

CENTRAL BOARD OF IRRIGATION



**NEW PROJECTS
FOR
IRRIGATION AND
POWER IN INDIA**

1948

SECOND EDITION

FOREWORD TO THE FIRST EDITION

This leaflet introduces to the reader the names of projects which are, at present, under construction or under investigation in India, for the utilization of the Water Wealth of the Nation. Very brief descriptions are also given.

It will be appreciated that during the investigation of projects important changes sometime become necessary in the details. As such the information furnished herein is liable to alter but it will give the reader a general picture of what is being done in the country.

N. D. GULHATI,
Secretary.

KENNEDY HOUSE,
SIMLA.

1st January, 1947

FOREWORD TO THE SECOND EDITION

The first edition of this leaflet was published early in January, 1947. It was got out hurriedly and was based on the information available in the Board's office. Since then some new projects have been conceived ; also modifications have been made, as a result of further investigations, in some of the schemes already projected. This revised edition contains a brief and up-to-date description of all major projects, for the provision of irrigation facilities and the production of cheap power, under investigation or under construction, in India, together with a note on the progress made so far. It is hoped that the information given will be of interest to the public, who, no doubt, appreciate that a speedy execution of the projects described herein, must be given the highest priority in the development plans of the country.

N. D. GULHATI,
Secretary.

KENNEDY HOUSE,
SIMLA.
1st April, 1948

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INDIA'S POTENTIAL RESOURCES

India is fortunate in her immense water resources and in her widespread waterways. A number of irrigation projects, some of them the most magnificent in the world, have been constructed during the last one hundred years in both Northern India and the South. A brief record of the achievements of irrigation engineers in India will be found in leaflet No. 1 of these Series. India leads the world in irrigation but, inspite of this, due to a high rate of increase in her population, food production has of recent years fallen below requirements. There is thus urgent need for the extension of irrigation facilities to new areas to step up production of food for the people. On a rough calculation it has been estimated that out of the total quantity of water available in the rivers of the country and the subsoils, only six per cent. has so far been utilised ; the rest runs to waste and in its progress to the sea does incalculable damage to life and property through uncontrolled floods. Large areas in various parts of the country are lying as culturable waste while existing cultivation in many areas produces but poor crops, for want of irrigation facilities. There is thus immense scope for the utilisation of the unused water resources of the country for the benefit of her people.

Cheap power is another vital need of the moment. Although India made a start as early as 1897 for the development of hydro-electric power but the total installed capacity has not so far passed the half million kilowatt mark. During the last quarter of a century, while other countries were rapidly developing their water power resources, such progress was denied to India. On a rough estimation, the total water power potential in India must be near 40 million kilowatts. Possibilities of development are immense and the future has a great promise in store for the people of India.

PROJECTS OF HIGH PRIORITY

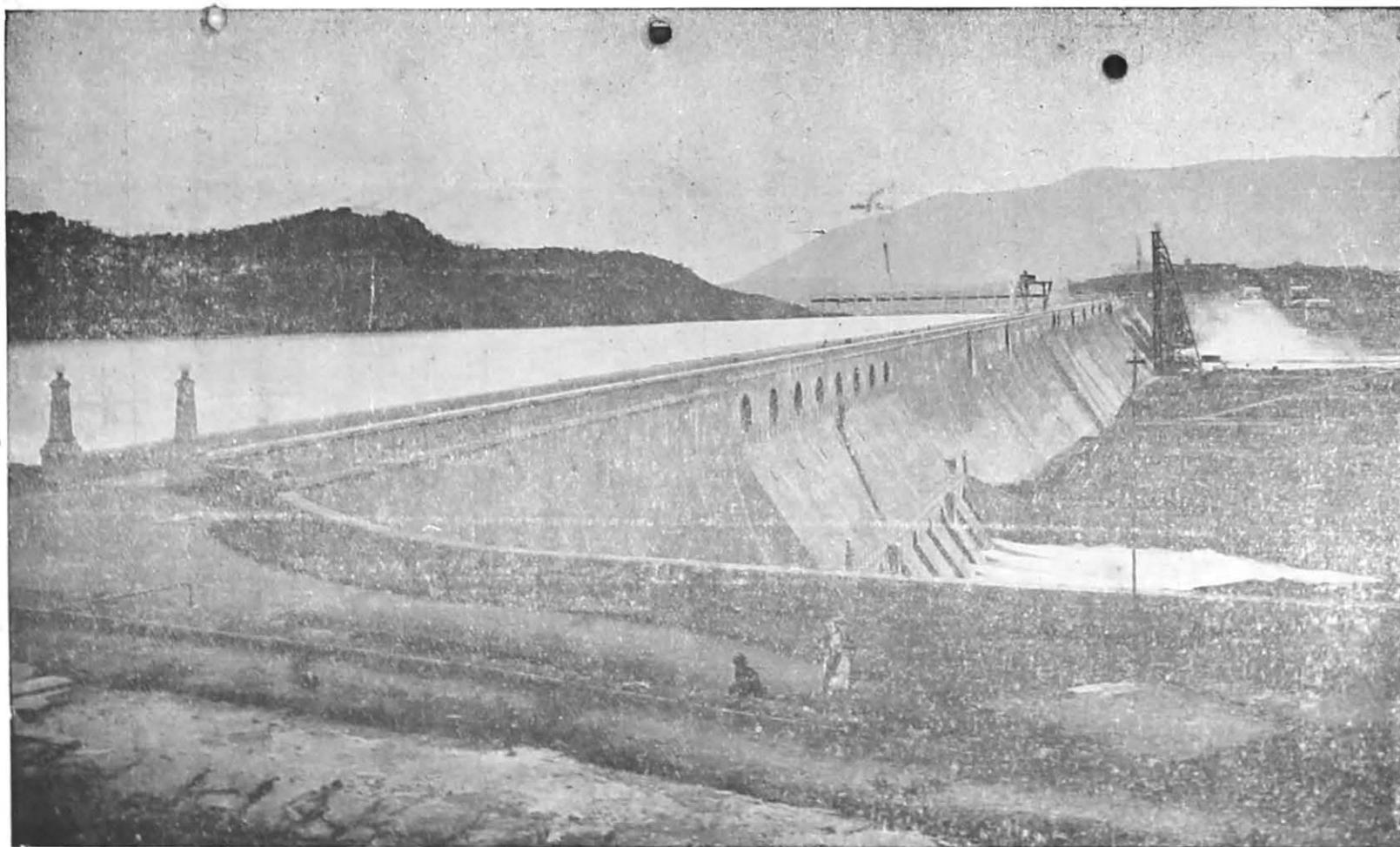
Of all schemes of development, there is no doubt, that projects relating to the development of irrigation and the generation of cheap hydro-electric power are going to play the most important part in raising the production per-capita and thus the standard of living of the millions of the country. These projects must, therefore, receive the best attention of the Government and the people and their execution should be given the highest priority.

THE NATURE OF NEW PROJECTS

The nature of irrigation projects that have been constructed in the past, whether canals, tanks or wells is familiar to all, but the nature of new projects is changing. Many of them are being designed on an extended and ambitious plan. As little water is left unused from the perennial flow in streams, more and more schemes are being based on storage of water available during the rainy season. Multi-purpose plans are being prepared to provide for irrigation, for hydro-electric power, for flood control, navigation, recreation facilities and fish culture.

Large river works provide excellent sites for recreation facilities. The picture opposite of the Mettur Dam in Madras which provides a lake, thirtythree miles long and upto four and a half mile broad, reveals an excellent site where one could go for a week end. The Krishnarajasagar Dam in Mysore is actually visited by a large number of people every day. Many such dams are under contemplation and will be built during the years to come. These sites will provide new "Places of pilgrimage" and it is hoped that recreation facilities will be provided there for the benefit of the people.

For convenience, the projects described herein have been arranged by provinces and states.



