigation in the Krishna delta is too low and much greater areas are likely to be irrigated in the delta by Tungabhadra water not used by Hyderabad and Madras on the Tungabhadra canals.

Financial aspects

5·11. Financial statements have been prepared in the usual forms both for Stage I and Stage II and are given in Appendix I.

The total cost of the scheme including direct and indirect charges in the 1st stage amounts to Rs. 84·82 crores and the return on the sum-at-charge at the end of 10th year after completion works out to 4·29% and goes on increasing. The total cost of the 2nd stage has been estimated as Rs. 124·93 crores and the return on the sum-at-charge at the end of 10th year after completion works out to 3·34% and goes on rising.

Gandikota project

5·12. The normal dependable yield from the river Pennar based on actual observations at the old Gandikota dam site is 11,500 m. c. ft. which is sufficient to irrigate 50,000 to 55,000 acres 1st crop. In the Krishna-Pennar Project it is proposed to give assistance to the Gandikota reservoir by sending supplies from Siddeswaram dam through Krishna-Pennar West Canal and thereby to increase the irrigation to 1,50,000 acres. The working tables for the year 1929-30 as revised by the Committee, however, show that available supplies in the Krishna are not sufficient even for the proposed irrigation on other canals and drastic reduction had to be made both in 2nd crop irrigation and power, to balance the water account. The Committee, therefore, recommend that Gandikota Project should be kept separate and not mixed up with Krishna Projects.

Surveys and investigations

5·13. If the Committee's proposals are approved, steps may be taken immediately for the surveys and preparation of estimate of remodelling Kurnool-Cuddapah Canal to carry a discharge of 6000 cusecs also for the completion of investigations on the Kaveli, Kanupur and Krishna-Pennar East Canals, so that actual work of construction on this part of the 1st stage may be started within six months and irrigation benefit may commence accruing in about 3 years time. Along with the above, surveys

and investigations of Nandikonda dam and the right bank canal may also be started and designs and estimates prepared. Work on surveys of Madras Canal and the Barrage on the Pennar river which are already in progress, should be completed. It should be examined whether a suitable site for the Pennar Barrage can be found a few miles lower down. This will greatly reduce the length and expense on the tail portion of the Nandikonda right bank canal and head reach of the Madras Canal. Similarly Hyderabad State should immediately start detailed surveys and alignment of the left bank canal from Nandikonda. It should be possible to complete these investigations and to start work on the dam and the main canals in about a year. In the meantime preliminary preparations for construction could be taken in hand.

The possibility of setting up a cement factory in the neighbourhood of the Nandikonda dam should also be explored at the same time. Field investigations should also be carried out to see whether it is possible to divert water from Godavari or any of its tributaries into Krishna above Nandikonda reservoir into the Nandikonda left bank canal. These will show whether it is possible to release Krishna water for use south of Madras.

5'14. A comparative statement showing irrigation and power benefits and cost etc. of the Krishna-Pennar project (i) as prepared, (ii) as modified because of the discharge at Siddeswaram being less than that at Vijayawada and (iii) as per Committee's proposal, is given below:—

“It will be seen that in both Stage and Full Plan of Krishna-Pennar project, irrigation and power will be less than that anticipated. The drop in irrigation is specially marked in Full Plan. Proposals of the Committee will serve a much larger area at an appreciably less cost per acre. The income from betterment fee will also be considerably higher as the proposals are intended to benefit mostly dry areas and the proportion of second crop on which such fees are not levied is low.”

Particulars	As per Krishna-Pennar	
	As per Madras proposals	
	Total (lakhs)	Equivalent wet.
		(lakhs acres)
STAGE I		
Irrigation 1st crop	7.46	4.97
Irrigation 2nd crop	5.56	5.56
Krishna Delta 2nd crop	7.15	7.15
Pennar 2nd crop	1.29	1.29
Perennial . . . . .	.50	.50
Total	21.96	19.47
Additional food grains	10.3 lakh tons	
	@ 1/2 tons per acre.	
AREA OF SUBMERSION		
Siddeswaram	1,74,080 acres	
Someswaram	1,28,000 acres	
Nandikonda . . . . .	..
Cost	Rs. 77.60 crores	
Betterment fee	Rs. 10.61 crores	
Sale proceeds of Poraboke lands	Rs. 73 crores	
Cost per acre	Rs. 353	
Power	100,00 k w continuous.	
Sum at-charge at end of 10th year after completion	Rs. 85.69 crores.	
Return on sum at charge	3.14 per cent increasing.	

NOTES.—The correct comparison is between columns 4—5 and 6—7 100,000 k.w. Irrigation of 2nd crop in delta will go up to 6.00 lakh acres.

** The cost per acre is high on account of difficult country through
rage.

Project		As per Committee's proposal		Hyderabad Scheme	
As actually anticipated with modified proposals		Total (lakhs)	Equivalent wet.	Total	Equivalent wet.
Total	Equivalent wet.				
7.46	4.97	26.61	18.35	..	..
5.56	5.56	..	..	..	..
6.25	6.25	3.50	3.50	..	..
1.29	1.29	..	..	In the year of dependability.	
.50	.50	.25	.25	..	..
21.06	18.57	30.36	22.10	6.75	6.42
5.61 lakhs tons @ 1/4 ton per acre.		5.8 lakhs tons @ 1/4 tons per acre.			
1,74,080 acres		1,27,500 acres			
1,28,000 acres		70,000 acres			
Rs. 77.60 crores		Rs. 84.82 crores		Rs. 32.22 crores	
Rs. 10.61 crores		Rs. 36.12 crores			
Rs. .73 crores		Rs. 8.18 crores.			
Rs. 368		Rs. 250		Rs. 477**	
60,000 k. w. continuous		60,000 k. w. continuous			
Rs. 89.16 crores		Rs. 87.32 crores			
2.61 per cent decreasing		4.29 per cent increasing			

and not between 2—3 and 6—7 ; without increase in power from 80,000 to which the canal would pass and full development not taking place in first

Particulars	As per Krishna-Pennar	
	Total (lakhs)	Equivalent wet.
STAGE II		
Irrigation 1st crop	22.65	17.94
Irrigation 2nd crop	8.71	8.71
Krishna Delta 2nd crop	4.50	4.50
Pennar IInd crop	1.29	1.29
Perennial . . . . .	.50	.50
Total	37.65	32.94
Additional food grains	17 lakhs tons	
Cost	Rs. 130.6 crores	
Betterment fee	Rs. 36.10 crores	
Sale proceeds of poramboke lands	Rs. 6.47 crores	
Cost per acre	Rs. 351	
Power	100,000 k. w. continuous	
Sum-charge at the end of 10th year after completion	Rs. 144.03 crores	
Return on sum-at charge	3.45 per cent increasing	

STAGE III

Irrigation 1st . . . . .	..	..
Irrigation 2nd crop . . . . .	..	..
Irrigation delta crop . . . . .	..	..
Pennar 2nd crop . . . . .	..	..
Perennial . . . . .	..	..
Total . . . . .	..	..
Additional foodgrains . . . . .	..	..
Cost . . . . .	..	..
Betterment fee . . . . .	..	..
Sale proceeds of poramboke lands . . . . .	..	..
Cost per acre . . . . .	..	..
Power . . . . .	..	..

NOTES.—The correct comparison is between columns 4—5 and 6—7
100,000 k. w. Irrigation of 2nd crop in delta will go up to 6.00 lakh acres.
** The cost per acre is high on account of difficult country through
stage.

Project	As per Committee's proposal		Hyderabad Scheme	
	Total lakhs	Equivalent wet.	Total	Equivalent wet.
As actually anticipated with modified proposals				
	Total	Equivalent wet.		
22.65	17.94	36.96	25.29	
2.71	2.71	..	..
1.50	1.50	1.00	1.00	
1.29	1.29	..	..	In 50 per cent of the years.
.50	.50	.25	.25	
28.65	23.94	38.21	26.54	8.60 7.94
6 lakhs tons		6.54 lakhs tons		
Rs. 130.6 crores		Rs. 124.92 crores		Rs. 32.22 crores.
Rs. 35.37 crores		Rs. 48.27 crores.		
Rs. 6.47 crores		Rs. 11.56 crores.		
Rs. 456		Rs. 327		**Rs. 375
80,000 k. w. continuous		80,000 k. w. continuous		
Rs. 156.19 crores		Rs. 139.77 crores		
2.58 per cent decreasing		3.34 per cent. increasing.		
..	..	36.96	25.29	
..	
..	..	**4.50	4.50	
..	
..	..	.25	.25	
..	..	41.71	29.94	8.60 7.94
..	..	7.71 lakhs tons		
..	..	Rs. 132.43 crores		Rs. 32.22 crores
..	..	Rs. 48.27 crores		
..	..	Rs. 11.56 crores		
..	..	Rs. 318		**Rs. 375
..	..	100,00 k. w. continuous		

and not between 2—3 and 6—7 ; without increase in power from 80,000 to which the canal would pass and full development not taking place in first

CHAPTER VI

SUMMARY AND RECOMMENDATIONS

KRISHNA-PENNNAR PROJECT

6.0. (1) It has been assumed in the project that the inflows at Siddeswaram will be the same as recorded at Vijayawada. Actually these will be 15% less, as 15% of the discharge at Vijayawada comes into the Krishna from the catchment below Siddeswaram.

(2) The Siddeswaram dam would submerge an area of 1,74,080 acres of which 1,13,892 is cultivated. It will also submerge 98 villages and displace about 50,000 people (*vide* para. 4.0). Compensation on this account would amount to Rs. 7.35 crores.

Likewise Someswaram dam would submerge 1,28,000 acres including 68,400 acres of cultivated area and valuable gardens and displace about 1,00,000 persons (*vide* para. 4.1). The cost of compensation alone would amount to Rs. 7.7 crores:

(3) The capacity of 75,000 cusecs proposed for Krishna-Pennar Link Canal is excessive and can be reduced to 10,000 cusecs. The estimate for this canal is likely to be heavily exceeded (*vide* para. 4.3).

(4) The duties taken for all the canals are low and the discharges provided are high. Large reductions can be made without loss of efficiency (*vide* para. 4.14).

(5) The programme of development of irrigation expected in the Krishna-Pennar Project is very optimistic. Development in the case of delta canals for 2nd crop may be attained in 4-5 years but canals in Rayalaseema and other upland areas would take not less than 10 years to develop (*vide* para. 4.18).

(6) The Krishna-Pennar Project permanently debars a very large area of about 40 lacs of acres of the lower Krishna Basin in Guntur and Nellore district, which is fit for irrigation and subject to scarcity conditions (*vide* para. 4.23).

(7) The cost of works and working expenses are likely to be higher and the revenues lower than those anticipated. The return on the outlay will therefore be appreciably less (*vide* para. 4.21).

Committee's proposals

6.1. For the full development of the Krishna Valley and economical utilization of its waters, it is necessary to have 3 dams on the Krishna river. The first of these should be at Siddeswaram, the second at Nandikonda and the third at Pulichintala.