The Stanley Dam across the Cauvery at Mettur in Madras.
The reservoir formed by the dam is 60 square miles in extent.
There will be many such "Places of pilgrimage" in India in the near future.

ASSAM

Assam possesses large potentials of hydro-power. It has roughly been estimated that it should be possible to generate upto four million kilowatts of continuous power in the province by developing eleven sites on different rivers. All the projects would involve storage by construction of high dams involving a total reservoir capacity, during monsoon, of 68 million acre feet*. Most of these projects can be designed as multipurpose schemes for power generation, perennial irrigation, extension and improvement of navigation and flood control.

A large number of minor schemes are also under investigation. These will irrigate about 300,000 acres.

BARODA STATE

The Zankhari Project visualises a storage reservoir of 120,000 acre feet capacity by the construction of a masonry dam 3,500 feet long, across the combined Zankhari and Gira valleys. The project will irrigate an area of 9,000 acres and the falls on the canal will be utilised for generating 2,300 kW. of electric energy. The scheme is expected to cost rupees one *crore*.

The Sabarmati Irrigation Project comprises a masonry dam across the Sabarmati, with a useful capacity of 230,000 acre feet. The supplies from the reservoir will be let down the river and picked up by a weir 25 miles below. The reservoir will provide irrigation to 45,000 acres, will generate about 6,000 kW. and will cost about rupees two *crores*.

BHOPAL STATE

The Kolar Nadi Hydro-electric-cum-Irrigation Project has, as its main feature, a storage reservoir, capacity of about 390,000 acre feet, across the Kolar *Nadi*, a tributary of the Narbada. The water stored during rains will be utilised, at first, for development of electric power, 16,500 kW., through a power channel 16 miles long and dropping the water back into the *Nadi*. The tail water will be picked up lower down and utilised for irrigation of 96,000 acres. The total cost of the scheme is rupees four *crores* and it is expected to be completed in four years.

*See at the end

BIHAR

The most important scheme in Bihar is the Kosi Project under investigation with the Central Waterpower, Irrigation and Navigation Commission. It will be a multi-purpose project for irrigation, power, navigation, flood control, silt control, soil conservation, drainage, reclamation of water-logged areas, malaria control, fish culture and recreation facilities. The project will comprise a dam about 750 feet high across the Chatra Gorge in Nepal just above the sacred temple of Baraha Kshetra to store about 11 million acre feet of water ; power plant at the dam site capable of generating upto 1·8 million kW. of cheap power at 50 per cent. load factor ; a barrage in Nepal across the Kosi to control and stabilise the river channel, and to divert its supplies into two canals, one on either bank, for irrigating about a million acres in Nepal Territory ; and a second barrage near the Nepal Bihar border with two canals on the left and one on the right bank, for irrigating over two million acres in Bihar. The project is roughly estimated to cost rupees 90 *crores*. After the preliminary investigations which are in progress, have been completed, the execution of the whole project may take about ten years.

The Gandak Valley Project envisages the construction of a weir across the river Gandak just as it emerges out of Nepal hills at Tribeni below the regulating intake of the existing Tribeni canal and taking off another canal from the right bank of the river. The scheme is likely to bring about 600,000 acres of land under irrigation and is estimated to cost rupees two to three *crores*. Surveys are in progress.

The Sakri Canal Project consists of a datum wall across the river Sakri just below the railway bridge at Powrah, Gaya District and a head regulator for a canal from the right bank which will augment supply in the tanks. The scheme will roughly cost about rupees 17 *lakhs* and, when completed, will irrigate about 50,000 acres. Work on the canal has been started and the construction of head works will be started soon. The scheme is expected to take about two years to complete.

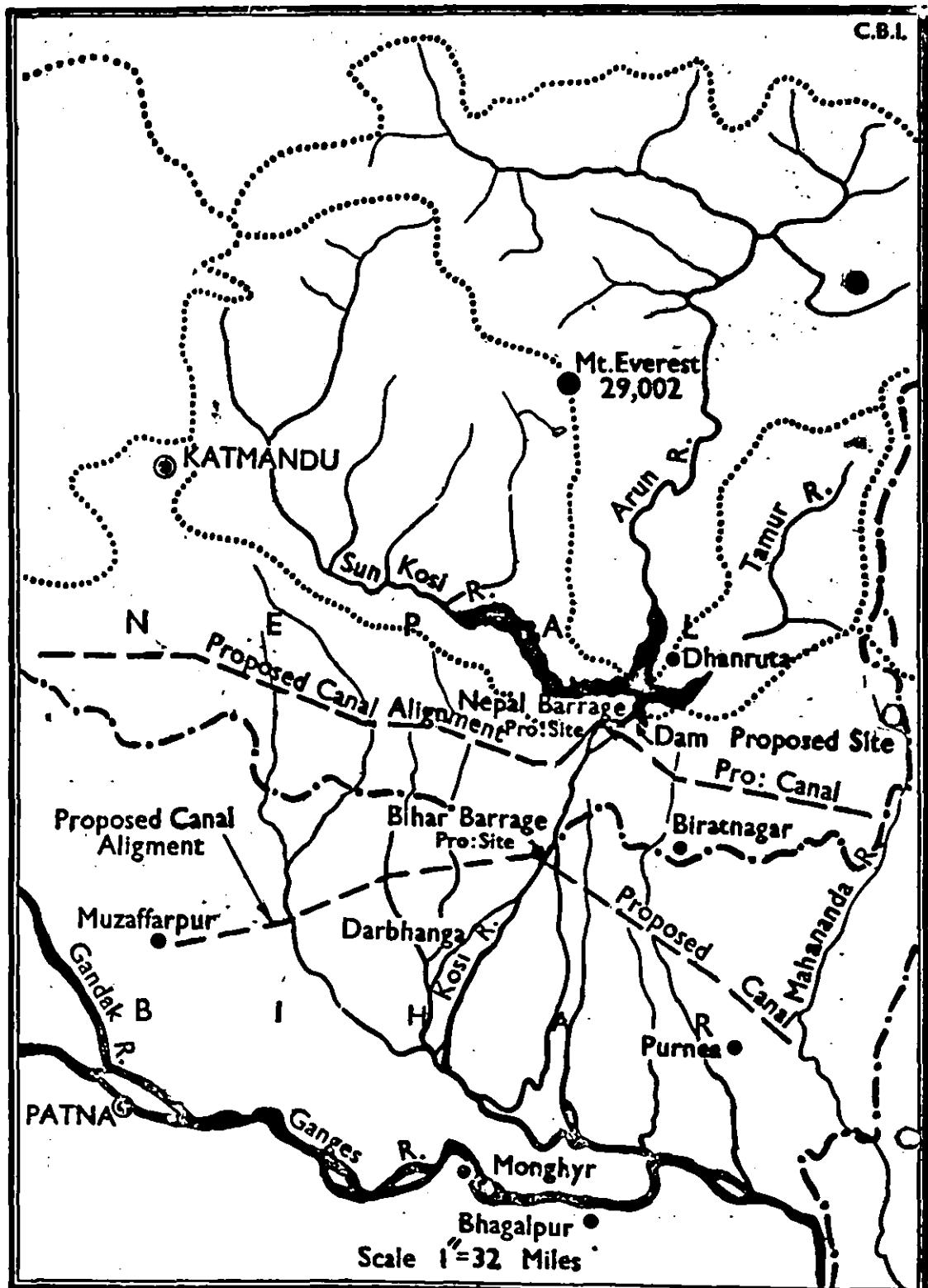
In addition, several minor irrigation and drainage schemes have been projected, chiefly in North Bihar.

BOMBAY

The Meshwa Canal Project comprises a pick-up-weir at Raska and a canal on the right bank of the Meshwa river in Kaira District. It will irrigate about 10,000 acres of monsoon crops. The work is estimated to cost rupees 18 *lakhs*.

The Mahi Canal Project comprises a storage of 244,000 acre feet capacity at Kel on the Panam river (tributary of the Mahi) and a

C.B.I.



Index Map of Kosi Project

canal 68 miles long from the pick-up-weir at Wanakbhor. It is expected to irrigate 120,000 acres in Kaira District. The cost of the project is estimated at rupees three *crores*.

The Wardala Tank Project comprises a tank with a capacity of 5,382 acre feet in the Kaira District. It is expected to irrigate 4,500 acres. The cost of the work is estimated at rupees 11 *lakhs*.

The Gangapur Dam Project comprises a storage of 126,500 acre feet on the Godavari at Gangapur, District Nasik. It will irrigate an additional area of 40,000 acres on the existing Godavari Canals. The work is estimated to cost rupees 2.2 *crores*.

The Girna Project comprises a storage of 483,000 acre feet on the Girna at Panjham in the Nasik District. It will irrigate 110,500 acres in Khandesh Districts. The work is estimated to cost rupees four *crores*.

The Asoga Reservoir Scheme comprises a storage of 460,000 acre feet on the Malaprabha river at Bhutewadi, Belgaum District. The scheme will irrigate 74,200 acres in Belgaum District. It is estimated to cost rupees 4.7 *crores*.

The Daddi Project comprises a storage of 1,037,000 acre feet on the Ghataprabha river, Belgaum District, a right bank canal from the reservoir, 120 miles long and a left bank canal 78 miles long from the Dhupdal Weir. It is expected to irrigate an area of 400,000 acres. The estimated cost is likely to be rupees 20 *crores*.

The Koyna Hydro-electric Scheme envisages the construction of a dam about 300 feet high across the Koyna river a few miles north of Helwak to store about 2.5 million acre feet for power and irrigation. The scheme, when fully developed, is capable of meeting a demand of the order of 250,000 kW. (continuous) after reserving part of the storage for irrigation. When finally developed, this would be one of the biggest power stations in the country. Preliminary surveys for the scheme are in progress.

The Kalinadi Hydro-electric Project contemplates harnessing the waters of the river Kali for the development of power. Investigations connected with this project were started in January, 1947. It is expected that 350,000 kW. continuous is available in the Kalinadi basin distributed in five power stations. The districts likely to be served from this source of power are Dharwar, Kanara, Belgaum and Bijapur.

CENTRAL PROVINCES AND BERAR

Three tanks are at present under construction—one in Balaghat and two in Chhindwara District—designed to irrigate 20,000 acres of rice.

It has further been decided to undertake the construction of 11 other projects at an estimated cost of rupees 3·78 *crores*. These works, when completed, will irrigate over 200,000 acres of rice. The most important work is the Arha Reservoir, which alone will irrigate 160,000 acres.

COCHIN STATE

The Peechi Reservoir Scheme comprises the construction of a dam 106 feet high, across the river Manali at Peechi about 15 miles from Trichur. Canals will take off both flanks and will irrigate about 26,000 acres. The estimated cost of the scheme is rupees 150 *lakhs* and it is expected that, when completed, will increase production of paddy by about 15,000 tons per annum. This scheme includes the advantages of Thannikudam and Pillathodu schemes, previously contemplated, thus rendering them unnecessary.

The Chalakudy River Diversion Work contemplates the construction of a low masonry weir across the Chalakudy river, to irrigate an area of about 23,131 acres, at a cost of rupees 60 *lakhs*.

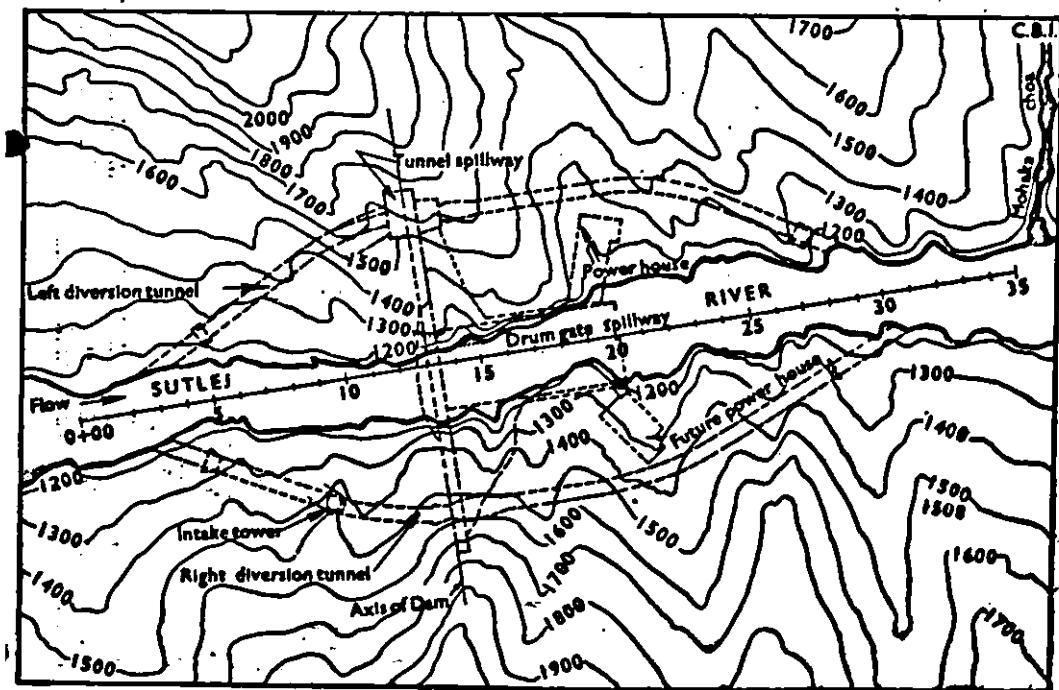
The Cheerakuzhe Scheme comprises the construction of a diversion weir across Cheerakuzhe river at Kuzheepilly-kara. The area irrigated will be over 7,000 acres. The estimated cost of the scheme will be rupees 16 *lakhs*, and will take about two years for completion from the date of commencement.

Hydro-electric Development.—Four sites exist for the development of hydro-electric power on the Chalakudy river within a length of six miles. The development falls into five progressive stages and, when completed, will provide, 100,000 kW. of continuous power or 200,000 kW. at 50 per cent. load factor. The first stage now under construction consists of the construction of a dam across the river above the Poringalkuthu falls; the storage capacity of the reservoir being 28,700 acre feet. The total cost of all the stages is estimated to be rupees 20 *crores*. The development of these schemes will also enable about 6,000 acres waste land to be brought under paddy cultivation.

EAST PUNJAB

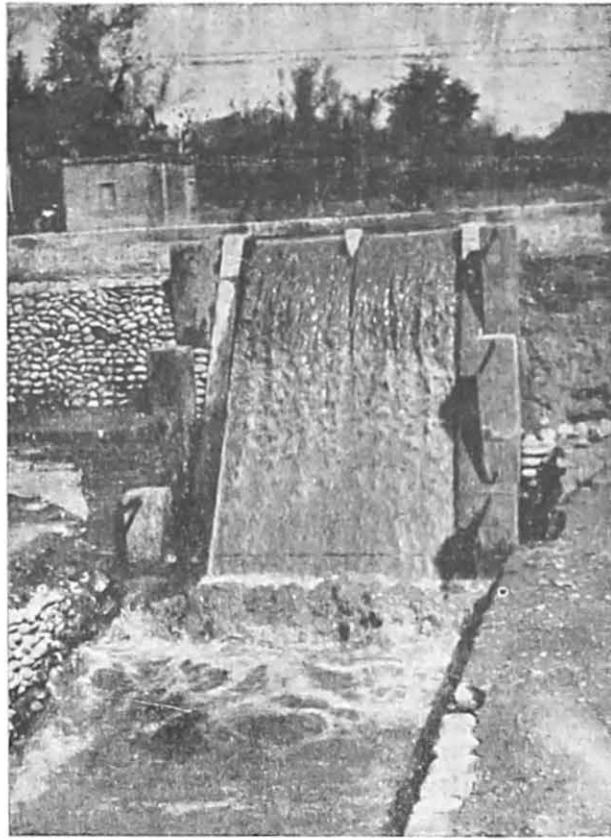
The Bhakra Dam Project comprises a dam, 480 feet high, across a gorge in the river Sutlej at Bhakra ; the reservoir so formed will have a useful capacity of 3·5 million acre feet, sufficient to give a mean discharge of 6,600 cubic feet per second* for a period of 270 days—the dry part of the year. The irrigation system will consist of 200 miles of lined canals and a net-work of distributaries and will command an area of about 4·5 million acres. The scheme which is expected to cost rupees 70 *crores* will also generate 160,000 kW.