Stage I

6.11 The dam at Nandikonda should be constructed first with F. R. L. +590 and not +540 proposed by Hyderabad. This dam would be a very high one and would require over 6.01 million cubic yards masonry. The foundations, however, are very good and construction should present no difficulties, it can be expedited if undertaken as a joint work by Hyderabad and Madras as has been done in the case of Tungabhadra dam construction. Canals should be constructed on both banks from this dam to command about 50 lakhs acres in Guntur and Nellore districts on the right side and about 12 1/2 lakhs acres in Warrangal and Nalgonda districts of Hyderabad and Nandigama taluq of Madras on the left side (*vide* paras 5.42, 5.50).

The Madras canal as proposed in the Krishna-Pennar Project together with the barrage on the Pennar river should also be taken up. This canal will in the initial stages be fed with water escaped from the tail of the Nandikonda right canal (*vide* para. 5.51).

The Kurnool-Cuddapah canal should be remodelled and its discharge increased to about 6,000 cusecs to feed its present ayacut and the ayacuts of Kaveli, Kanupur and Krishna-Pennar East Canal which should be constructed along with the remodeling of the Kurnool-Cuddapah Canal. This part of the scheme can start irrigation in about 3 years after the start of constructions (*vide* para. 5.43).

Stage II

6.12. This dam at Siddeswaram on the Krishna should be started. F. R. L. of the dam should, however, be kept +885 against +898.5 proposed in the Krishna-Pennar project (*vide* para. 5.41).

Working tables show that the lower height would be adequate for the diversion needed. It will also reduce the area submerged from 1,74,080 acres to 70,400 acres and number of persons displaced will be reduced correspondingly.

The Krishna-Pennar link canal should be constructed generally on the lines proposed in the Krishna-Pennar Project but its capacity should be reduced from 75,000 cusecs to 10,000 cusecs. This quantity would be adequate to feed the Krishna-Pennar West, the Kaveli, the Kanupur and the Madras Canals and in case of necessity would help the Krishna-Pennar East Canal also. In this proposal, the cutting in Mittakondala ridge will be greatly reduced and it might be cheaper to provide a tunnel for a part of the length (*vide* para. 5.49).

*The Krishna-Pennar West Canal should be constructed for irrigation only and no allowance should be made for feeding proposed Gandikota Reservoir as no water will be available from the Krishna (*vide* para. 5.45).

Stage III

6.13. The Pulichintala dam (the foundation geology of which will require careful examination before the site can be considered suitable) should be constructed to generate power and help in 2nd crop irrigation in Krishna delta.

According to present studies, the full utilizations of the Madras share of Godavari waters for irrigation does not appear economically feasible. About 130 t. m. c. ft. (2.98 m.a. ft) can be diverted to the Krishna delta and a part of the remaining share can be used in Godavari delta and upland areas on both banks and for generation of power if a storage dam is built on the main river or one of its tributaries along with a diversion weir at Polaveram [*vide* Appendix D and para. 5.10 (b)]. These studies should, however, be pursued further and to the extent they hold promise of such utilization, it may be possible to extend irrigation south of Madras (*vide* para 5.10).

*NOTE:—The Chairman of the Technical Committee has desired that the last sub-paragraph of paragraph 6.12 should be reworded as follows :—

“The Krishna-Pennar West Canal should be constructed for irrigation only and allowance for feeding proposed Gandikota Reservoir made only when water is made available by adjusting intensity of irrigation in other areas or other similar reservoirs.”

6.14. The costs and benefits of the various stages are given (*vide* Tables VI & VII).

	I Stage	II Stage	III Stage
Irrigation 1st crop .	26·61 lakh acres	36·51 lakh acres	36·51 lakh acre
Irrigation 2nd crop .			
Krishna Delta .	3·50 lakh acres	1·00 lakh acres	4·50 lakhs acres
Pennar Delta .			
Total .	30·36 lakh acres	37·76 lakh acres	41·26 lakh acres
Power (continuous) .	60,000 k.w.	80,000 k.w.	100,000 k.w.
Food production .			
tons per acre	5·8 lakh tons	6·65 lakh tons	7·82 lakh tons
Cost .	Rs. 84·82 crores	Rs. 124·93 crores	Rs. 132·43 crore
Cost per acre .	Rs. 208	Rs. 331	Rs. 321

6.2. The Committee's answers to the terms of reference are as follows:—

- (a) How the waters of these rivers can be used to the best advantage, and recommend for inclusion in Part II of the Plan and project which would bring about extension of irrigation facilities to as large an area as possible on the most economic basis which can be completed in a reasonable time?

The Committee consider that the Krishna-Pennar Project in its present form should not be proceeded with and in its place the alternative proposals explained in Chapter V which can be carried out in stages may be adopted. These proposals would make the best use of Krishna waters and bring about extension of irrigation facilities to as large areas as possible on the most economical basis.

The completion of Statge I would take about 10 years but partial benefits would accrue after 3 years.

- (b) Whether there will be sufficient waters left for the needs of the Godavari and Krishna deltas after the utilization proposed under the Krishna-Pennar Project?

Krishna-Pennar Project does not affect the Godavari delta. On completion of the full plan of this project there will only be enough water to irrigate 1 1/2 lakhs acres in the Krishna delta and a large area of about 40 lakhs acres lying on the right bank of the Krishna in Guntur and Nellore districts will permanently remain without irrigation.

- (c) Whether the Krishna-Pennar Project is technically sound and economically a better proposition than other schemes considered, and whether, having regard to the urgent need for increased food supply, especially of rice, this project should be included in Part II of the plan ?

The Krishna-Pennar Project is technically sound but has several serious defects as mentioned in detail in the report and is, therefore, not recommended for inclusion in Part II of the Plan. Instead the inclusion of the Committee's proposals Stage I in Part II is recommended.

- (d) Whether it can be completed within 3 to 4 years if funds can be provided ?

This is not possible so far as the Krishna-Pennar Project is concerned but of the Committee's proposals in Stage I, the Kanupur, Kaveli and Krishna-Pennar East Canals can be completed and put into operation within 3 years.

A. N. KHOSLA,
Chairman.

MOTI RAM,
Member.

G. R. GARG,
Member-Secretary.

APPENDIX A

GOVERNMENT OF INDIA

Planning Commission

No. PC (V) 59/1/51

New Delhi, December 17, 1951.

From

Shri N. R. Pillai, I.C.S.,
Secretary, Planning Commission,
NEW DELHI.

To

The Chief Secretary to the Government of Madras,
MADRAS.

SIR,

I am directed to refer to the Madras Government's proposal in respect of the Kistna-Pennar and Ramapadasagar projects for inclusion in the second part of the Five Year Plan and the preference expressed by the State Government in favour of the Kistna-Pennar project in case only one large project can be included in the Plan. The Planning Commission considers that it will not be possible to include in the Plan two large projects like the Kistna-Pennar and the Ramapadasagar, and that it would be useful to have a technical enquiry conducted as to the best and most economical manner of utilising the waters of the Kistna and Godavari allotted to the Madras State before a decision is reached. In consultation with the Ministry of Natural Resources and Scientific Research, the Planning Commission, therefore, proposed to appoint a committee for the purpose.

The composition of the committee will be as below:—

Shri A. N. Khosla, I.S.E., Chairman,
Central Water and Power Commission. *Chairman.*

Shri Moti Ram, Chief Engineer,
Irrigation, U.P. *Member.*

Shri G. R. Garg, I.S.E., Director,
Irrigation, Central Water and Power Commission. *Member-Secretary.*

The terms of reference to the committee will be as follows:-

- (a) How the waters of these rivers can be used to the best advantage, and recommend for inclusion in Part II of the Plan a project which would bring about extension of irrigation facilities to as large an area as possible on the most economic basis which can be completed in a reasonable time;
- (b) Whether there will be sufficient waters left for the needs of the Godavari and Kistna deltas after the utilisation proposed under the Kistna-Pennar project;
- (c) Whether the Kistna-Pennar project is technically sound and economically a better proposition than other schemes considered, and whether, having regard to the urgent need for increased food supply, especially of rice, this project should be included in Part II of the Plan and;
- (d) Whether it can be completed within 3 to 4 years if funds can be provided.

It is expected that the committee will be able to start its work in January, 1952, and to submit its report within a period of about two months.

I am desired to request the Madras Government for its co-operation and assistance in the work of the committee.

Yours faithfully,

(Sd.) TARLOR SINGH

Deputy Secretary

for Secretary, Planning Commission.

Copy forwarded for information to :—

Shri G. R. Garg, I.S.E.,
Director, Irrigation, Central Water & Power
Commission.

R. JAGANNATHAN,

Under Secretary to the Govt. of India.

APPENDIX B

MEMORANDUM OF AGREEMENT

I. THE KRISHNA.

The dependable annual flow in the Krishna basin based on the recorded gauging at Vijayawada is accepted as 1715 t.m.c. ft. This figure may have to be increased to allow for any omissions in respect of existing utilisations in any State.

Shri Venkatachari's statement that the actual flow will be in excess of the recorded gauged flow by 8% is noted.

2. The existing utilisations (subject to corrections mentioned in para 1) plus flows required for projects under construction in the concerned States, as stated below, are hereby allocated to the respective States:—

Bombay	176 t.m.c.ft.
Hyderabad	180
Mysore	98.5
Madras	290
	744.5

3. The balance of flow for new projects after meeting the above allocations works out to 970.5 t.m.c. ft. For purposes of allocation, this has been taken as 1,000 t.m.c. ft. For this balance upto 1,000 t.m.c. ft. the allocations are made as hereunder:—

	Percent.	t.m.c.ft.
Bombay	24	240
Hyderabad	28	280
Mysore	1	10 (provisional)
Madras	47	470

For balance flow in excess of 1,000 t.m.c.ft. mentioned above, the allocations will be as follows:—

Bombay	30 per cent.
Hyderabad	30 "
Mysore	1 (provisional)
Madras	39

The allocation to Mysore may have to be slightly adjusted to the extent of additional 1% as a result of further engineering scrutiny. This addition will come out of the share of Madras.

4. The above allocations are subject to the condition that the diversion of supplies across the western ghats for the Koyna Project will be limited to 57.5 t.m.c.ft.

II. THE GODAVARI.

The dependable annual flow in the Godavari basin based on the recorded gaugings at Dowleshwaram is taken as 2,500 t. m. c. ft.

2. The existing utilizations plus supplies required for projects under construction in the concerned States as stated below are hereby allocated to the respective States :—

Bombay	57 t. m. c. ft.
Hyderabad	208
Madhya Pradesh	30
Madras	300
	<hr/>
TOTAL	595

3. Of the balance flow of 1,905 t.m.c. ft. (say 1,900) which remains available after meeting the allocations in para 2, the allocations to the various States will as below:—

	percent.	t.m.c. ft.
Bombay	3	57
Hyderabad	26	494
Madhya Pradesh	24	456
Madras	47	893
		<hr/>
TOTAL		1900

These percentages will apply whether the supplies are in excess or short of the dependable flow assumed above.

III. GENERAL

The allocations in the case of the Krishna and the Godavari have been made on an annual basis. The new utilizations have to be so adjusted as not to interfere with the existing daily utilisation for existing works and agreed utilization for new works.