The work on the Bhakra Dam construction has commenced in right earnest. Funds to defray the cost of this project have been allotted by the Central Government and steps are being taken to obtain the requisite plant and machinery. Work on the railway line and pilot headings of the diversion tunnels is in progress.



A general layout at the Bhakra Dam site

* See as the end.



Experiments in progress to evolve the best design for the destruction of energy of waters that will fall over the Bhakra Dam.
The picture on the left shows "The Shooting Bucket" and that on the right "The Deep Bucket". The model represents a discharge of 115,000 cusecs on the original.

The Nangal Power Project comprises a weir across the Sutlej at Nangal eight miles downstream of the site of the proposed Bhakra Dam, above which a lined canal of 10,000 cusecs capacity will be taken off for two power houses situated at 12 and 18 miles downstream of the weir. Each power house will be operated by a fall of about 98 feet and will have an installed capacity of 48,000 kW. in the pre-Bhakra stage. The installation at each power house will be augmented by 24,000 kW. in the post-Bhakra stage. The firm power available will be 80,000 kW. and 140,000 kW. in the pre-Bhakra and post-Bhakra stages respectively. The pre-Bhakra stage of the project including transmission and distribution is estimated to cost rupees 22 *crores*.

GWALIOR

The only scheme which is under contemplation is the construction of a dam on the Sindh River, with a storage capacity of about one million acre feet. It is also anticipated that 16,000 kW. will be generated at the dam site.

HYDERABAD

Four schemes are at present under construction or about to be started. The most important of these is The Tungabhadra Project which is being taken up jointly with Madras and on which construction work is now well in hand. From this, about 600,000 acres will be irrigated and about 139,000 kW. of energy provided in Hyderabad State. The other three schemes are minor in nature and will irrigate about 28,000 acres in all.

Seven major schemes are under investigation, estimated to irrigate nearly three million acres and to generate over 500,000 kW. In addition there are thirty two minor projects which will, among them, irrigate about 550,000 acres.

JAIPUR STATE

The Morel Irrigation Project comprises the construction of an earthen dam 53 feet high, across the river Morel about four miles upstream of Lalsote-Sawai Madhopur Road. The capacity of the reservoir, to be regulated for a period of every ten years, is 1,950 million cubic feet and the supplies released from it will irrigate about 22,000 acres per year in the first seven years and about 12,000 acres in the last three years of the period. The project is estimated to cost about rupees 20 *lakhs* and will yield an average percentage return of 4.2 per annum for the first ten years.

In addition, there are a number of short term and other minor schemes costing over rupees four *crores*, under construction or investigation. When completed, these will irrigate about 303,000 acres.

JODHPUR STATE

The Jawai River Irrigation and Hydro-electric Project comprises a reservoir with a capacity of 0·17 million acre feet on the river Jawai, one mile east of Erinpura Road Railway Station on the B.B. and C.I. Railway. The project will command an area of 110,000 acres. In addition, there will be a hydro-electric station of 1,570 kW., maximum output, at the canal head and one of 2,530 kW., maximum output, at the canal tail where a drop of some 92 feet occurs. The estimated cost of the scheme is rupees 1·67 *crores*. Work was commenced in February, 1946 and the construction of the main dam, a masonry gravity structure, is well advanced. It is hoped that water will be available for irrigation to some of the lands commanded, by the end of 1948.

MADRAS

The Ramapadasagar Project, is, by far, the most important multi-purpose scheme projected in Madras. The reservoir on the Godavari will be one of the biggest in the world. A dam 428 feet high with the lowest foundation level 190 feet below the river bed and one and a half mile long, will be built to store 15·6 million acre feet of water. Three canals which will take off the reservoir, one on the left and two on the right, will provide irrigation facilities to an undeveloped area of 2·35 million acres (all paddy) and will improve the existing supply to another 2·1 million acres of land. The project will develop 100,000 kW. of firm electric power and about 20,000 kW. of secondary power and provide, in addition, navigation facilities in the Godavari all through the year. The project is estimated to cost rupees 86 *crores* and will take about 12 years for completion. The project, when completed, will provide one million tons of rice per year, which according to the present price means an annual food production of rupees 24 *crores*.

The Tungabhadra Project, work on which is being taken up jointly by Madras and Hyderabad, has as its main feature a concrete dam, 8,200 feet long and 160 feet high across the Tungabhadra, a major tributary of the Kistna. The dam will impound 2·6 million acre feet of water which will be drawn in equal quantity by Madras and Hyderabad. The total area to be irrigated in Madras will be 300,000 acres of which 36,000 acres will be under wet garden crop. In addition, Madras will also generate a small quantity of hydro-electric power. The cost of the project to Madras will be rupees ten *crores*.

The Kistna Power Project will utilise the surplus flow in the Kistna river by the formation of two reservoirs, one on the Kistna river at Siddeswaram, Kurnool District and the other on the Pennar

river at Someswaram, Nellore District. The stored waters in the reservoir on the Kistna and surpluses in the river, will be diverted to the reservoir on the Pennar for irrigating about three million acres, through Bhavanasi river in the Kistna Valley, a canal in deep cutting through the ridge separating Kistna and Pennar Valleys, and then along the existing streams from the ridge cutting the Pennar. Of the canals to be constructed, the most important will take off from the reservoir on the Pennar and will be about 300 miles long. The scheme is expected to cost rupees 78 *crores*.

It is also proposed to build a reservoir at Gondikota across the Pennar, to irrigate 100,000 acres dry crop on both sides of the river. The scheme will cost rupees 30 *crores*. There are also possibilities of developing hydro-electric power.

The Lower Bhawani Project comprises a reservoir on the river Bhawani, a tributary of the Cauvery, and will irrigate an area of 200,000 acres. The project will cost rupees four *crores*.

The Malampuzha Project comprises the construction of a dam across the river Malampuzha about two miles north of Kadukkakunnam in Palghat Taluk to store about 100,000 acre feet of water in the first stage increasing to about 185,000 acre-feet later on. Irrigation facilities will be provided to the existing *ayacuts** on the right side and a new canal will take off on the left which will cross the two rivers Koravar and Kannade by means of aqueducts and finally empty into the Gayatri river. By the completion of the first stage, about 38,000 acres will be cultivated with a second crop and 13,455 acres with a third crop besides 2,000 acres of perennial crop. The probable cost of the project will be about rupees 3·8 *crores*.

The Perur Project (Upper Pennar) envisages the construction of a dam across the river Pennar near Perur village in Dharmavaram Taluk, Anantpur District in two stages. The capacity of the reservoir after the second stage will be about 46,000 acre feet and irrigation water will be supplied to about 8,000 acres. The cost of the scheme is likely to be rupees 75 *lakhs*.