2. The use of water passed by one State for her use downstream, out of the share allocated to her and passing through the reservoir of another State may be used by the latter State, solely for power purposes, provided that such quantities are not impounded in their passage through the reservoir for more than the period agreed upon between the Governments concerned, which agreement shall not be unreasonably withheld.

3. The allocations made under parts I and II shall be reviewed after 25 years.

[474. No major project shall be undertaken for construction be any State unless it has been fully investigated and necessary detailed estimates have been prepared, and duly examined.

*Annual Yield of Krishna, Godavari and Pennar Rivers (June-*Krishna River at Vijayawada
Anicut

Year	-----	
	t. m. c. ft.	m. a. c. ft.
1895-96	1937	44.47
1896-97	2366	54.32
1897-98	2450	56.24
1898-99	2342	53.76
1899-1900	879	20.18
1900-01	2550	58.54
1901-02	1882	43.20
1902-03	1722	39.53
1903-04	2906	66.71
1904-05	1528	35.08
1905-06	1066	24.47
1906-07	1702	39.07
1907-08	1943	44.61
1908-09	2178	50.00
1909-1910	1857	42.63
1910-11	2087	47.91
1911-12	1218	27.96
1912-13	1756	40.31
1913-14	1576	36.18
1914-15	2751	63.15
1915-16	2146	49.27
1916-17	3473	79.73
1917-18	2652	60.88
1918-19	777	17.84
1919-20	1949	44.74
1920-21	1378	31.63
1921-22	1787	41.02
1922-23	1761	40.43
1923-24	2021	46.40
1924-25	1935	44.42
1925-26	1837	42.17

—May) in t.m.c.ft. and m.a.c.ft.

Godavari River at Dowleswarm Anicut		Pennar River at Sangam Anicut	
t. m. c. ft.	m. a. c. ft.	t. m. c. ft.	m. a. c. ft.
3736	85·77	...	...
4666	107·12	...	...
3444	79·06	...	...
2336	53·63	...	...
438	10·06	...	...
3456	79·34	...	...
2417	55·49	...	...
1417	32·53	...	...
4092	94·94	...	...
1879	43·14	...	...
2141	49·15	...	...
3098	71·12	...	...
5847	134·23	...	...
4042	92·79	...	...
2358	54·13	...	...
4452	102·20	...	...
2492	57·21	...	...
2936	67·40	...	...
2679	61·50	...	...
5308	121·85	...	...
3024	69·42	...	...
4477	102·78	...	...
3868	88·80	...	...
2732	62·72	...	...
3819	87·67	...	...
960	32·04	...	...
3174	72·87	173	3·97
2956	67·86	125	2·87
2616	60·06	19	0·44
2500	57·30	97	2·23
3298	75·60	137	3·15

REPORT OF THE TECHNICAL COMMITTEE

Annual Yield of Krishna, Godavari and Pennar Rivers (June—

					Krishna River at Vijayawada Anicut.	
Year					t.m.c.ft.	m.a.c. ft.
1926-27	.	.	.	.	1904	43.71
1927-28	.	.	.	.	2039	46.81
1928-29	.	.	.	.	1920	44.07
1929-30	.	.	.	.	1655	37.99
1930-31	.	.	.	.	1901	43.64
1931-32	.	.	.	.	2533	58.15
1932-33	.	.	.	.	2371	54.43
1933-34	.	.	.	.	2640	60.61
1934-35	.	.	.	.	1759	40.38
1935-36	.	.	.	.	1622	37.24
1936-37	.	.	.	.	1677	38.50
1937-38	.	.	.	.	1704	39.12
1938-39	.	.	.	.	2165	49.70
1939-40	.	.	.	.	1792	41.14
1940-41	.	.	.	.	1804	41.41
1941-42	.	.	.	.	1334	30.62
1942-43	.	.	.	.	1678	38.52
1943-44	.	.	.	.	1582	36.32
1944-45	.	.	.	.	1213	27.85
1945-46	.	.	.	.	1491	34.23
1946-47	.	.	.	.	2289	52.55
1947-48	.	.	.	.	2063	47.36
1948-49	.	.	.	.	1922	44.12
1949-50	.	.	.	.	2049	47.04
1950-51	.	.	.	.	2098	48.16

—May) in t. m. c. ft. and m. a. c. ft.

Godavari River at Dowleswaram Anicut		Pennar River at Sangam Anicut	
t.m.c. ft.	m.a.c.ft.	t.m.c.ft.	m.a.c.ft.
3076	70·62	33	0·76
3757	86·25	51	1·17
3239	74·36	47	1·08
2907	66·74	99	2·27
2857	65·59	180	4·13
4850	111·34	83	1·91
3756	86·23	34	0·73
4990	114·55	115	2·64
4611	105·85	19	0·44
3510	80·58	113	2·59
4411	101·26	71	1·63
4887	112·19	81	1·86
4840	111·11	203	4·66
2472	56·75	175	4·17
4876	111·94	113	2·59
1420	32·60	106	2·43
4030	92·52	68	1·5
2809	64·49	232	5·33
3811	87·49	175	4·02
4232	97·15	33	0·76
...	...	220	5·05
4145	95·16	121	2·78
3342	76·72	...	...
4235	97·22	...	...
2350	53·95	...	...

APPENDIX C

NOTE ON THE AVAILABILITY OF WATER AT THE HEAD OF KURNOL CUDDAPAH CANAL.

In the stage plan proposed by the Committee, K. P. East, Kaveli and Kanupur canals will be fed from the Tungabhadra by remodelling the K. C. canal. It is to be seen whether sufficient water is available in the river to meet the demands of these canals in full.

2. *Dependable annual yield at Mallapuram dam site.*—According to the agreement reached between the Governments of Madras and Mysore regarding the sharing of waters of Tungabhadra, the waters of Bhadra and Tunga were jointly gauged by the two states at Lakkavali, Mallapuram and Sankesula and as a result of the said gauging and discussions, the net dependable flow at Mallapuram after meeting the requirements of existing irrigation above Mallapuram was agreed to as 340,000 m.c.ft.

According to the same agreement, Mysore share above Mallapuram excluding existing, irrigation was finally fixed at 84 t. m. c. ft. leaving a balance of 256 t.m.c.ft. to be shared by Madras and Hyderabad. This quantity of 84 t.m.c.ft. is slightly in excess of the allotment made in the inter-state Conference held by the Planning Commission on 27th and 28th July, 1951.

Bombay's proposed utilization above Mallapuram is only t.m.c.ft. for Dharam Wardha storage Scheme. Hence the annual dependable yield after allowing for all the existing and proposed utilizations above Mallapuram may be taken as 255 t.m.c.ft.

3. *Capacity of Tungabhadra dam.*—The Tungabhadra dam is designed for a storage capacity of 133 t.m.c.ft. at f.r.l. 1633. The f.r.l. has been fixed on the following considerations :

- (1) Reservoir full on 1st November.
- (2) No impounding to be done from 1st November to 30th June.
- (3) Madras and Hyderabad to have 65 t.m.c.ft. each including evaporation losses.

These quantities of 65 t.m.c.ft. each will provide for the need of all new and pre-Mughal irrigation and also the assistance to old Kurnool Cuddapah Canal and Rajolibanda canal proposed by Hyderabad State.

The contribution to the Krishna for delta irrigation will be in addition to the above quantity of 65 t.m.c.ft. and met by regulated flow from the reservoir. This contribution and its distribution, though not finally fixed, seems to be of the order of 700 cusecs per day (*vide* specifications Tungabhadra Dam Design).

4. *Requirements of Madras Canal from the dam.*—Total annual irrigable area on the low level canal taking off from the Madras side of the dam is 2·94 lakh acres about 95 per cent of which is proposed to irrigate dry crops. The equivalent wet area may therefore be taken as 2·0 lakhs acres. This will require only 40 t.m.c.ft. Development of this irrigation according to the Project Report is likely to take 10 years. Considering, however, the sparsity of population and backward condition of the people, it is not likely to take less than 15 years to develop the area fully. Hence for the first 10 years the requirements of irrigation will be fully met with 27 t.m.c.ft. and the remaining supplies would be available for being utilised elsewhere.

5. *Requirements of K. C. canal.*—The requirements of K.C. canal as per proposal of the Committee are of the order of 58·60 t.m.c.ft. *i.e.*, 0·70 t.m.c.ft. in June, 12·40 t.m.c.ft. in July 14·50 t.m.c.ft. in August, 11·50 t.m.c.ft. in September, 9·8 t.m.c.ft. in October, 7·5 t.m.c.ft. in November and 1·9 t.m.c.ft. in December.

6. As stated above, the annual dependable yield at the dam site is 255 t.m.c.ft. Deducting 133 t.m.c.ft. for storage in the dam, balance that will be passed below the dam will be 122 t.m.c.ft.

The inflow between the dam site and the Sunkasela anicut from which existing K. C. canal takes off is of the order 70 t.m.c.ft. The total flow in this reach is therefore, 120+72 or 192 t.m.c.ft. Practically the whole of this occurs during monsoon months and it can be safely presumed that 20 per cent of it can be diverted into the K. C. canal. The balance requirements can be met from the storage and also partly from the low flow in November and

December. The following table gives the quantities required from the storage supplies, inflows etc :—

Month	Requirements in		Met from		
	Cusecs maxm.	t.m. c.ft.	Storage	Surplusing & inflow 22+70	Low flow
June	300	0.70	0.70	..	..
July	5100	12.40	2.50	9.90	..
August	6000	14.50	2.50	12.00	..
September	4875	11.50	2.50	9.00	..
October	4050	9.8	2.50	7.30	..
November	3200	7.5	6.50	..	1.00
December	780	1.9	1.50	..	0.40
TOTAL		58.3	18.7	38.20	1.40

As the reservoir will be kept full on 1st November, withdrawal of 10 t.m.c.ft. shown from storage during the months of July to October will really come from diversion and not from storage. Hence the quantity required in practice from the storage will be only 8.70 t.m.c.ft. As existing K.C. canal has got prior claim on the waters of Tungabhadra, half of the quantity of 8.7 t.m.c.ft. may be considered its legitimate share. This leaves only 4.35 t.m.c.ft. which the reservoir will be required to provide till the Siddeshwaram Dam is built.

APPENDIX D

NOTE ON THE DIVERSION OF GODAVARI WATERS TO KRISHNA BASIN

A study of the map of the Godavari and Krishna basins shows that the only place in the Hyderabad State from which it is possible to divert Godavari waters into Krishna basin is at Khushtapuram below the junction of the Manjira with the Godavari where the Hyderabad State proposes to build a dam. The catchment area of the Godavari at this site is about 35,000 sq. miles and annual dependable yield only 441 t.m.c.ft. This yield is hardly sufficient to meet the requirements of Nizambad and Warrangal districts in the Hyderabad State and existing and proposed utilizations in the Bombay State. Hence though the possibility of diverting the Godavari waters to the land situated below +1000 elevation exists, no water is available at the site for diversion.

Large tributaries of the river Godavari *viz.*, Pranhita Indravati and Sabari which meet the river below this dam site, contribute about 40 per cent., 20 per cent. and 10 per cent. of the flow reaching Dowleshwaram. But unfortunately the Godavari passes on into a ghat section right upto Polavaram or Ramapadasagar dam site. Any dam built in this reach can only be a power project with very little irrigation potential and no possibility of diversion on account of very high elevations. The only other site where there is a possibility of diverting supplies from the Godavari is at Ramapadasagar where a dam or diversion barrage will be necessary for the purpose. The Ramapadasagar project investigated by Madras visualised the construction of a dam with f.r. l. +198 (1st Stage) and storage capacity of 15.9 m.a. ft. The minimum reservoir level is proposed as +145 and the right canal f.s.l. at head +138.0. With a slope of 1 ft. in 4 1/2 miles throughout its length, the right canal is to cross the Krishna by means of an aqueduct with f.s. l. of +107 to irrigate an area of 4.2 lakhs acres in Guntur uplands. The total amount of water proposed to be diverted in the Krishna basin under this project is as given below :—

Krishna Delta 1st crop — Nil	*7.44	t.m.c. ft.
Krishna Delta 2nd crop — 6.4 lakh acres	134.81	t.m.c. ft.
Guntur uplands 1st crop — 4.2 acres	105.85	t.m.c. ft.
	248.10	

*This quantity is required for giving early supplies (June 1-14) for 1st crop irrigation in Krishna delta.

The proposal to take Godavari waters across the Krishna involves construction of an aqueduct which has been roughly estimated to Rs. 4.3 crores. This is likely to be heavily exceeded. The cost of the canal itself is expected to be Rs. 9.91 crores. The scheme is, therefore, very costly and has been dropped. This reduces the contribution of Godavari to Krishna area to 142.25 t.m.c.ft. only.

If Ramapadasagar dam is not built but a storage reservoir is constructed somewhere upstream either on the Godavari itself or some of its major tributaries and only a diversion barrage is built at the proposed Ramapadasagar dam site, this quantity will remain unaffected.

The total irrigable area in the Krishna delta, is 10.5 lakhs acres and 6.40 lakhs represents 62 per cent of it. If this percentage is increased to 80 per cent which is not desirable in the interest of maintenance of the fertility of the soil, the maximum diversion will be about 184.38 t.m.c.ft. The economics of this proposal will, however, need to be worked out.

It may be mentioned in this connection that in the development of Krishna Valley, a certain number of dams will be built on the Krishna where a large amount of power can be generated by irrigation water. To stabilise the power in non-monsoon months, about 3000 to 5000 cusecs will have to be let down. This amount of water by flowing over successive dams will be of great importance in the economics of power production and will after leaving the last dam irrigate the 2nd crop in the delta. If by suitably integrating the power systems the generation of power at Pulichintala is stopped and at Nandikonda restricted for a part of the year, it should be possible to divert about 130 t.m.c. ft. or 2.92 m.a.ft. from Godavari to the Krishna and take over the entire Krishna delta 2nd crop irrigation on to Godavari.

A question may arise whether the entire 1st crop of existing delta can be fed by Godavari waters.

The basin of Godavari does not consist of so much of Western Ghat areas as that of the Krishna. This results in the yield of the Godavari being less than that in the Krishna in bad years. Thus during 1899-1900, the annual runoff on Godavari was as low as 438 t.m.c. ft. *i.e.* 18% of its dependable flow, while in Krishna, it was never less than 777 t.m.c. ft. *i.e.* 45% of its dependable flow. Hence there is a danger in linking up of Krishna delta with Godavari waters.

Moreover the last dam site on the Krishna is at Pulichintala 35 miles above Vijayawada and the catchment area below this dam site to Vijayawada is 6400 sq. miles which contribute about 6.25% of the monsoon flow reaching Vijayawada. In case of a year dependable yield, this flow is of the order of 100 t.m.c. ft. (2.29 m.a. ft.) out of which at least 90% would be available for utilisation for irrigation in delta. The requirement of 1st crop irrigation to the extent of 10.5 lakhs is about 161 t.m.c. ft. (3.69 m.a. ft.). Hence the requirements to be met from Godavari will be only about 70 t.m.c. ft. (1.60 m.a. ft.). But for stabilising power for even 20,000 K.W. at the terminal reservoir in the 1st crop period, about 50 t.m.c. ft. (1.15 m.a. ft.) are required. This reduces the diversion possibility to 20 t.m.c. ft. (0.46 m.a. ft.) only which is negligible.

According to this the requirements for 2nd crop, the total diversion from Godavari is not likely to exceed 130 t.m.c. ft. (2.29 m.a. ft.). In years of normal yield of about 1900 t.m.c. ft. (43.51 m.a. ft.) in the Krishna (available in 50% of the years *vide* graph* 6) this quantity will be reduced to about 110 t.m.c. ft. (1.83 m.a. ft.). With such a small quantity of water for diversion, the economics of the proposal becomes problematic.

In any actual scheme of diversion, it will, however, have to be laid down that Godavari areas having prior claims on the Godavari, diversion will be allowed only when the waters are actually in excess of the requirements of the Godavari basin.

APPENDIX E

NOTE ON THE TOUR OF THE TECHNICAL COMMITTEE

The Committee made an extensive tour to get an idea of local conditions and to see the sites of important works included in the various projects for making use of Krishna and Godavari waters. During the tour they met prominent people and representatives of local organizations interested in the various projects and obtained their views. A summary of the memoranda presented by them is given at the end of this note.

Shri G.R. Garg and Shri Moti Ram, Members of the Committee left Delhi by air on the morning of the 17th February 1952 and reached Madras in the evening. The Chairman, Sri A. N. Khosla who was detained at Delhi owing to important work joined the Members at Madras on the 19th February.

During their stay of a little over two days at Madras the Members paid visits to the Madras Institute of Technology and the Government Hydraulic Research Station at Poondi and had discussions with the Chief Engineers for Irrigation and Electricity on technical matters. They also called on the Hon'ble Chief Minister and the Hon'ble Minister for Public Works at the Secretariat and met other Hon'ble Ministers and Secretaries of Departments at a dinner which was kindly arranged by the Madras Government.

In the course of discussion the Chief Engineer for Irrigation stated that the Krishna-Pennar Project would result in early food production as it is proposed to irrigate a considerable acreage of second crop in areas which were already developed and provide an assured supply to lands which were at present being precariously irrigated from tanks. The Chief Engineer for Electricity said that the demand for power in the near future in the central portion of the State would be met if a power house was constructed on any one dam on the Kistna or Pennar and that Power houses on other dams could be constructed later as load developed.

The Committee left Madras by Bombay Mail on the evening of the 19th February and reached Gooti on the morning of the 20th where they detrained. From Gooti they proceeded by road

and after inspecting Mitakondala cutting area, the trial pits dug there, and the site of the proposed Siddheswaram Dam on the Kistna reached Kurnool late in the evening. While inspecting Siddheswaram they also saw the gorge below the dam site for a few miles.

Leaving Kurnool on the morning of the 21st the Committee reached Hospet in the evening after inspecting aqueducts, tunnels, deep cuttings and other important works on Tungabhadra right bank canal. On the 22nd the Tungabhadra Dam on both the Madras and Hyderabad sides and Tungabhadra left bank canal were inspected and the party left Hospet by train in the afternoon, arriving at Madras on the morning of 23rd February. After a brief halt they left by road and reached Somasila at about 5.0 P.M. On the way a short halt was made at Gudur to meet local residents who had collected in large numbers. The Someshwaram dam site and the site of proposed pick-up weir on the Pennar were inspected the same evening.

The Committee left Somasila early in the morning of the 24th February and after a long journey by road reached Vijayawada at about 3.0 A.M. on the morning of the 25th February. On the way the dry areas of the Guntur and Nellore districts were seen and a visit was also paid from the right bank to the place where the Nandikonda dam has been proposed by the Hyderabad Government. This site can be reached only on foot but the local residents had made a track over very difficult rocky country at short notice to enable a jeep to be taken. Some time was spent at Guntur to meet representatives of associations and the president of the Rotary Club.

After halting for a few hours at Vijayawada a start was made for Hyderabad which was reached late in the evening. On the way the site of the proposed Pulichintala Dam was seen and numerous memoranda from villagers who had collected in large numbers all along the road and at Pulichintala were received. During their stay of about five days in Hyderabad State the Committee saw the Nizamsagar Dam, the Kadam Dam (under construction) the likely sites for dams on Indravati river near Bhupalapatnam in Madhya Pradesh, and the site of the proposed Nandikonda dam on the Krishna. They also held discussions with Hyderabad Engineers. The Chairman had to leave by air for Delhi on the morning of the 28th February on account of urgent work and the rest of the tour was done by the Members only.

Returning to Vijayawada by train in the early morning of 2nd March the Members spent another three days in Madras State during which they saw the Vijayawada anicut, Dowleshwararam anicut, the Godavari and Krishna deltas and the site of the proposed Ramapadasagar dam and the Godavari gorge above that site. They also met representatives of numerous local organisations who expressed their views and also gave written memoranda. The Committee left Vijayawada by train on the evening of the 5th March on the conclusion of their tour.

The Committee are grateful to the officers of the Madras and Hyderabad Governments for the courtesy and assistance received from them and for the arrangements made for transport to the places visited.

APPENDICES
APPENDIX F-I

A SUMMARY OF THE IMPORTANT REPRESENTATIONS

1. Shri O. P. Ramaswamy Reddiar formerly Chief Minister, Madras State, on behalf of the residents of South Arcot recommended the Krishna Pennar Project as it would meet the needs of the famine stricken areas in the south and suggested that long canal from Somasila should be provided to meet the irrigation needs of the areas which might be suffering from draught. He deprecated the Ramapadasagar Scheme because—

- (1) It had difficult foundation problem.
- (2) It did not give relief to famine stricken areas.
- (3) The drainage from the irrigated areas could only run waste into the sea.
- (4) It had no big power potential.

He suggested that hydel development on Vainganga, Indravati and upper reaches of Godavari should be taken up and the same water be diverted to Krishna basin through Hyderabad territory for irrigation purposes. As the areas proposed to be irrigated by Pulichintala or Nandikonda Reservoirs could be irrigated by the diverted waters of Godavari, the idea of these projects might be dropped.

2. Janab Sibghathulla Mayor of the Madras strongly favoured the Krishna-Pennar Project as it would help solving the problem of portable water supply to Madras City.

3. Shri R. Suryanarain Rao proposed that the high level Tungabhadra canal should be immediately investigated and taken up for execution. He recommended the Krishna-Pennar Project as it would provide irrigation facilities to the famine stricken areas and solve the water supply problem of Madras City.

4. Shri K. V. Varadachari, M.L.A., recommended the Krishna-Pennar Project as the Kurnool-Cuddapah canal could not provide adequate irrigation facilities to the Rayalaseema districts. He, however, complained that the Krishna Pennar canal was proposed to pass through a corner of Chittoor district and would provide irrigation facilities to a small area thereof.

He, therefore, proposed that the canal might be taken at a higher contour to extend the benefits of irrigation to a larger part of the district.