The Pykara Plant Extension, Third Stage was sanctioned in 1946 in order to meet the increasing power demand in the Pykara areas and also the seasonal as well as emergency deficiencies of the Mettur and Papanasam Hydro-electric Systems. The extension comprises a dam across the Pykara river to provide a storage of 45,800 acre feet, installation of 212,000 kW generating sets and extension of 110 KV lines. The scheme is estimated to cost rupees two *crores* initially and rupees 3·6 *crores* at the end of the tenth year.

*Irrigable area.

The Moyar Hydro-electric Scheme forms one of the post-war schemes of the Madras Electricity Department and was sanctioned in December 1945 at an estimated cost of rupees 193·1 *lakhs* initially rising to rupees 268 *lakhs* in five years. The scheme is designed to utilise the tail water of Pykara Power House in the Nilgiris District over a 1,200 feet drop in the Moyar valley about 10 miles north east of the present Pykara Power House. The installation will comprise three numbers 12,000 kW. turbogenerator sets with the necessary civil and hydraulic works. The generating station will be connected to Pykara by a double circuit 110 kV. line and to Mettur at Erode by a similar 110 kV double circuit line 72 miles long. The generation at Moyar is to serve the increasing demand for power in the Pykara and Mettur Systems.

MYSORE

Mysore has launched a number of projects in her post-war development scheme, the most important being the **Jog Power Project**, now renamed as **Mahatma Gandhi Hydro-electric Works**. The most magnificent Gassapa Falls on the river Sharavathi



A view of the Gassapa Falls; the photograph was taken from the Mysore end, in the month of February, 1947, with low river.

have been harnessed in the service of the people without impairing their natural beauty. The main works in the project are (i) a masonry dam 104 feet high located about 1·5 miles upstream of the falls, (ii) a storage reservoir designed for an ultimate capacity of 600,000 acre feet (iii) an *anicut* to divert the water

let from the storage into the power channel, (iv) the power channel, (v) the forebay for controlling the water into, (vi) penstocks and (vii) the generating station at the bottom of the gorge. The installed capacity of the power house will be 120,000 kW. and the whole scheme is estimated to cost Rs. 5.70 crores. The first unit capable of generating 12,000 kW. was switched on by his Highness the Maharaja of Mysore on February 21, 1948. The potential resources of Sharavati admit of the construction of an additional station with an installed capacity of 120,000 kW.

The Bhadra Reservoir Scheme comprises the construction of a dam 185 feet high above river-bed across the Bhadra at Lakkavally to impound about 1.55 million acre feet of water to irrigate 180,000 acres. It is also proposed to utilise the supplies drawn for irrigation first for power generation before letting them into irrigation channels. The power thus generated will be 12,680 kW. continuous. The estimated cost of the scheme is rupees 8.88 crores.

The Kabini Scheme comprises a storage reservoir with a capacity of 300,000 acre feet to irrigate 20,000 acres and is estimated to cost Rs. 1.3 crores.

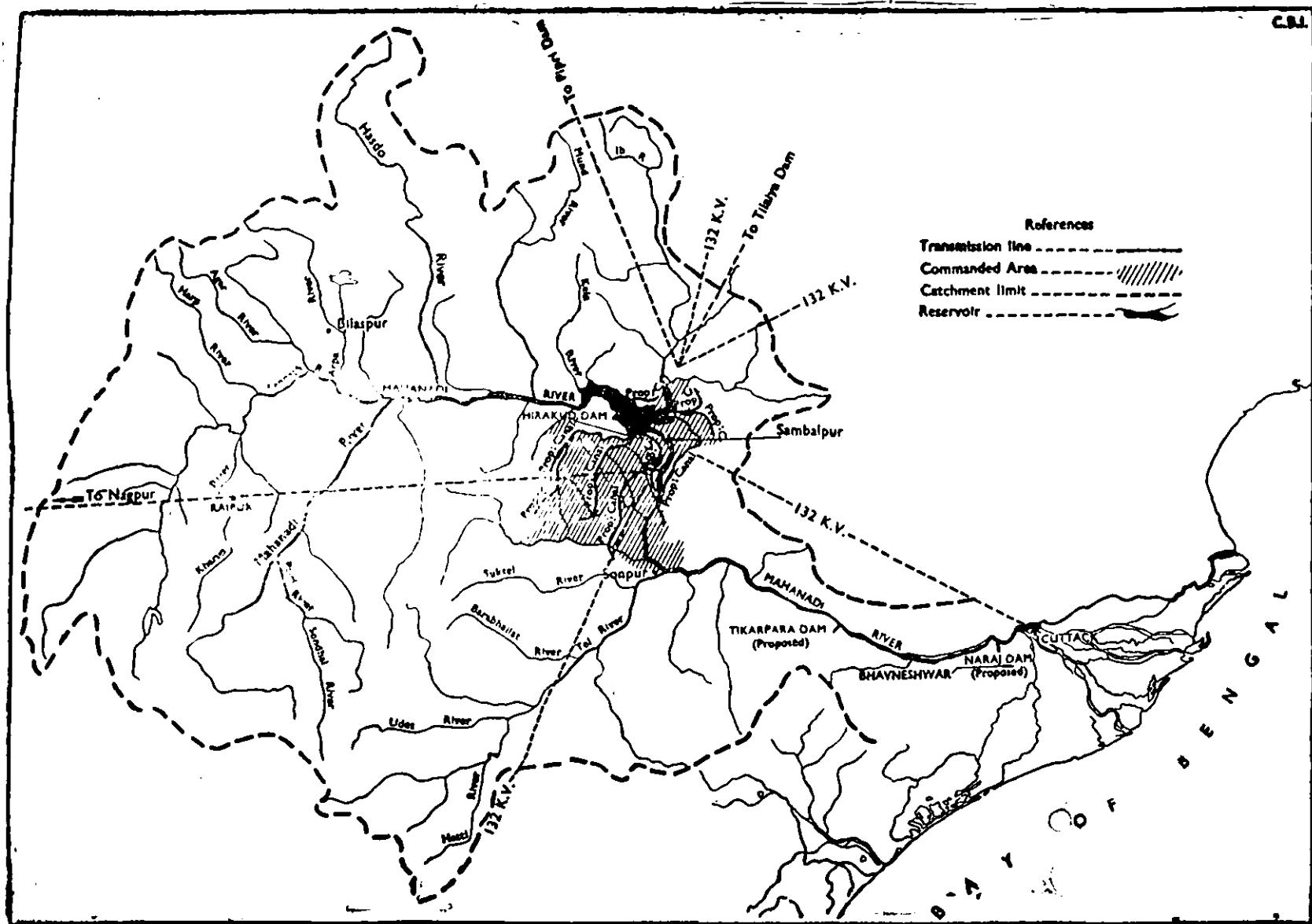
There are several other minor schemes under contemplation in the State, such as Hemavathi Reservoir Scheme, Rugu Reservoir Scheme and Makadet Scheme etc. The State has also launched a ten-year programme costing rupees two crores for the restoration of small derelict village tanks.

ORISSA

The Unified Development of Mahanadi Valley as designed by the Central Waterpower, Irrigation and Navigation Commission comprises three units namely the Hirakud Dam Project, the Tikarpara Dam Project and the Naraj Dam Project, each with its own canal system and hydro-electric power installations. The three units are capable of independent development, and also of forming an integrated part of the basin wide plan. It has been decided to make a start with the Hirakud Dam Project.

The Hirakud Dam Project comprises the construction of a dam, maximum height 150 feet and gross storage capacity of the reservoir 5.3 million acre feet—across the Mahanadi about nine miles upstream of the town of Sambalpur, gravity and lift canals on either side and two hydro-electric installations. The project will provide irrigation to 1,094,953 acres of land, generate 350,000 kW. and will also provide navigation facilities. The whole scheme is estimated to cost rupees 47.81 crores and will earn an annual return of 4.29 per cent. on the sum-at-charge. When completed, the project will bring about an annual increase of 340,000 tons in the food production of Sambalpur.

Index Map of Hirakud Dam Project.