5. Shri V. Raghavayya, M.L.A., preferred Nandikonda Project to Krishna Pennar Project as it would provide irrigation to a large area of Nellore district than the latter. He mentioned that the final selection of the project should be made with due regard to cheapness, feasibility of irrigation development in the area, the needs of the famine stricken areas and the water supply requirement of Madras City. He recommended a lower dam at Siddeswaram to meet the irrigation requirements of the Rayalaseema districts. In case, however, the Krishna Pennar Scheme was likely to be taken up first for execution, he would welcome the same but requested that the high lying areas of this district which were not commanded by the K. P. canals should be provided with lift irrigation.

6. Shri V. Gopal Krishnayya deprecated the Krishna Pennar Project and recommended the Nandikonda and Pulichintala projects for the developments of irrigation in the uplands of Guntur and Nellore districts. To meet the irrigation requirements of the Rayalaseema area he suggested a lower dam at Siddeswaram.

7. Prof. N. G. Ranga put up a strong plea for the prior claims of the valley residents on the waters of the Krishna and suggested a combined scheme at Nandikonda for Madras and Hyderabad States. He said that all the Andhras were united on this issue and were prepared to raise loans and pay betterment charges to meet the cost of the project. He suggested a modified scheme at Siddeswaram to meet the irrigation requirements of the Rayalaseema area and construction of Pulichintala dam in the final stage to complete the development of the lower Krishna Valley.

8. Sir S. V. Ramamurthy, former adviser to the Governor of Madras and acting Governor of Bombay, suggested that Pulichintala should be taken up as a short term measure to meet the country's present deficit in rice. As a long term scheme for integrated development of Krishna and Godavari Valleys he felt that a start should be made with the Godavari valley. He regretted that the Ramapadasagar scheme was not taken up by the Madras Government in spite of the thorough manner in which the investigations of that project were carried out, and the favourable opinion expressed by world famous authorities on the feasibility of the same. He was, however, favourably disposed

to an enquiry by the Chairman if a storage reservoir higher up on the Godavari or one of its tributaries and a pick up barrage at Pollavaram to meet the irrigation needs in the Godavari valley and diversion of surplus waters to Krishna valley would serve the same purpose. As a general policy he felt that the areas on either side of the river had prior claim on the water resources of the same and that any surplus after meeting its requirements might be diverted to the neighbouring areas. On the question of choice between extending irrigation facilities for first crop in new upland areas and second crop in the deltas, he was inclined to favour the latter with a view to meet the rice shortage in the country though as a long term policy it was likely to lead to difficulties such as water rights for the second crop. He felt that enough water could be found for the first crop in the uplands and the second crop in the deltas. Regarding the potable water supply for the city of Madras his view was that the same could be met either by improving the Buckingham canal or by pumping water from Krishna or Pennar.

9. The president of the Karnatak Maha Sabha met the Committee at Hospet and represented that the highlevel canal should be immediately investigated and taken up.

10. *Nellore District Ryots' Association.*—The representatives of the Association urged that the dam at Somasila should be constructed as this would ensure a steady and regular supply to the Nellore delta system. They also recommended the Nandikonda scheme which was calculated to bring large areas of their district under irrigation.

11. A deputation of Somasila ryots led by Shri P. Venkat Subbaiyya met the Committee and recommended the construction of Somasila reservoir. Shri G. C. Kandayya, M. L. A. on the other hand pressed for implementing the Nandikonda scheme.

12. Shri Krishna Rao on behalf of Andhra Kisan Ryots Association suggested that in the best interest of the Krishna Valley people and the needs of the central Andhra, Nandikonda project should be immediately investigated. He also urged that Krishna-Pennar project should be modified by dropping Someswaram reservoir and lowering the height of Siddeswaram dam to impound water sufficient only to meet the needs of Kurnool and Cuddapah districts. He also pleaded for taking up Pulichintala project to get quick results.

13. Ryots of Markapur and Cumbum Taluks of Kurnool district urged the need to take up the Korti Kanuma, Nandikonda and Sangmeswaram projects.

14. Communists of Kanchikarcherla urged the Government to take up immediately the Pulichintala project to solve the food problem

15. Krishna River Valley Peoples Welfare Association in their memorandum suggested an alternative scheme to Krishna-Pennar Project. This alternative envisaged to provide irrigation facilities to large areas of Cuddapah, Kurnool, Chittoor and some areas of Nellore, Guntur, Krishna and West Godavari districts by providing a smaller Siddeswaram reservoir, Nandikonda and Pulichintala reservoirs.

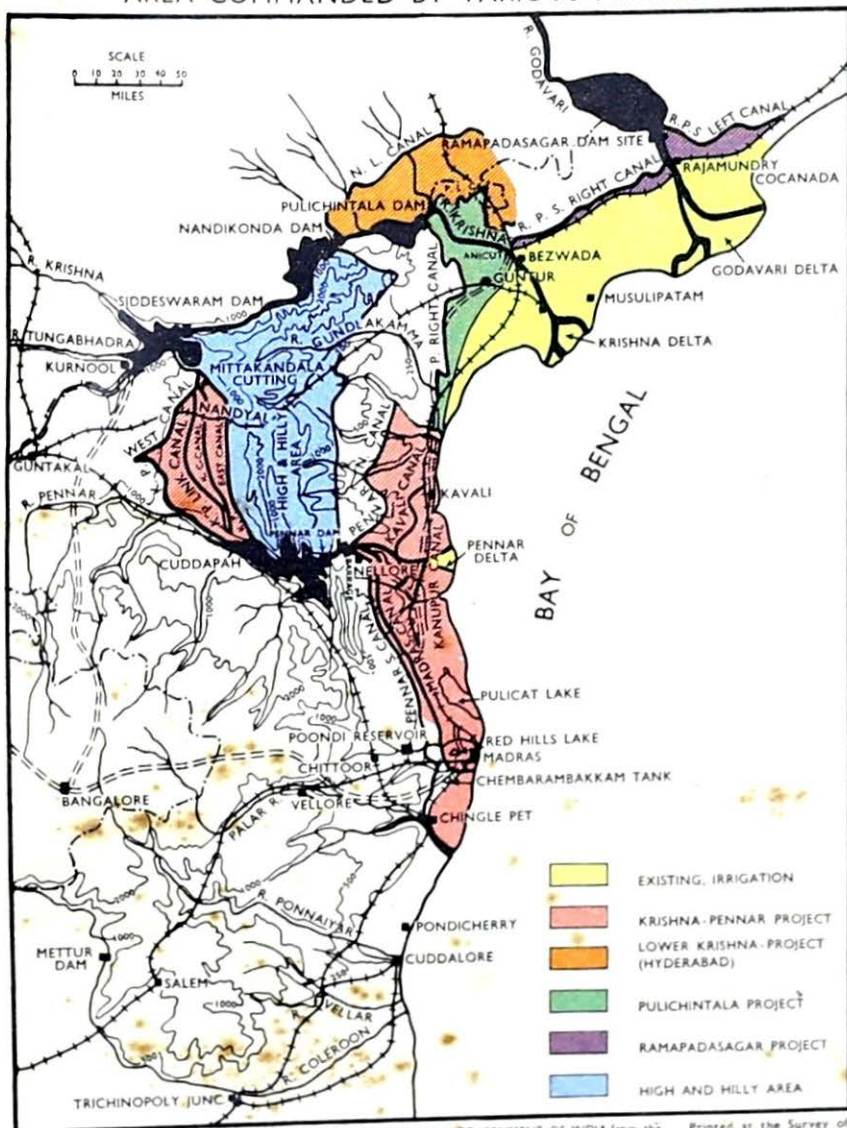
16. The *Ad-hoc* Committee of the People of Dowleswaram presented a detailed memorandum expressing their regret on the Ramapadasagar scheme being shelved by the Madras Government on not very convincing grounds. They deprecated the Krishna-Pennar Project on the grounds that it would—

- (i) deplete the Krishna waters to the detriment of the Krishna delta second crop and the development of the valley areas of Krishna and Guntur districts;
- (ii) submerge costly lands and villages in reservoir areas;
- (iii) involve unnecessary heavy expenditure in the Mitta Kandala cutting ;
- (iv) generate less electrical power ;
- (v) bring a very small area under the first crop, large area being under the second crop in the first stage of the scheme.

Comparing the Ramapadasagar and Krishna Pennar projects they stated that though both the schemes were equally costly and offered equal irrigation and power benefits, the former scheme was more thoroughly investigated, did not involve diversion of waters from one valley to another and was capable

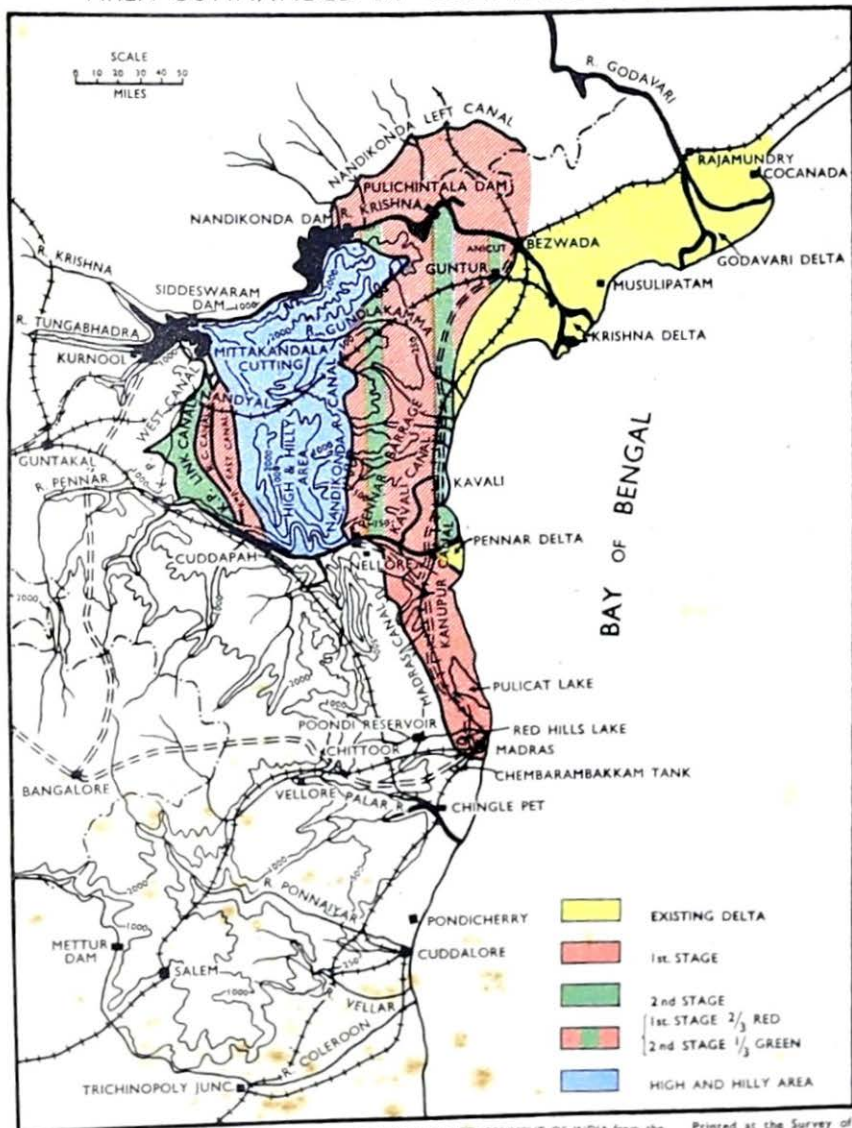
KRISHNA & GODAVARI VALLEY PROJECTS

AREA COMMANDED BY VARIOUS PROJECTS



KRISHNA & GODAVARI VALLEY PROJECTS

AREA COMMANDED BY COMMITTEE'S PROPOSAL



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of speedy execution. They therefore recommended an integrated development of Godavari and Krishna Valley starting with Ramapadasagar as the first project. Further, in their view, the Nandikonda scheme should be taken up as it would provide irrigation facilities to high areas of Nellore, Guntur, Krishna and West Godavari districts answering at the same time anti-social activities rampant in that area. As Nandikonda was a big scheme and likely to take a longer period, they recommended the Pulichintala scheme to overcome rice shortage in the country by growing second crop in the Krishna delta temporarily. They were, however, of the opinion that the capital resources of the country should be equitably distributed on as large areas as possible. As for Madras Water Supply they held the view that it was a local problem which did not merit consideration in the selection of these multipurpose projects. Red Hills lake could meet the water supply requirements of the city if the Government purchased the water rights of the 7500 acres which at present received irrigation from this source.

APPENDIX G

COMMENTS OF THE GOVERNMENT OF MADRAS

THE KRISHNA-PENNAH PROJECT—COSTS AND BENEFITS

(a) The Krishna-Pennar Project is one which has been investigated in appreciable detail. It contemplates, in conjunction with an enlarged Gandikota Project in the Cuddappah district which would be feasible with supplies of Krishna waters, the irrigation of 20·69 lakhs acres of wet crops and 2·27 lakhs acres of dry crops (equivalent to 21·83 lakhs acres in all of wet crops) in the first stage and 34·37 lakhs acres of wet crops and 3·76 lakhs acres in all of dry crops (equivalent to 36·25 lakhs acres of wet crops) in the final stage. The cost of the first stage works is expected to be Rs. 78 crores, or Rs. 67 crores if betterment fees are deducted. The return will be 3·5%. The cost of the works in the complete plan is expected to be Rs. 130 crores or Rs. 94 crores after allowing for betterment fees, and the return 3·8%.

(b) The areas to be irrigated in lakhs of acres in the first stage and in the complete plan will be as follows :—

Districts	1st Stage			Full Plan			
	1st crop		Second Crop (wet)	1st crop		Second Crop (wet)	
	Wet	Irrigated dry		Wet	Irrigated (dry)		
Kurnool	0·50	1·00	...	1·30	2·60	...	
Cuddappah	0·63	1·27	...	1·33	1·16	...	
Nellore (new)	4·37	...	4·37	12·39	...	4·37	
Nellore (old delta) . . . . .	...	...	1·29	...	...	1·29
Chittoor	0·12	...	0·12	2·54	...	0·12	
Chingleput	1·07	...	1·07	4·81	...	1·07	
Krishna } Krishna . . . . .	...	...	4·55	...	...	4·55
Guntur } Delta . . . . .	...	...	2·60	...	...	2·60
TOTAL	6·69	2·27	14·00	20·37	3·76	14·00	

2. VIEWS OF KHOSLA COMMITTEE ON THE KRISHNA-PENNNAR PROJECTS AND COMMENTS THEREON

(a) The Khosla committee has conceded that the Krishna-Pennar Project is generally technically sound, but has criticised it on the following grounds :—

- (i) that the available supplies in the river at Siddeswaram will be 15% less than that assumed in the Project Report which relates to availability at Vijayawada ;
- (ii) that the Siddeswaram and the Someswaram reservoirs in the plan will submerge large areas, about 3 lakhs of acres (including cultivated and garden lands in the case of the Someswaram area), and displace about 1,50,000 persons in all;
- (iii) that the cost of the project works (mainly under the cutting needed to convey the water stored up at Siddeswaram to the Kundiu, and the cost of the waterway to carry the water up to the Pennar dam) and working expenses, are likely to be considerably higher and the revenues lower than those assumed by this Government;
- (iv) that the designed capacities of the canals in the projects are too large and the duties assumed for all the canals low ;
- (v) that the food yield and rate of development of irrigation under this project are over-estimated ;
- (vi) that emphasis is laid on second crop instead of on first crop, which will spread relief over larger and nearer areas ;
- (vii) that the benefits of the project will largely go to areas already served by canals or tanks, while vast tracts lying close to the Krishna and having no alternative means of irrigation supplies will be permanently denied such supplies.

(b) (i) As regards the first criticism, it may be pointed out that Madras has been given 470 t.m.c.ft. or 47% of the net dependable flow available in the river at Bezwada after allowing for utilisation by existing projects and projects under investigation. Hyderabad is to get 28% or 230 t.m. c.ft. It may be that the

availability at Siddeswaram dam of the proposed Krishna-Pennar Project will be 15% less, the 15% representing the contribution of the catchment area between Siddeswaram and Bez wada. This small quantity of water to be taken at Siddeswaram by Madras will be adjusted to the credit of Hyderabad's share for a project below Siddeswaram, from out of the catchment contribution below that place. After all, so long as Hyderabad get their 280 t.m. c.ft. it does not matter where Madras takes its total of 470 t.m.c.ft. Further that the actual dependable river flow at Siddeswaram will be definitely greater than 470 t.m.c.ft. and there will be no difficulty whatever in tapping it at Siddeswaram entirely.

(ii) The answer to the second criticism is that poromboke lands form a large part of the reservoir beds, being nearly 35% in the case of Krishna reservoir and 45% in the case of the Pennar reservoir. Some of the lands which are in the top 20 ft. of the bed can be irrigated in summer when the lakes are low. This may be about $\frac{1}{3}$ or $\frac{1}{4}$ of the area of occupied lands. The owners can be given some areas of these lands for growing an irrigated crop and the returns from these will be as much as, if not better than, those from rain-fed crops in a notoriously dry region. Irrigation facilities for such lands can be given from the Kurnool-Cuddappah Canal or otherwise in the case of the Krishna Reservoir, and from Gandiketta or by pumps and contour channels in the case of the Pennar reservoir lands. A certain area of garden lands, particularly in the Pennar areas, may be affected, but this is inevitable in the larger interests of the State. New gardens can be raised outside the water-spread limits. As regards the displacement of population, suitable provision has been made for rehabilitation. Submersion of land and displacement of population are inevitable in any major reservoir project.

(iii) As for the criticism regarding costs, something similar can be said of any estimate. The cost of the works referred to have been estimated by the Madras Engineers, on a conservative basis, in the light of their considerable experience of the costs of similar works under construction, and without any tendency to under-estimating.

(iv) The Madras proposals in respect of capacities of canals and duties are based on the actual duties realised in the areas irrigated by the Kurnool-Cuddappah Canal and those in the Cauvery-Mettur Project. Similarly for the criticism regarding food yields and rate of development.

(v) As regards the project's emphasis on second crop, it may be pointed out that emphasis on the first crop no doubt spreads irrigation benefits over large areas, but it is expensive in first cost taking time in construction and development. Second crop, or additional crop on first crop area, is a non-guaranteed crop, and a scheme including this feature is cheaper in initial cost, quicker in construction, yields, etc. and takes less water if it is on an area also having tanks previously supplied. The area in the Nellore district have these features and, in the initial stages, the water for the second crop can come from guaranteed flows, but later, by a rotation scheme, out on non-guaranteed flows *i.e.* flows in excess of the safe dependable flows assumed. The quantities so realised can be used on new areas and new canals for first crop in the second stage of development. The immediate use of water for 2nd crop, limiting the new areas and new canals, is a very useful proposal in the present context of shortage of rice.

(vi) The chief criticism of the Committee is that the project will debar permanently the irrigation of an area of 40 lakhs acres of the lower Krishna basin in the upland tracts of the Guntur and Nellore districts. The upland areas are not by any means wholly in the Krishna basin as assumed by the Committee and, moreover, not all that area is likely to be commandable. The eastern slopes of the Nallamalsis and the Darsi, Podili and Udayagiri talukas of the Nellore district may be in need of relief, but the areas adjoining the irrigated areas of Guntur are not badly off—they grow valuable tobacco and other crops. Large areas of the Guntur district are being irrigated by the Krishna, and it is appropriate that in the new project water must first be given to the areas in the Ceded districts in which famine is endemic. A part of the Nellore uplands will, in fact, be served by the Krishna-Pennar Project, and the intention was to find water for the uplands in Guntur and the balance of lands in Nellore, from the Godavari by an inter-connection between the Krishna and the Godavari. This very inter-connection is supported by the Committee in its report.

(c) A noteworthy fact is that the Committee's alternative proposals include the Krishna dam of the Krishna-Pennar Project. The Committee has recommended, as part of its plan, the same dam with the same design and features, but with a full reservoir level of *plus 885* instead of *plus 898*.

3. BASES OF THE COMMITTEE'S ALTERNATIVE PROPOSALS AND COMMENTS THEREON

(a) The Committee has put forward certain alternative proposals which are said to be based on the following general principles :—

- (i) The scheme should provide for the most economical and optimum use of the waters of the Godavari and Krishna rivers from a broad national point of view ;
- (ii) That the scheme should provide irrigation to first crop in as large an area as possible ;
- (iii) In allocating water for second crop, some preference should be given to delta areas where maximum benefits from the food production point of view can be secured earlier ;
- (iv) As far as possible the water allocated to Madras State should be utilised fully ;
- (v) Provision should be made for generation of adequate power without sacrificing essential irrigation interests ;
- (vi) Areas liable to frequent famine and distress should receive special attention and at an early date ;
- (vii) Relief should be afforded to Madras City where the drinking water supplies are inadequate and there are no alternative sources of augmenting the supplies ; and
- (viii) The project should be capable of being executed in stages.

(b) (i) The first, the fourth to sixth and the eighth principles will be objected to by none. The seventh has been dealt with later in this note.

(ii) The third principle practically conflicts with the second. As a matter of fact the terms of reference to the Committee contain the following expression :—

“ and whether having regard to the urgent need for increased food supply, especially of rice.....”.

It is the stabilisation of precarious irrigation under tanks in Nellore and the growing of a second crop on existing wet lands, both envisaged by the Krishna-Pennar Project, which will yield rice quickly.

(iii) Even according to the Committee's sixth principle ; it is the Rayalaseema area liable to scarcity conditions frequently which should receive first attention—not the Guntur district a part of which has excellent irrigation under the Krishna.