- district and Sonepur State and a very substantial increase in that of the delta. The preliminary work in connection with the construction of the dam is in progress.

To utilise the flow of the Machkund River at Duduma Falls for hydro-electric generation, a joint scheme of the Madras and Orissa Governments was sanctioned in April 1946. The scheme is capable of an ultimate development of 100,000 kW. The first stage will consist of three penstocks and three generating units, power upto 34,500 kW. becoming available by 1950. The second stage will comprise the construction of the Jalapat Dam, the third stage the fourth penstock and generating unit and the fourth and final stage will consist of the fifth and sixth penstocks and generating units. The estimated cost of the scheme is rupees six *crores* rising to rupees 8·4 *crores* in ten years and is to be shared by the Madras and the Orissa Governments in the ratio of 70 : 30. Work on local roads, camps, anti-malarial works, acquisition of tool and plants and arrangements for construction of power supply etc. are in progress.

Minor schemes include small dams and diversion weirs on streams and the improvement of existing irrigation tanks. Fiftyone such schemes estimated to cost rupees 70 *lakhs* are in hand.

PATIALA STATE

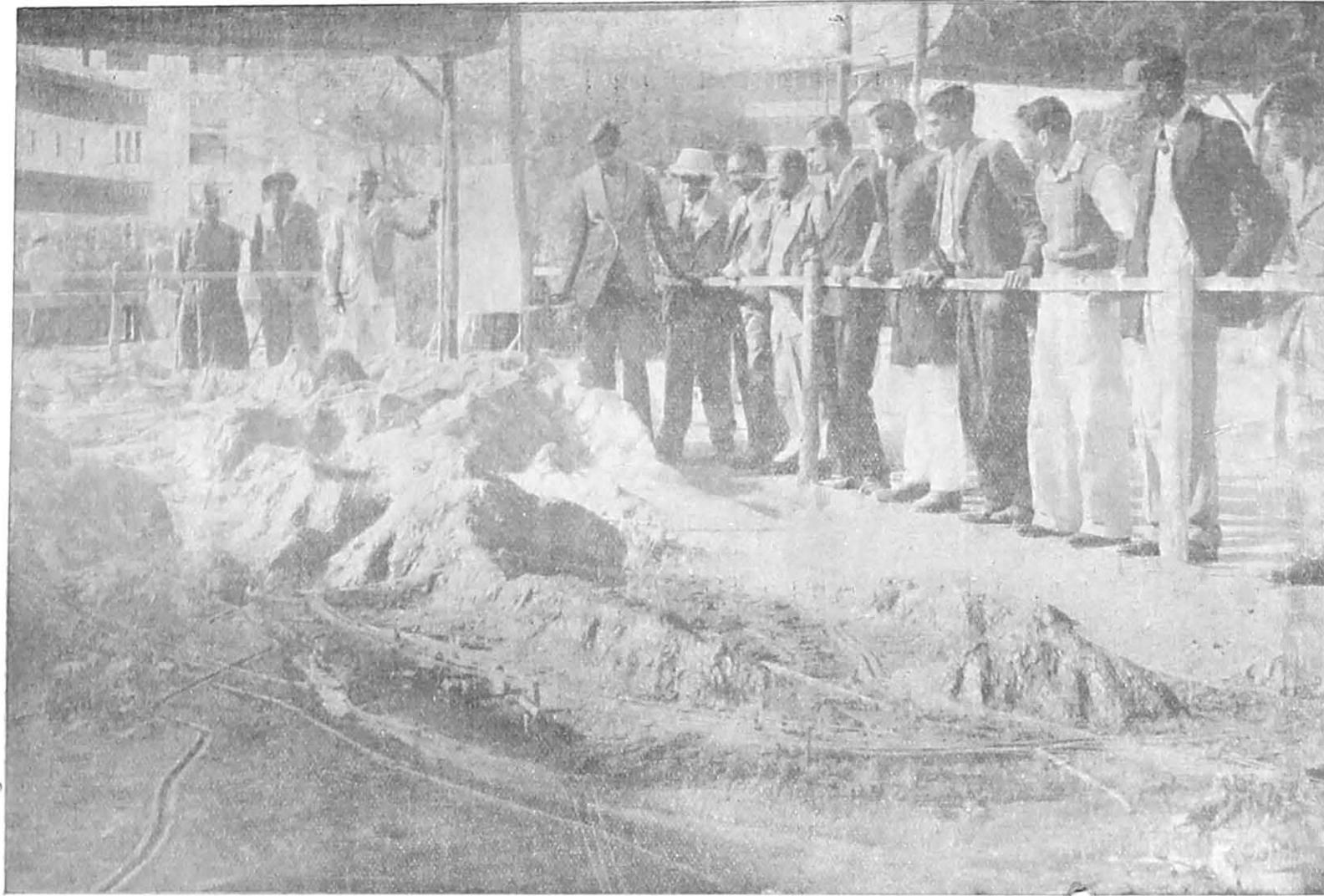
The Patiala Government have recently sanctioned a hydro-electric project which will generate about 16,000 kW. of firm power at a load factor of 70 per cent. The project comprises the construction of a dam near Simla on the Ashni Nadi about four miles from Kandaghat capable of impounding 163,000 acre-feet of water. The estimate cost of the project is rupees five *crores* and it will take four years to complete. Preliminary investigations are in progress.

RAJPUTANA STATES

The Chambal Hydro-electric Scheme (Holkar State), which is the first of a series of reservoirs in the contemplated multi-purpose regional development of the Chambal Valley, comprises the construction of a dam about 200 feet high across the river Chambal near Chaurasigarh about 30 miles on the North West of the Shree Chhatrapur Railway Station on the B.B. and C.I. Railway. The reservoir will have a storage capacity of 6·89 million acres. Power produced will be 28,000 kW. continuous. Irrigation to the extent of about 100,000 acres is also possible from the reservoir by tunnelling through a ridge. The estimated cost of the scheme is rupees seven *crores*.

Two pick-up weirs proposed downstream are one each in Mewar and Kotah State territories. It is expected that power stations to be constructed at these weirs will generate 68,000 kW. and 56 000 kW. of power respectively at 50 per cent. load factor.

The total cost of the whole scheme is estimated at rupees 22·5 *crores*.



A large model of the Mahanadi at the Exhibition of Irrigation Engineering and Research organised by the Board at Delhi in November 1946.

UNITED PROVINCES

The Sarda Hydro-electric Project is one of the major schemes in hand at present. It is proposed to combine into a single drop a large number of existing falls on the Sarda Canal and to install a power house at Kathima about nine miles from Banbassa, the head-works of the Sarda Canal. The power house will generate 41,400 kW. of electrical power for domestic, agricultural and industrial purposes in the districts of Naini Tal, Almora, Bareilly, Pilibhit, Shahjahanpur, Lakhimpur, Kheri, Sitapur, Hardoi, Lucknow, Bara Banki, Unnao and Rai Bareli in the United Provinces. The cost of the scheme is rupees 2·89 *crores*. Transmission lines will cost another four *crores* of rupees. Work is in progress and the foundation pit is being excavated.

The Mohammadpur Power House on the Ganga Canal has been completed, except for the installation of the turbines etc. The installed capacity will be 9,300 kW. and the firm capacity about 6,000 kW.

The Lalitpur Reservoir will impound 78,030 acre feet by an earthen dam 40 feet high in the Shazad *Nadi* in the Jhansi District. The water stored will be utilised for extending irrigation on the Betwa Canal system in Jalaun District. The estimated cost of the scheme is rupees 27·3 *lakhs*. The work is expected to be completed by June 1949.

To provide additional storage for Gagar and Garai Systems **The Nagwa Dam** on the Karamnasa, about three miles above Sylhet, is under construction. The estimated cost of the scheme is rupees 32·4 *lakhs*. The work on the Nagwa Dam was started during October 1947 and it is expected to be completed by the end of 1949. Forty per cent. of earthwork on afflux *bund* and the dam has been completed and other works are in progress.