4. THE COMMITTEE'S PROPOSALS AND COMMENTS THEREON

(a) (i) Saying that it has borne in mind the principles referred to in para 3 (a) above, the Committee, while not recommending the Krishna-Pennar Project as it stands, has put forward new set of proposals, which include the construction of three reservoirs on the Krishna (at Siddeswaram, Nandikonda and Pulichintala), a reservoir on the Godavari or the Indravati or the Pranhitta, a diversion barrage on the Godavari at the site of the Ramapadasagar dam and another on the Pennar and many canals taking off from the Krishna reservoirs and from the rivers Godavari, Krishna and Pennar. It has modified and incorporated in its place portions of the Krishna-Pennar Project. It has recommended development by stages, the several stages being as follows :—

STAGE I

This comprises the construction of a dam at Nandikonda with an F. R. L. of *plus* 590 (as against *plus* 540 proposed by Hyderabad—what area this will submerge and what population this will displace has to be ascertained by investigation) and its left side and right side canals ; the diversion barrage on the Pennar, the Madras Canal, the Krishna-Pennar East Canal, the Kavali Canal and the Kanupur Canal (as proposed in the Krishna-Pennar Project but with reduced dimensions) ; and the remodelling of the Kurnool-Cuddappah Canal, its discharge being increased to about 6,000 cusecs so as to carry Tungabhadra water to the last mentioned three canals also (*viz.* the Krishna-Pennar east, the Kanupur and the Kavali canals). The Nandikonda dam will be constructed and the reservoir operated jointly by the Governments of Madras and Hyderabad. The right side canal will be a long contour canal with some tunnels on the way, running for 224 miles, and tailing into the Pennar. Out of a gross area of 45.47 lakhs of acres commanded by it, about 25 lakhs of acres are proposed to be irrigated.

STAGE II

This comprises the construction of a dam at Siddeswaram with an F. R. L. of *plus* 885 (against *plus* 898·5 proposed in the Krishna-Pennar Project), the Krishna Pennar Link canal (generally on the lines proposed in the Krishna-Pennar Project but with capacity reduced from 75,000 cusecs to 10,000 cusecs and the Mittakondala cutting replaced if possible by a tunnel), and the Krishna-Pennar West Canal for direct irrigation only and not for feeding the Gandikota reservoir also as proposed by Madras.

STAGE III

This comprises the construction of the Pulichintala dam on the Krishna, a storage reservoir on the Godavari (near Inchampalli on the main river, or on the Indravati near Bhopalatnam or at some place on (the Pranhita) a diversion dam on the Godavari at the site of the Ramapadasagar dam, and a Right Bank Canal and a Left Bank Canal taking off from the barrage referred to above.

(ii) The Committee has not furnished the areas to be irrigated by Krishna waters in the various districts, but it has indicated that the first stage will irrigate 37·11 lakhs acres of dry and wet crops equivalent to irrigation of wet crops on 22 lakhs acres, in this State, the cost of works being Rs. 84 crores, and that 45 lakhs acres of dry and wet crops, equivalent to irrigation of wet crops on 26 lakhs acres, will be irrigated in the first and second stages put together, the cost of works being Rs. 125 crores for both stages put together. In the third stage an additional 3 to 5 lakhs acres of second crop is expected to be irrigated.

(iii) As regards the full utilisation of Madras's share of the waters of the Godavari, the Committee states that it does not appear to be economically feasible. It has thrown out suggestions for the use of the waters in the Godavari and Kistna deltas, and of the surplus, for irrigation south of Madras City, and adds that further studies and investigations are necessary. In short, the Committee has not dealt with the Godavari as extensively as it has dealt with the Kistna.

(b) The Committee's proposals that in Stage I the first 73 miles of the Kurnool-Cuddappah Canal be remodelled to take a discharge of about 6,000 cusecs at the head, and supply Tungabhadra waters to the Kavali, the Kanupur and the Krishna-Perinar East Canals also, does not seem to be practicable. At the outset, it is fairly clear now that the available supplies in the Tungabhadra will be barely sufficient for the existing schemes of Madras and Hyderabad on the river. The calculations of the Committee do not take into account the latest developments concerning the utilisation of the Tungabhadra waters. The execution of the Tungabhadra High Level Canal Scheme in the near future may mean that no portion of the water will be available for use in the Kurnool-Cuddappah Canal.

(c) The Committee, while conceding that areas liable to frequent famine and distress should be given first priority, has provided for irrigation of the Guntur areas not liable to distress so frequently as the Ceded Districts, but has stated that Krishna water cannot be found for the Gandikota reservoir for irrigation of lands in the notoriously backward Cuddappah district. By itself, the Gandikota Project can irrigate only 50,000 acres in the Cuddappah district, but if Krishna water is supplied, it can irrigate 1,50,000 acres. The Gandikota scheme is one of the vital projects in the scheme of protecting the area from the frequent ravages of famine.

(d) The Committee itself admits that the storage dam proposed by it at Pulichintala would be founded on jointed shales and slates which would require careful geological examination and probably extensive foundation treatment would be necessary. It is doubtful whether this proposal would be economic.:

(e) Another important defect in the Committee's proposals is that it omits the provision for a reservoir on the Pennar. The average flow of this river is 102 t.m.c. ft., but the dependable flow is very low, as the flows vary between very wide limits, from 10 t.m.c. ft. in one year to about 250 t.m.c. ft. in another. Besides, discharges in big floods last for only a few days, and these cannot be put to use unless there is a reservoir at the gorge in the Eastern Ghats, through which the river forces its way to the plains

(f) The Nandikonda dam and the Krishna Right Canal also have difficult or objectionable features. The chief of these are (1) the useful capacity of the reservoir is relatively very small compared to its total capacity, (2) the quantity of masonry is nearly

5 times that of the other alternatives, (3) the canal head is 245 ft. above the bed level of the river and takes off with a tunnel 2 to 3 miles long at its head, (4) the canal is very large canal in rocky country with bare rock or only a crust of about 6" of earth in many places, (5) the length of the canal on contour is about 350 miles but it has been assumed that it can be shortened to 224 miles, (6) the duties assumed for the Canal appear to be too high and canal capacities may need increase, and (7) there are certain proposals to be supplied by one method for sometime and by another later on.

The Committee also admits that the cost of the Lower Krishna Left Canal under the Nandikonda Scheme "is somewhat high on account of difficult country involving construction of tunnels and other expensive works. Details have not been scrutinised". Again in estimating the cost of branch canals under the Lower Krishna Right Canal at Rs. 40 per acre, it has stated "The rate is slightly lower than that adopted in the Krishna-Pennar Project, but it is justified because a large proportion of the irrigation will be dry and the channel dimensions will be comparatively smaller a detailed survey will have to be done before a correct estimate can be prepared".

(g) Again, in criticising the Krishna-Pennar Project, the Committee has stated "unreasonable to take Krishna water for the benefit of areas across the Pennar, which are already served by a large number of tanks and do not normally suffer much distress". Yet, in recommending the irrigation of practically the same or similar areas across the Pennar with water to be dropped into the same Pennar by a canal proposed by it, the Committee says "there is a large number of small and large tanks in the area commanded by the lower half of the canal (Lower Krishna Right Canal) and these will have a favourable influence on the rapid development of irrigation. The total ayacut of the tanks is about 2 lakhs acres but the supply is at present precarious. Conditions will be stabilised when assured supplies pass down into the tanks."

(h) The Committee also proposes to link the Krishna and the Pennar but by a long route *via* Guntur etc. The link proposed under the Krishna-Pennar Project is the shortest.

(i) The estimate for the Pulichintala Dam put by the Committee at Rs. 7.50 crores does not seem to be acceptable. The cost was estimated in 1910 at Rs. 8.34 crores and at present

rates it is more likely to be Rs. 25 crores. Even if a dam of a different design is to be built, the cost is likely to be much more than Rs. 7.50 crores.

(j) It is not clear why the Nandikonda Project, which has yet to be investigated in detail on the Madras side, should be taken up in the first stage, relegating the Siddeswaram Dam on the Krishna, a project investigated in detail and adopted by the Committee itself, to the second stage.

(k) The Committee's proposals contemplate the irrigation of dry crops on large extents of land, the equivalent irrigation of wet crops being less than under the Krishna-Pennar Project. The crying need is for rice and not millets.

(l) The Committee considers that Godavari waters could be diverted to the Krishna, or Krishna areas taken over by the Godavari for supply, in which case areas *south* of Madras could be provided with water. It has added that further investigation will be necessary in this regard. It is not clear why the Committee has not dealt with the possibility of supplying the Guntur area with Godavari water in putting forward an integrated scheme.

5. INTEGRATED PLAN FOR UTILISATION OF KRISHNA AND GODAVARI WATERS—SEVERAL POSSIBILITIES.

Actually, it should be possible to evolve any number of integrated schemes for the utilisation of the waters of the Krishna and Godavari for the irrigation of lands in Kurnool, Cuddappah, Chittoor, Guntur, Nellore and Krishna districts. One possible scheme for the Krishna is described below :—

(1) WITHOUT A PENNAR RESERVOIR

This will consist of :—

- (a) The Siddeswaram Reservoir,
- (b) The Mittakondala Cut,
- (c) The Krishna Pennar East Canal,
- (d) The Krishna Pennar West Canal,
- (e) The Kaveli Canal,
- (f) The Kanupur Canal,
- (g) The Barrage on-Pennar.
- (h) The Madras Canal.

and cost Rs. 51 crores in all and will irrigate 10 lakhs acres for first crop and 2 lakhs acres for second crop.

(2) WITH A PENNAR RESERVOIR

Same as (1) above but with the addition of the reservoir at Someswaram.

This will cost Rs. 71 crores and will irrigate 10 lakhs acres for first crop and 5.5 lakhs acres for second crop.

(3) AN INTEGRATION OF THE ABOVE TWO PLANS WITH A NANDIKONDA RESERVOIR.

This plan may have : (i) a Pulichintala dam and a canal from it to irrigate the Pulichintala Ayacut as in the Committee's plan (subject to the investigation of the comparative costs of supplying the area from Nandikonda and Pulichintala) ;

(ii) A Pennar North Canal as in the Krishna-Pennar Project (subject again to investigation of comparative costs of supplying the area by this method and by the Committee's method) ;

(iii) a Nandikonda Right Side Canal to serve areas not commanded by the Pulichintala Canal and the Pennar North Canal, but without accommodation for supplies required for the Madras Canal and

(iv) the other works as in (1) and (2) above.

Under these proposals, the Nandikonda dam need be of just that height as is required for the Hyderabad scheme, and so far as the South Canal from Nandikonda is concerned, it (the Nandikonda dam) will act only as a diversion dam, the storage required for the canal being held at Siddeswaram. The Siddeswaram reservoir will then have to be of the original size provided for in the Krishna-Pennar Project, and it might be desirable to make the Mittikondala cutting big enough to carry 32,000 cusecs even at the first stage. All parts of this last plan except those relating to Nandikonda have been fully investigated as a part of the Krishna-Pennar Project and are ready for execution. The cost of this plan would be Rs. 75.79 crores plus X plus Y plus Z, where X is the Madras share of the cost of Nandikonda Dam, - Y that of the Nandikonda Right Canal and Z Nandikonda fuller development. Separate figures for Y and Z have to be worked

out because the scheme will have to be worked out in two stages, Y falling in Stage I and Z in Stage II. There will also be a Stage III. The detail of the stages will be as follows :—

	Cost in crores of Rs.
STAGE I	
Siddeswaram Reservoir as per original	19.06
Krishna-Pennar Project Plan	19.06
Mittikondala cut and improvements to Krishna-Pennar Project link for 32,000 cusecs	11—10
Krishna-Pennar East Canal	5.17
Kavali Canal	2.52
Kanupur Canal	1.81
Pick-up Barrage	1.13
Madras Canal	12.00
Nandikonda Scheme as per Hyderabad Plan	X crores
Nandikonda Right Side Canal to be investigated and estimated for as per Committee's proposals but without allowance for supply to Madras and to be executed in Stage I as in the Committee's proposals	Y crores
TOTAL	52.79 plus X plus Y crores
STAGE II—	
Krishna-Pennar West Canal	4.28
Nandikonda fuller development	Z crores
Pennar Dam for fuller Development	19.72 crores
	76.79 crores plus X plus Y plus Z crores.

STAGE III

Godavari-cum-Krishna development, consisting of a Dam at a place to be decided, on the Godavari.

A diversion dam at Ramapadasagar. Canal to the left.

Canal to the right emptying at as high a point on the Krishna as possible.

Pulichintala Plan as envisaged by the Committee.

Pennar South Canal for any water that may be available for development.

6. CONCLUSION

(a) The question of how the available Krishna waters might be utilised is predominantly one for technical men, who alone can judge the feasibility and cost of any scheme or schemes in this connection.

As regards policy, the Government of Madras are of opinion, subject to the above (a), that any scheme for utilising the available Krishna waters should be framed so as to involve minimum cost and be within the financial means available, and should be one which will give the maximum extent of addition to irrigation and food production. The Madras Government are, further of the opinion that first priority should be given to providing additional irrigation facilities to commandable drought areas, and in particular to the districts of Kurnool, Cuddappah and Chittoor, and those parts of Guntur and Nellore districts which suffer from drought along with Rayalaseema.

If, as a result of schemes on the Godavari and the linking up of the Godavari and the Krishna, extra water becomes available, the question of supply for irrigation in the best interests of the country as a whole, by extending the canals, might be taken up in the light of the then prevailing conditions.

(b) It is the opinion of the Madras Government's engineers that if any plan for the utilisation of Madras's share of the Krishna waters is to be taken up in the near future, the best course would be to construct the Siddeswaram Dam, or a modified version of it, and attendant canals, etc. in the first stage, and simultaneously investigate the Nandikonda and Pulichintala schemes. This technical opinion might be examined in the light of the statement of the Madras Government's policy in (a) above.

(c) The Planning Commission has included a project on the Krishna in the Five Year Plan, without mentioning anything about what expenditure is proposed during the period. It is not also clear whether the cost is to be met from Central loans entirely or from Central loans in part, the rest being found by the States concerned. The amount which this State Government could borrow is necessarily limited, and it has not enough resources even to meet the cost of important sanctioned schemes under execution. The plan for the utilisation of Madras's share of the Krishna waters would be a major one, about the biggest ever for Madras, costing well over Rs. 120 crores, whatever might be the constituent schemes.

APPENDICES

APPENDIX H I

COMMENTS OF THE GOVERNMENT OF HYDERABAD

(Extracts from a letter from the Chief Minister of Hyderabad dated the 21st November, 1952.)

It is to be pointed out that the Government of Hyderabad do not agree with the view expressed in the Press Note, dated 1st November 1952, that the Report is an interim one sent by the Khosla Committee. As a matter of fact, it is a final report so far as the main recommendations of the Committee are concerned. The further investigation and survey suggested by them is intended to work out details of the schemes they have recommended. It is also felt that the Report of the Committee need not have been kept strictly confidential.

This Government does not also agree with the statement in the Press Note that the Khosla Committee had not answered the terms of reference owing to insufficient material at their disposal. In fact, this Government feel that the Khosla Committee have fully investigated the various schemes that were submitted by the Madras and Hyderabad Governments, and expressed their definite opinion on the merits and demerits of each one of them. They have made an exhaustive analysis of all of them and given their conclusions in an unmistakable language. A perusal of Chapter V of the Report which deals with the Committee's proposals and the grounds on which they base them, show that they have dealt with all aspects of the issues referred to them in detail and made their definite recommendations. There is nothing in the Report to show that there was lack of material or insufficient material before the Committee nor is there anything to indicate that their Report should be considered as an interim Report subject to modification after further surveys and investigations. On the other hand, it will be seen that on page 85 of the Report under the heading "Committee's proposals" they made specific recommendations suggesting that their proposals should be carried out in three stages so far as Krishna Valley projects are concerned. On page 87 of the Report, the Committee have given definite answers to the terms of reference stating the questions and the answers seriatim.

On these grounds and others based on an exhaustive examination of the Report, the Government of Hyderabad regret to say that they do not agree with the statements made in the letter and the Press note referred to above. They consider that it is necessary in the interests of all concerned, that the Planning Commission should clarify these points after a fuller consideration of the Report in the light of the above observations.

The Hyderabad Government take the view that further surveys and investigations should be carried out strictly in accordance with the recommendations made by the Khosla Committee and should be restricted to purposes for which the Technical Committee have suggested these surveys and investigations. A perusal of para. 9 of the letter addressed to the Secretary, Planning Commission, by the Khosla Committee printed at the commencement of the Report, will clearly show that the surveys and investigations contemplated by the Khosla Committee, are those that are indicated in para. 8 of their letter. Para. 8 deals with the possibility of diverting Godavary water into the Krishna with a view to release the unused balances becoming available for Madras. A reference to this subject has been made in para. 9 and it has been suggested that immediate steps should be taken to implement the first stage of the Committee's plan and the necessary surveys and investigations mentioned in para. 8. It has also been mentioned that these investigations should be carried out under the guidance and control of the Technical Committee. In para. 7, they have also indicated that the figures mentioned by them were based on rough estimates and may have to be suitably altered as a result of detailed investigations and survey which must be carried out. So far as the further survey and investigation on the lines suggested by the Commission is concerned, this Government has no objection for their being carried out, and are sending their officers as required for the Conference to be held on the 8th of December, 1952.

It will then be seen that the Hyderabad Government are in general agreement with the best and most economical method of utilisation of Krishna waters suggested by the Khosla Committee and they take the view that it is only the details that have to be worked out in the light of the recommendations made. This Government is anxious that the best and most economical and extensive use of Krishna waters should be made without depriving the Krishna valley of its due share of waters both for irrigation and power. They are also anxious that the scheme should be such as to make it possible to release unused

waters of Krishna for utilization in Madras. Both these objects should be achieved in a manner that there is no undue disadvantage or damage to any part of the country whether in Hyderabad State or in Madras State. From this point of view, the Hyderabad Government desire that some better alternative than Siddeswaram dam should be found to satisfy the requirements of Madras because they feel that the construction of a dam at Siddeswaram would result in the submergence of a large number of villages and considerable area of land under cultivation. The Hyderabad Government desire that the alternative suggestions offered by the officers of this Government may be examined by the Technical Committee under whose directions the further surveys and investigations are going to be conducted before that part of the scheme is finally approved.

APPENDIX II

MINUTES OF A CONFERENCE HELD IN THE PLANNING COMMISSION ON MONDAY, THE 8TH DECEMBER, 1952, TO CONSIDER RECOMMENDATIONS OF THE TECHNICAL (KHOSLA) COMMITTEE ON THE UTILISATION OF THE KRISHNA AND THE GODAVARI WATERS.

PRESENT :

PLANNING COMMISSION

Shri G. L. Nanda . . .	Deputy Chairman.
Shri V. T. Krishnamachari .	Member.
Shrimati G. Durgabai . .	Member.
Shri A. Zaman . . .	Deputy Secretary.
Shri P. C. Suri . . .	Private Secretary to the Deputy Chairman.
Shri S. Rammohan . . .	Technical Officer (Power).
Shri C. S. Parthasarathy .	Technical Officer (Irrigation).

TECHNICAL (KHOSLA) COMMITTEE

Shri G. R. Garg . . .	Member.
Shri Moti Ram . . .	Member.

GOVERNMENT OF MADRAS

Shri T. M. S. Mani . . .	Secretary, Public Works Department.
Shri N. Padmanabha Ayyar .	Chief Engineer.

GOVERNMENT OF HYDERABAD

Shri Zahir Ahmed . . .	Development Commissioner.
Shri P. Papiiah . . .	Chief Engineer.
Shri M. Jaffar Ali . . .	Superintending Engineer.

The Planning Commission appointed a Technical Committee under the chairmanship of Shri A. N. Khosla to formulate an integrated programme for the most economic utilisation

of the share of the Madras State of the waters of the Kistna and the Godavari and to suggest a specific project or projects which would fit into the programme and satisfy the tests laid down by the Planning Commission in paragraph 10 of chapter 7 of the Draft Outline for inclusion in the Five Year Plan.

2. The Technical Committee have drawn up an integrated programme but have suggested that further investigations should be made before their proposals are finalised. Investigations will also have to be made before recommending particular schemes for inclusion in the Five Year Plan. Both sets of investigations can be carried out together.

3. The conference accordingly decided on the following programme of investigations:—

(i) Remodelling of the Kurnool-Cuddapah canal including, if necessary, remodelling of Sunkesula ancicut for this purpose. The Madras Government will complete the necessary investigations within a period of four months.

(ii) *The Nandikonda dam—*

(a) The Government of Hyderabad will furnish existing data in full to the Madras Government and to the Planning Commission immediately. It is understood that these estimates have been brought up-to-date.

(b) Detailed investigations on the canal system on the Madras side will be made by the Madras Government within a period of ten months.

(c) Investigations made by the Hyderabad Government on the canal from the Nandikonda dam on the Hyderabad side will be brought up-to-date within a period of three months.

(iii) *The Pennar dam—*

The Madras Government may renew the proposals and, after further investigation, place them before the Planning Commission within a period of three months.

(iv) *The Pulichintala dam—*

The Madras Government will carry out further investigations and bring the estimates up-to-date. They will also examine the question whether a dam or a barrage should be provided. The entire investigation should be completed within a period of nine months.

- (v) The Madras and the Hyderabad Governments will submit a joint note in regard to the cost of the Nandikonda dam upto +475 for the purpose of a second crop irrigation in the Krishna delta.

4. The results of the investigations decided on above should be communicated to the Planning Commission as and when they become available within the periods agreed to. The investigations should include the preparation of fairly accurate estimates of costs.

5. The investigations referred to in paragraph 3 above will be carried out under the general guidance of the Technical Committee, *viz.*, the Khosla Committee. The Technical Committee will continue to function until in consultation with the Governments of Madras and Hyderabad an integrated plan has been finally drawn up and specific recommendation has been made for the inclusion of a project or projects in the Five Year Plan.

6. Members of the Technical Committee, who were present at the conference, made it clear that they had no time to study the memoranda submitted by the Governments of Madras and Hyderabad on the report of the Committee.

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