The Sapra Dam Project provides for the construction of an earthen dam 55 feet high on the Sapra river to impound 64,300 acre feet. This will provide water for 72 miles of new canals in the Lakheri Dhasan Doab and eight miles of extensions in the Siaor System both in Jhansi District. The estimated cost of the work is rupees 41 *lakhs*. The work will start in April 1948 and is expected to be completed by 1950-51.

The Piprai Dam Project aims at supplying water for irrigation in the Lalitpur Tehsil of Jhansi District and augmenting supplies in the Betwa Canal for the irrigation of new areas in Jalaun District. An earthen dam 97 feet high will be constructed on the Naraini River which forms the boundary of the Central Provinces and the United Provinces. The estimated cost of the scheme is rupees 1·86 *crores*. Negotiations with the Central Provinces are in progress in

regard to the construction of this dam and work is expected to be started in 1948-49. The scheme will take three years to complete.

New Channels on the Sarda Canal System, 1,062 miles in length, are proposed to be constructed for extending irrigation facilities to the areas, which were hitherto without any means of irrigation, in the Districts of Hardoi, Unnao, Lucknow, Rai Bareli, Pratapgarh, Sultanpur and Allahabad. The estimated cost of the scheme is rupees $1\cdot 51$ *crores*. Preliminary work has just been undertaken and the scheme is expected to be completed by 1951-52.

The Pipri Dam and Power Station Project is the most important scheme contemplated in the province. It comprises the construction of a masonry dam 280 feet high to impound 8.87 million acre feet across the river Rihand near the village Pipri in the Mirzapur District. The dam will cost rupees $16\cdot 25$ *crores*, subsidiary dam at Obra another rupees $3\cdot 0$ *crores*, and transmission lines rupees 10 *crores*, making a total of rupees 29 *crores*. The power house will have an installed capacity of 230,000 kW. It will also bring about four million acres under irrigation. Flood control, fish culture, navigation and recreation facilities will be additional advantages. The authorization to start work on the project has recently been given by the Government. Completion of preliminaries, such as establishment of cement factory, construction of roads etc., will take at least two years. Building of the dam and power house will take another four years, making a total of six years in all, from the date of commencement.

The Yamuna Hydro-electric Project is another major scheme for power development. It will utilise for power generation a total drop of approximately 750 feet available in the rivers Tons and Yamuna. The development of power will be in two stages. In the first stage 40,000 kW. and in the second stage 49,600 kW. will be available throughout the year. In addition, 47,200 kW. power in the first stage and 72,800 kW. power in the second stage will be available for another six months from May to October. The total estimated cost of the scheme including transmission lines is rupees 21 *crores*.

The Betwa Power Project will be developed in two stages and is the first power project to be started in the Bundelkhand region. The first stage will consist of a storage dam at Piprai on the Naraini river, a tributary of the Betwa, and a power station at Dhukwan, where the additional water which the storage dam at Piprai will make available in the Betwa will give a suitable discharge and enable 2,500 kW. of firm hydro-electric power to be produced. The cost of the power station project at Dhukwan will be rupees $1\cdot 31$ *crores* and the electrical energy will be supplied to the towns of Lalitpur, Jhansi, Hamirpur, Orai, Kalpi, Mahroni, Chirgaon, Orchha, Moth and Datia.

Work will be started in 1948-49 and is expected to be completed in 1950-51. The second stage comprises the construction of Singhpura Dam for the power development of 45,000 kW. The total cost of the scheme is rupees 4·7 *crores* and the anticipated return is 5·8 per cent. The scheme will take three years for completion.

The Nayar Dam Project will involve the construction of a dam 600 feet high to store 1·4 million acre feet of water on the river Nayar; a tributary of the Ganga. Hydro-electric plants proposed to be set up will have an installed capacity of 200,000 kW. at Marora Dham and 32,000 kW. at Byasghat. The water released from the lake will be utilised to irrigate an area of 238,000 acres and will also improve the irrigation of 1,068,000 acres at present irrigated by the Upper Ganga Canal System. It is estimated that approximately 232,000 maunds of additional food grains, 150,000 maunds of sugar and 60,000 maunds of cotton will be produced by the construction of the dam. The scheme is estimated to cost rupees 24 *crores*. Sub-surface explorations are nearing completion and further investigations regarding the suitability of foundations for the dam are in hand.

The Gogra Power Project aims at harnessing the immense potentialities of the river Gogra for power development by short-circuiting the loops in the Karrali river by means of tunnels across the intervening hills and thus making available a net drop of about 1,000 feet for power generation. It is estimated that hydro-electric power of the order of 300,000 kW. will be generated in two stages. The scheme will also benefit Nepal. A sum of rupees 1·04 *lakhs* has been sanctioned for the preliminary ground survey.

The Ramganga Project will impound 2·2 million acre feet in the Ramganga Valley, by a dam 340 feet high across the gorge in the river about two miles upstream of the Kalagarh Forest Rest House in the District Garhwal. It is expected that approximately 800,000 acres will be irrigated and 66,000 kW. hydro-electric power will also be available during the irrigation period. The scheme is expected to cost rupees 14 *crores* and the new irrigation canals and extension of the existing canals will cost another rupees eight *crores*. The preliminary operations for determining the suitability of foundations are in hand.

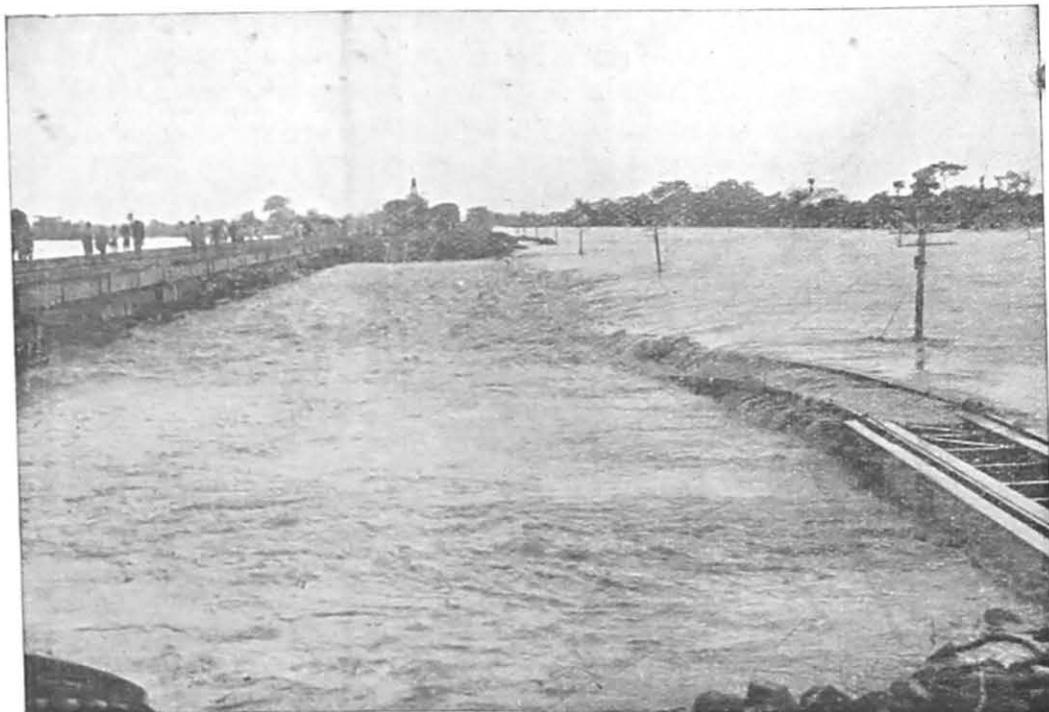
The Kothri Dam Scheme envisages the construction of a dam 250 feet high across the river Kothri, a tributary of Khoh to impound 180,000 acre feet. About two-third of water will be available annually for irrigation and the scheme will generate secondary power to the extent of 5,000 kW. The work will take three years to complete from the date of commencement and will operate in the Garhwal District and adjacent Bhabhar areas.

The Pinder Hydro-electric Scheme will involve the construction of two dams, 200 feet and 500 feet high across the river Pinder, a tributary of the Ganga near Karanprayag which will enable the development of 40,000 kW. of firm power and 50,000 kW. of seasonal power. Preliminary investigations of the scheme are in progress.

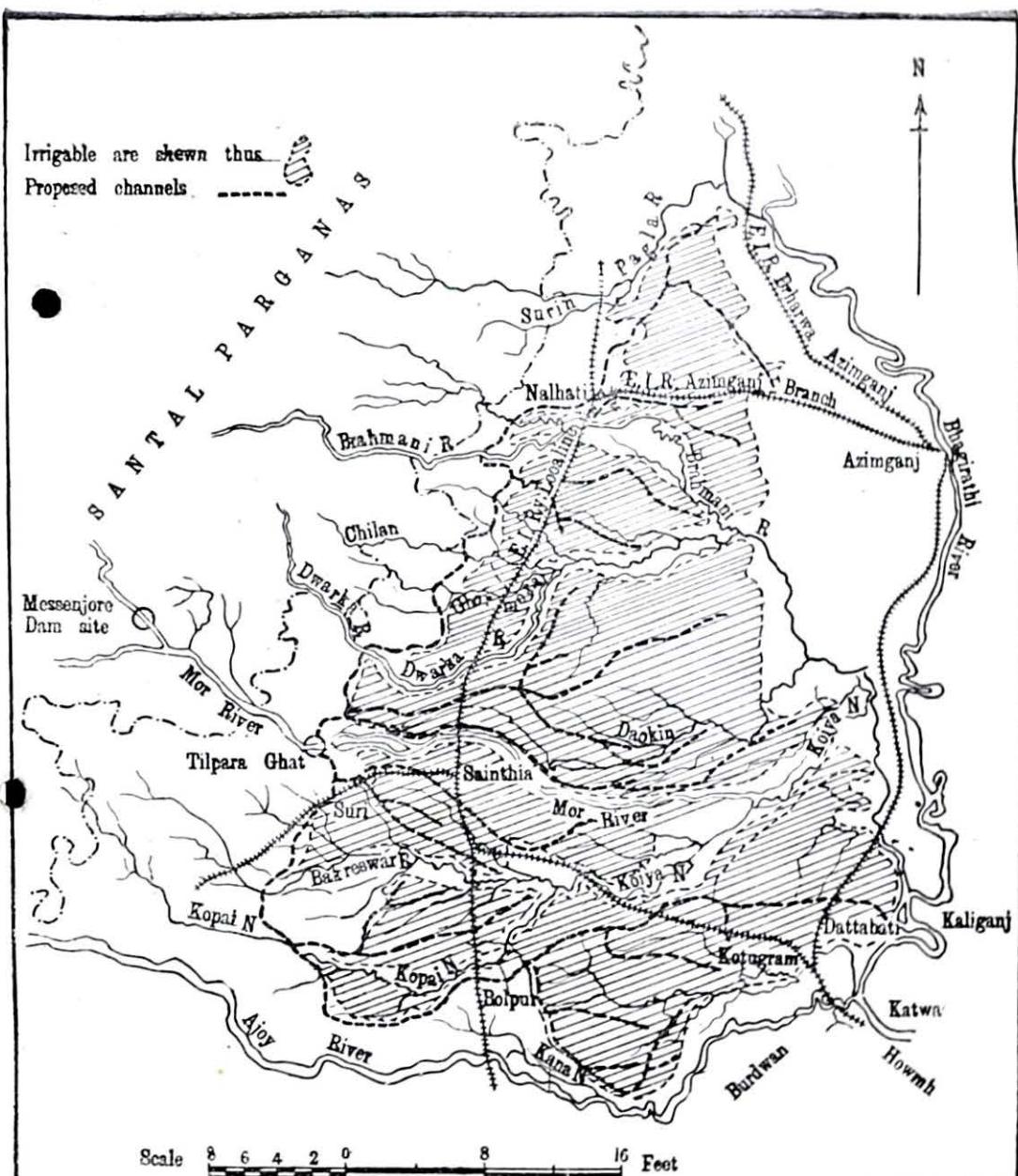
In addition, a number of minor schemes and scheme for installation of a substantial number of tubewells in various part of the province are under construction or under investigation.

WEST BENGAL

The Damodar Valley Project which is the most important scheme in the province will provide perennial irrigation to three quarter of a million acres and generate 300,000 kW. of power. The irrigation to be provided by this project is anticipated to give the cultivators an additional income of rupees six *crores* every year. The project comprises a number of dams. The additional advantage of the scheme will be the reduction in yearly flood damage from the Damodar. The scheme is expected to cost rupees 55 *crores*. The Central Government have recently passed an Act for the formation of a semi-autonomous Damodar Valley Corporation. Construction work on the project will commence immediately.



A view of the Damodar in Spate—Note the havoc caused.



Index map of the Mor Project.

Work has already been started on the Mor Project which comprises the construction of a dam at Messenjore and a barrage with a canal, 3,300 cusecs, on either bank of the river Moorakshy near the town of Suri, headquarters of Birbhum District. The canal will command a total culturable area of nearly 600,000 acres. In addition, there will be a small hydro-electric generating station. The dam will

impound waters which now run to waste ; the reservoir will have a capacity of nearly one million acre feet. The scheme will cost over rupees seven *crores*. The new crops that will be grown will be worth rupees 4·5 *crores* per year.

Jaldhaka Hydro-electric Scheme envisages the harnessing of promising sites on the Jaldhaka river in the District Darjeeling for the development of power. It is estimated that power can be developed upto the tune of 10,000 kW. during dry weather and as much as 17,000 kW. to 33,000 kW. continuous during the monsoon. This will meet all the tea factory loads.

In addition, there are many other minor schemes under construction and investigation.

CONCLUSION

In addition to the principal works that are under construction or under investigation and which have been listed in the preceding paragraphs, there are a large number of small works, the details of which may not interest the readers.

It is, however, useful to remember that the projects that are under construction or investigation, when completed, will add over 27 million acres of irrigation to India's existing 48 millions and will add about 9 million kW. of hydro-electric energy to the existing paltry half million.

COMPREHEND THE TERMS

ONE CUSEC represents a volume of water equivalent to the flow of one cubic foot of water per second. Flowing continuously for 24 hours, it will cover five acres to a depth of about five inches—normally considered as a good watering for irrigation purposes. If used for a town water supply, one cusec can supply 30 gallons per head per day to a population of 18,000 souls.

AN ACRE FOOT denotes a volume of water sufficient to cover an area to a depth of one foot. Two acre-feet of water are equivalent to one cusec flowing for 24 hours. A million acre feet of water is equal to 43,560,000,000 cubic feet and is sufficient to cover an area of ten square miles to a depth of 156 feet. This represents a storage sufficient to feed a canal of 185 cusecs capacity for the flow season in a year (normally 270 days).

Falling through a height of 150 feet, a cusec can generate 10 KILOWATTS or units of electric energy sufficient to drive a 12 h. p. car at a speed of 40 miles per hour on a reasonably good road, and roughly equal to the energy output of a hundred men. One kilowatt or unit of electric energy is sufficient to light 25 average sized electric bulbs or to irrigate 50 acres of land per year by pumping water from a depth of about 20 feet. Not more than one thousand such units are required to drive a passenger train at a speed of 50 miles per hour. Every unit of electricity, generated by hydro, represents a saving of 5 tons of coal per year.